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Report on existing open-source electronic medical records

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INTRODUCTION

One of the responsibilities of the World Health Organisation (WHO) is to contain outbreaks of emerging viral disease, such as Ebola or H1N1 (swine flu). To more quickly tackle outbreaks and perhaps even prevent the spread of disease, the WHO organisation needs ways to gain reliable data about diseases as soon as an outbreak is identified as well as to disseminate guidelines of care based on that data. Information Technology (IT) has been considered a good option to do this, although myriad problems of data standards has slowed the process. Recently experts on emerging viral diseases met as part of the EViDence Project to discuss and stipulate what such an IT system might do. This report, an adjunct to that meeting, considers whether there is an existing open-source Clinical Information Systems (CIS) that meets these requirements.

EViDence project

In October 2009, clinical experts in emerging viral disease from: Oxford's Clinical Research Unit in Vietnam, the Mahidol-Oxford Research Unit in Thailand, the WHO's Emerging and Dangerous Pathogens Alert and Response Operations and from Papworth Hospital met with researchers and IT specialists from University of Cambridge, the non-governmental organisation (NGO), Aptivate and representatives from WHO's technical arm to discuss how a CIS could be used to improve care at the bedside for critically ill patients with emerging viral diseases as well as for data collection purposes suitable for research. The group decided on six characteristics that were essential for such a system:

1) The ability to change the organisation of data on the screen to suit a particular clinic.
2) The ability to embed treatment protocols adapted from local, national and international guidelines.
3) The ability to create reminders
4) The ability to construct, maintain, and utilize a list of available drugs
5) The ability to be quickly customised by the clinical staff
6) The ability to allow clinicians to measure the overall performance of their ICU

It is also important to note that the assumed context is a system appropriate for intensive care medicine and that unlike most such environments in high-resource countries, the ability to integrate with peripheral equipment (e.g. ventilators) is not required. Systems then will first be assessed on their suitability for intensive care medicine and then on whether they were customisable by the clinical staff. If a system meets both of these criteria, it will be scored on the remaining parts of the 6-point clinical vision established at the preliminary meeting of the EViDence group.

Study scope

The review covered twelve open source electronic record systems for healthcare. There are a large variety of such systems in healthcare and we considered all those that store electronic health data for use by an organisation, but not by a person. Systems were found through searching Google, The Global Health Information Network (www.tghin.org) and SourceForge with the following keywords: Clinical Information System, Electronic Patient Record, Electronic Health Record, and Electronic Medical Record. Only systems that were free and of which the code-base was open source were included; these are listed in Table 1.

OpenMRS	http://www.vistasoftware.org/
OpenEMR	http://www.openehr.org/
PatientOS	http://www.patientos.org/
VistA	http://openmrs.org/wiki/OpenMRS
EHMIS	http://www.ehmis.net/
Ultimate EMR	http://www.uemr.com/
GnuMED	http://wiki.gnumed.de/bin/view/Gnumed
OpenEHR	http://www.oemr.org/
OpenClinic	http://openclinic.sourceforge.net/
Medical	http://medical.sourceforge.net/index.html
Care2X	http://care2x.org/
Medscribbler	http://sourceforge.net/projects/medscribbler/

Table 1: Open Source Electronic Medical Records

SYSTEMS

Overview

Half of the open source systems available have been built around the doctor-patient encounters as the episode of interaction, making them best suited to general practice or hospitals that dispense long-term drug regimes for diseases such as HIV. Three other systems focus primarily on hospital logistics of getting information from one place to another, with design efforts less concerned with patient care. Three systems were appropriate to hospital intensive care. Of these, none are currently practitioner-customisable and only one intends to be so in the future. Although none of these systems met the criteria, we have described each one in order to create a record of our research and propose which one might be built upon to meet the EViDence criteria in the future.

The amount of information recorded below depends on how much was available; however, we made an effort to relay: the impetus of the project, its general properties, and its technical infrastructure. We have also included images of the user interface to help the medical audience gain a feel for a system without necessarily understanding its technical capabilities.

Hospital systems

VistA

VistA is a mature health information system developed by the US Department of Veterans Affairs. It is in place across all Veterans hospitals and clinics and has been shown to decrease costs significantly. As it was developed with government funding it is in the public domain and there are no licensing fees. Recently, this system has also been made free of charge for use in developing countries and related systems, such as the MUMPS language/database have been replicated with open-source versions. The system however, is difficult to install and configure and there are many providers in the US who sell their services to do this. There is also an open-source version, WorldVistA ,which has the development goal of being able to install in 1 hour. Details can be found here: (http://www.vistasoftware.org/resources.htm)

VistA is a very versatile system and can be configured to fit any type of healthcare organization, from clinics and medical practices to nursing homes and large hospitals. Its components include, a graphical user interface referred to as the computerized patient record system, computerised order entry, bar coded medication administration, electronic prescribing and clinical guidelines. It is also

possible to configure some versions to be web-based. It's interface can be seen in Figure 1. Documentation can be found here: (http://www4.va.gov/vdl/)

VistA is appropriate for intensive care and there have been numerous suggestions to use it. However, in addition to it not being customisable and complicated to install, it's architecture and user interface are old. We do not recommend using it.

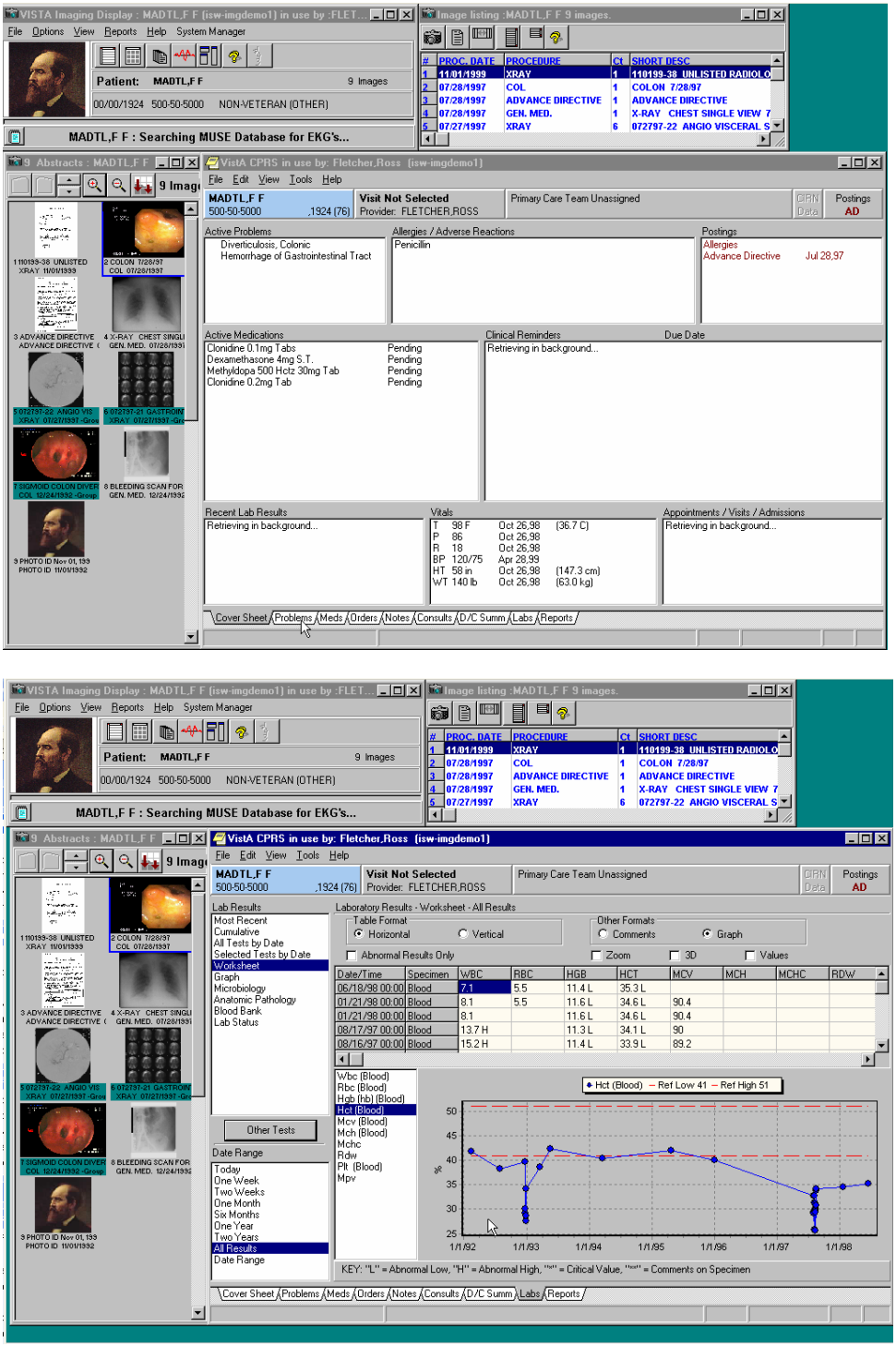

Figure 1: VistA:cover sheet and lab results page

OpenEHR

OpenEHR is an international non-for-profit foundation created by University College London (UCL) and Ocean Informatics Australia. It has focused on the back-end design of an electronic health record. An overview of the system design can be seen in Figure 2.

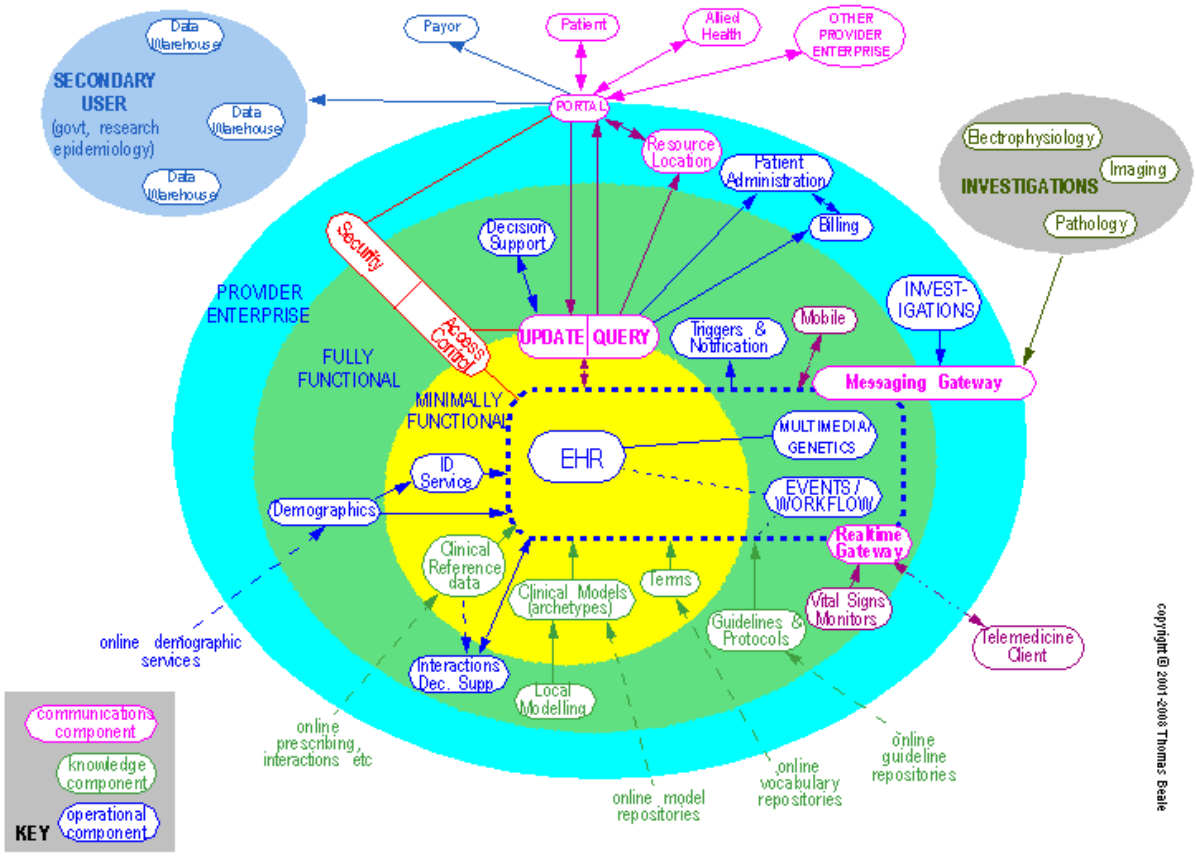

Figure 2: OpenEHR service design overview

The model is based on archetypes which are formal models of a domain concept, such as blood pressure. Archetypes can be taken from a general repository and customised or built from scratch. They can also be associated with different terms, making the platform easy to customise or to translate, without losing consistency across sites. There is a model for developing and vetting archetypes so that quality is maintained. It is worth noting that the National Health Service in England as developed over a 1000 archetypes.

Archetypes can be developed in the Archetype Description Language, a text based language similar to html, or can be generated with an Archetype editor which allows one to associate certain types of data and descriptions with an archetype (http://www.openehr.org/download/software.html). The editor is based on creating trees and logic associations and with some training could be used by anyone.

Practical development of openEHR, as opposed to the design work and research done at UCL, is being carried out by a small group of 15 programmers working on this project in their spare time. They have a long list of ideas that they would like to implement, but the work progresses slowly because of the small size of the team. They have however, made a Java API that developers can use to experiment with openEHR. They do not recommend using it for development purposes as it has

not been thoroughly tested. There is also a re-usable, open database available at (http://www.openehr.org/knowledge/).

This is a well researched system that could be applicable to intensive care and has the possibility of meeting all of the requirements, but a front-end would need to be built. PatientOS is an example of a front-end build of the openEHR system and is also open-source.

PatientOS

PatientOS is an industry-driven open-source system that gains revenue from service contracts of installing and customising this system. It appears to be a front-end implementation of openEHR. Currently forms and reports are customisable, meeting points 2, 3, and 5 of the EViDence clinical vision. The user interface is not yet customisable, but the website states that it will be in future. Reminders and drug lists are not mentioned, but should be conceivably customisable given the design of the system and its described goal 'to allow all words that the user sees to be customisable.' Its latest interface is shown in Figure 3 and does not show much graphing ability as of yet. Nonetheless, it is likely that this system will meet all of the requirements specified by the EViDence group, but when it will be finished is as yet, unpublished.

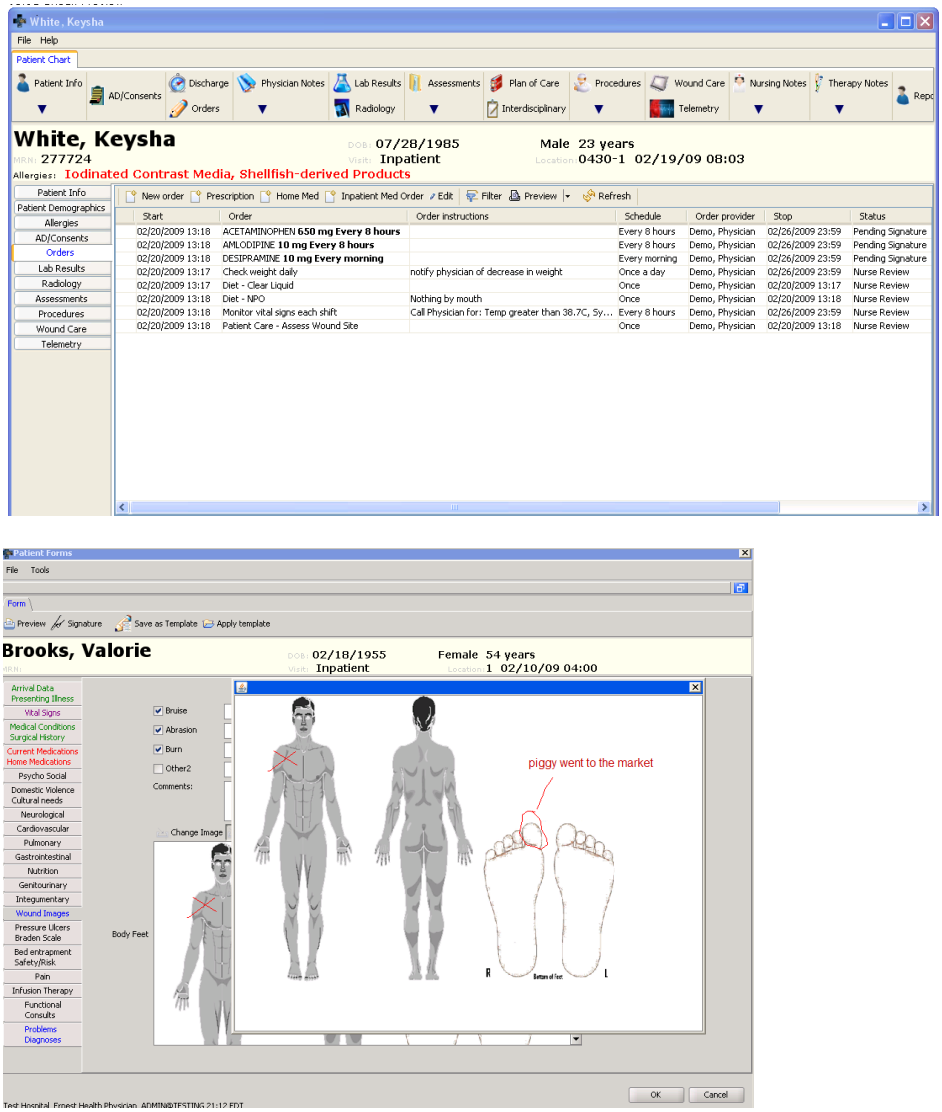

Figure 3: PatientOS: orders and unit-specific form

Encounter-based systems

OpenMRS

OpenMRS is a community-developed, open-source system led by a collaborative effort of the Regenstrief Insitute (Indiana University) and Partners in Health (Boston Philanthropic Organisation). It was intended to contribute to providing sustainable health information technology that could be used to fight diseases most prevalent in low-resource countries, including AIDS, tuberculosis and malaria. It has been supported by World Health Organisation, Center for Disease Control, and the Rockefeller Foundation and has been implemented in over 20 countries in Africa and Asia. It is extensible by an IT specialist within the confines of its data model, but does not allow practitioner-customisation

The interaction paradigm is based on a doctor-patient encounter, allowing the doctor to record data for a specific interaction. The data model is based on a concept dictionary, in which a concept could be a diagnosis, tests, procedures, drugs or other general questions. Forms are then created using a concepts-value pairs, in which a value can be associated with a concept (e.g. Blood Pressue 120/90). The interface allows for a doctor to view a particular encounter or graph of concept(s). These two activities are done on two separate tabs. Although such a data structure is useful for data collection the user interface does not present the data in an integrated, and therefore meaningful, way to the clinician, as show in Figure 4.

OpenMRS uses MySQL database, Java APIs, Microsoft InfoPath for forms development, and HL7 data standard for messaging. .

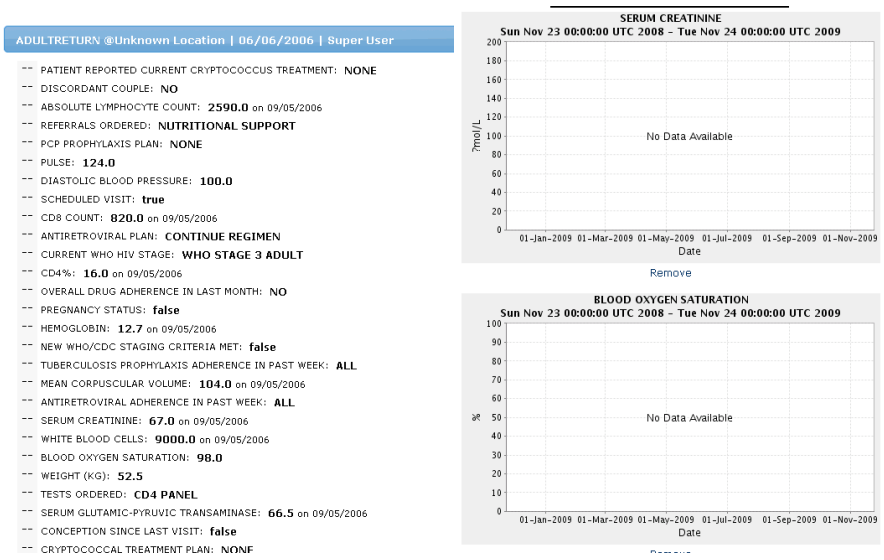

Figure 4: OpenMRS: encounter list, encounter form, graphs

OpenEMR

OpenEMR is non-for-profit company founded in 2005 by a medical doctor and owner of a small primary care facility in North Carolina. It is web-based and oriented towards general practice medicine. It allows recording of patient history, encounters, issues, immunizations, document upload and electronic billing. It is not customisable and does not have a useful interface that integrates data as show in Figure 5. The system is built on a MySQL database.

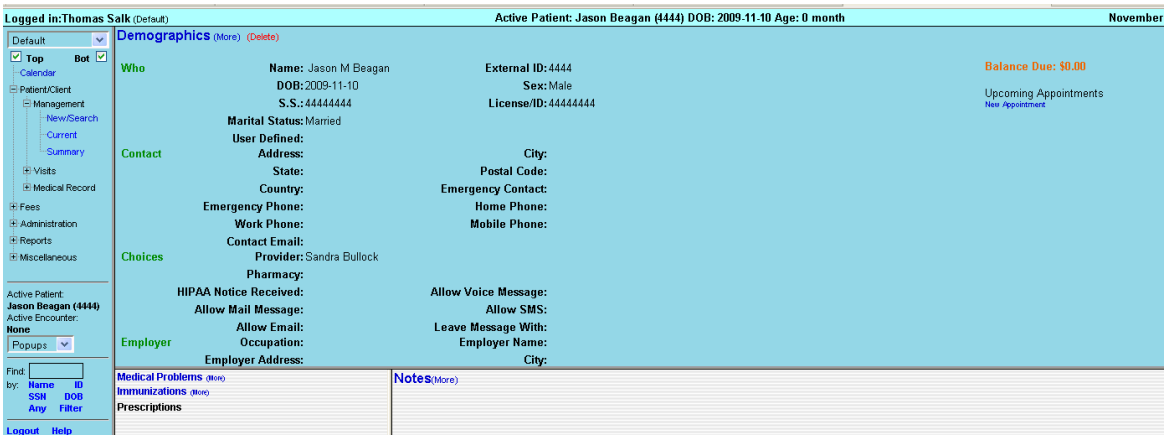

Figure 5: OpenEMR main screen

Ultimate EMR

Ultimate EMR is a US-based commercial company whose business is built on customising their open-source platform. They system is targeted at small medical practices and allows the entry of patient data through fixed, non-customisable forms. Data can be view in its entirety or as summaries, which are broken down into categories such as problem list, vital signs, surgical history, allergies, medications, and social history. External documents (e.g ECG, imaging) can be added and grouped under folders. The documentation does not describe the data model, but the majority of data is entered as free text. The interface nicely integrates data as shown in Figure 6, but the free-text model makes data-mining difficult. It is developed in Python.

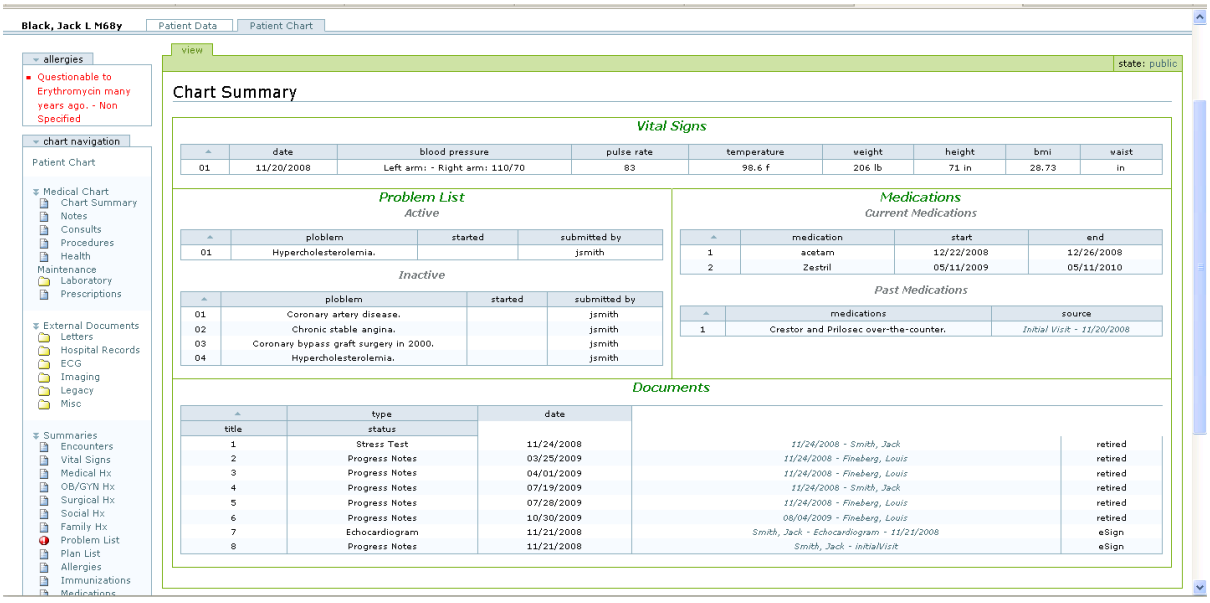

Figure 6: UltimateEMR Chart

GNUMed

GNUmed is a system built by a group of practising doctors, programmers and free software enthusiasts from around the world with the goal of a paperless medical environment. It is built to support small clinics and is not suitable for hospital IT. It can support patient records as well as administration. Customisation is currently done in SQL. It is shown in Figure 7.

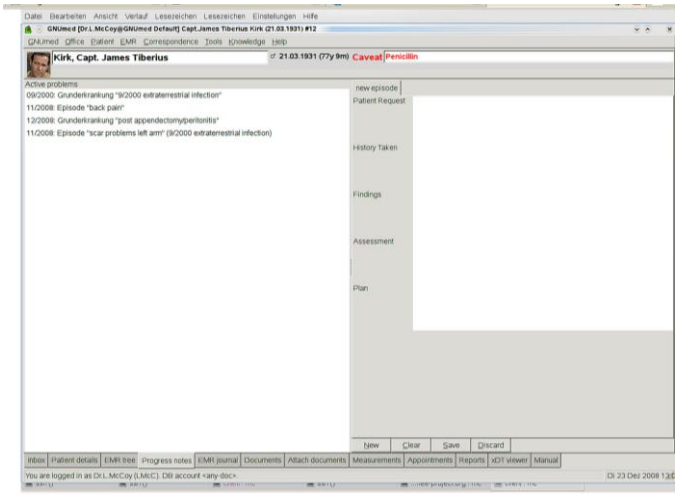

Figure 7: GNUMed interface

OpenClinic

OpenClinic is an open-source system with a single named developer who is working with a beta-tester. The system is aimed at small general practices and basic administration and has primarily been used in private practice. It is meant as a data repository and is suitable for statistical analysis, but the interface does not integrate data well as shown in Figure 8. One of its key features is that it translates easily, with versions in Spanish, English, Bulgarian, Dutch and Traditional Chinese.

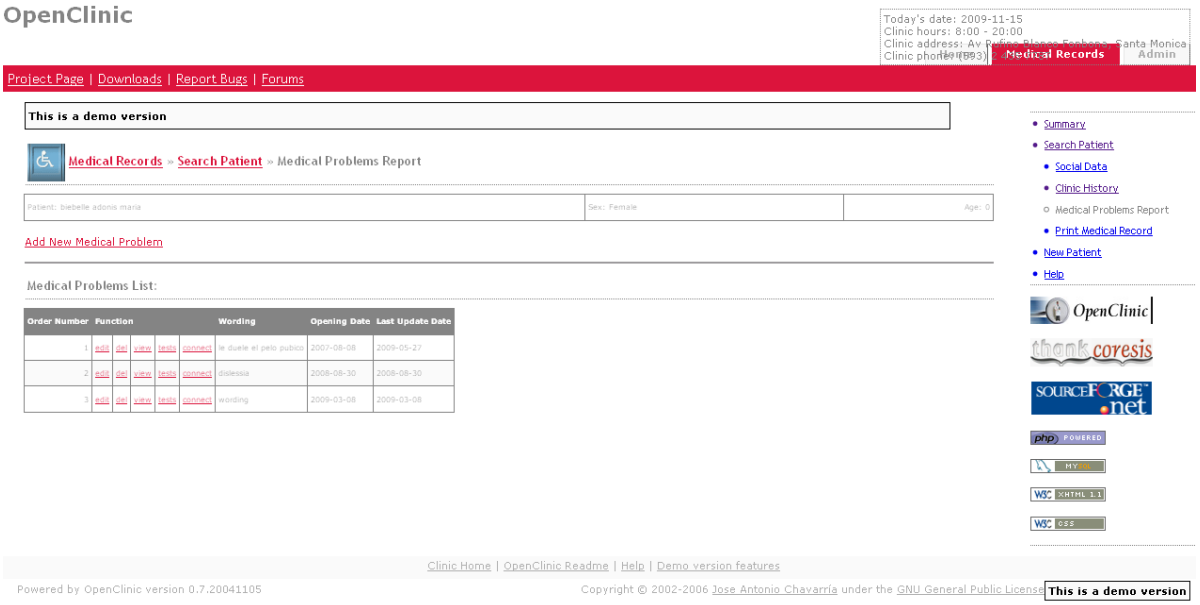

Figure 8: OpenClinic overview

MedScribbler

Medscribbler is a proprietary software that has recently been released for open-source development by Scriptnetics. It is a fully competed electronic medical record that has been optimised for handwriting and voice recognition on a tablet. It appears mainly to be used for general practice. It is shown in Figure 9.

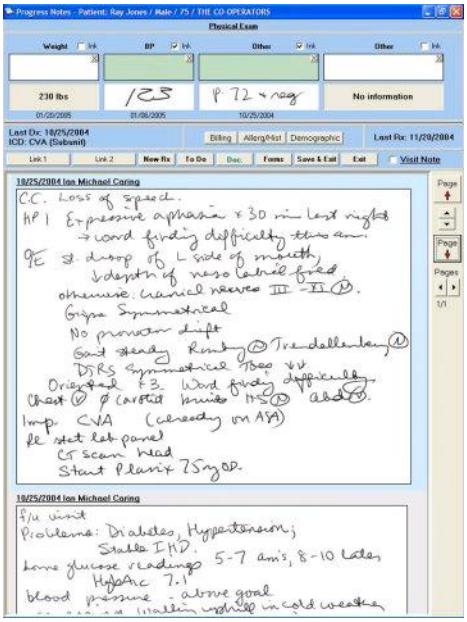

Figure 9: MedScribbler example page

Hospital logistics

eHMIS

This system was initiated as a doctoral research project in Tororo Hospital (Uganda) in 2003 under supervision of a professor at the University of Heidelberg. The system was designed to provide electronic data, such as morbidity from certain diseases, for public health decisions. It was not geared towards supporting clinical work. It's administrative interface is shown in Figure 10.

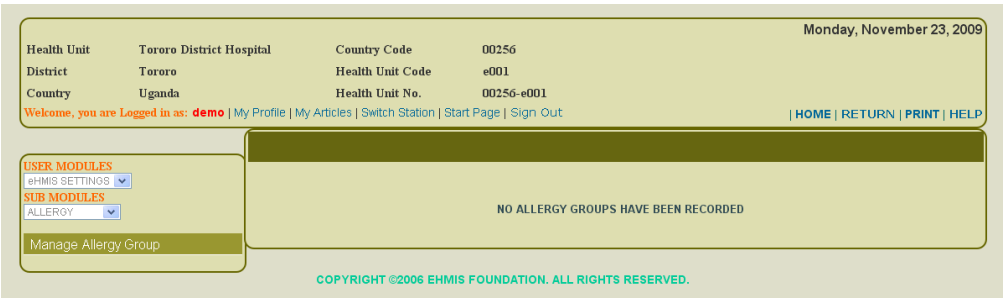

Figure 10: eHMIS

Care2x

Care2x is a suite of four components, a hospital information system which integrates existing systems in a hospital, practical management for general practice, a central data server, and a health data exchange protocol. Started by a nurse and his efforts in his spare time to fix his own hospital system, it has since been translated into twenty languages, including recently Thai. It has a very large number of developers, and seems to be in active use in a number of places. However, it does not seem to be customisable and it is not appropriate for intensive care. Parts of its construction however, might be useful.

Medical

Medical is intended to be a combination of an electronic medical record and a health information system. It is primarily built upon openERP, an enterprise resource planning software, and seems to

concentrate on the logistics of hospital running rather than on patient care. The alpha version is expected in 4 months times.

CONCLUSION

This report considered 12 open source electronic record systems for the healthcare domain, a surprising number of systems that more or less do the same thing, keep a patient record for use by medical practitioners. This suggests the diversity of IT needed in healthcare to carry out different tasks, as well as, the diversity of practices even within the same area (e.g. general practice medicine). Despite the large number, only three of the systems described are appropriate for usage in hospital intensive care. Each of these systems has a disadvantage: VistA is not customisable, openEHR is only a back-end, and PatientOS is not yet finished. PatiestOS, building on strong, sound design research embedded in openEHR, is the only one specified to meet the 6-point clinical vision of the EViDence group. When it is finished, it will need to be re-examined.

We suggest that any further work be built upon openEHR and PatientOS.