CUSTOMISATION OF OPENMRS FOR THE LEISHMANIASIS RESEARCH AND TREATMENT CENTRE IN ETHIOPIA

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Abstract
In this era of evidence based medical practice, low and middle income countries (LMICs) are significantly affected by the scarcity of locally generated data. This is mainly due to the absence of electronic medical record systems even in large medical and research centres. Most still use paper-based patient registration and documentation. However, the shift to digital records can benefit both clinicians and patients. Developing countries need health information technology more than other countries due to the challenges in patient tracking and exchanging data even within one medical centre. In Ethiopia, similar to other LMICs, medical recording, patient transfers and consultations are all done with paper-based documentation, creating several drawbacks, including legibility, storage for an archive, accessibility to patient information, and security. The shift to electronic medical records can help not only clinical teams to have access to the cumulative health history of their patients, but researchers and public health sector workers too, providing data for further disease control and surveillance. Therefore, it is crucial to capture and collect medical data in digital format using electronic health record (EHR) applications in a cost-effective way.

Introduction
Ethiopia is one of the most populated countries in Africa. It is also categorised as low-income country, where the economic situation engenders a lag in development of the most important areas, including healthcare. As a result, the access to specialised healthcare centres is quite limited in most regions as specialists and dedicated diagnostic tools are available solely at few tertiary levels of care. However, over the past decade the healthcare service delivery has been improving in the country.

The Ethiopian health system is a three-tier healthcare delivery. These are the primary healthcare delivery unit, the general hospital, and specialised hospital services. The primary level includes district hospitals serving 60,000 to 100,000 people, health centres 15,000 to 25,000 people, and health posts 3,000 to 5,000 people. A general hospital is meant to serve 1 to 1.5 million people and a specialised hospital 3.5 to 5 million people. Additionally, there are non-governmental organisations and faith-based organisations that support healthcare delivery in the country.

In most facilities (at national, regional and district level), the key processes such as medical record keeping, patient transfers and consultations are done with paper-based documentation, creating several drawbacks, including legibility, storage for an archive, accessibility to patient information, and security. The shift to electronic medical records can help not only clinical teams to have access to the cumulative health history of their patients, but researchers and public health sector workers too, providing data for further disease control and surveillance. Therefore, it is crucial to capture and collect medical data in digital format using electronic health record (EHR) applications in a cost-effective way.

As a component of information and communication technology (ICT) infrastructure, EHR systems cannot fully perform without a stable power supply, network connection and hardware. Also, technical support and financing play a key role in providing high quality service. Moreover, the typical lack of ICT resources in these regions raises challenges that go beyond the
technological ones.

Ethiopia is affected by many health problems including non-communicable chronic diseases and infectious diseases. In addition, there are neglected tropical diseases such as Leishmaniasis, which is endemic in more than 100 countries. It affects the poorest and is nurtured by adverse environmental changes, malnutrition, lack of sanitation and co-infection with other diseases, such as HIV.

**Approach**

This project was conducted within the EuroLeish network, which is a Marie Sklodowska-Curie Innovative Training Network for the European Union’s Horizon 2020 research and innovation programme. The network aims to implement new and more efficient tools and strategies that will help to control and treat Leishmaniasis.

This paper describes the implementation process of an EHR system at the Leishmaniasis Research and Treatment Centre (LRTC) based in Gondar, Ethiopia. The centre consists of a laboratory and a clinic that provides medical care services for outdoor and indoor patients. A number of clinical trials have been conducted and published by this centre in the last ten years. The staff are well trained in good clinical laboratory practice, and the centre is used as a training facility on Leishmaniasis for the health workers in the region. In addition to clinical trials, routine care is given to patients with all forms of Leishmaniasis. Annually, close to 400 patients are treated and more evaluated on follow up.

**Specificity of low-resource settings**

Since the LRTC is situated in a low-resource region, there are important requirements for the EHR system, it must be cost effective, able to work offline, and be customisable. Cost-effectiveness can be achieved with adoption of open-source solutions, although this implies an investment in ICT specialised personnel. To select an open-source EHR (OS EHR) system, a comparison of several options must be done. After an extensive analysis, testing installations, and viewing available demos, the most appropriate OS EHR was chosen. This is described in the next section.

Another essential feature of an EHR system for developing countries is the ability to work in an offline mode without a network connection. Due to unstable power supply and poor network access, the EHR system should give an opportunity for clinical staff to work offline. Hence, it is crucial to have an alternative approach to data entry that allows it to be kept locally and synchronised with the server when there is power and connectivity.

Additionally, the EHR system should provide clinical staff with customisable reports and data entry forms. This requirement is based on the necessity of reporting to governmental and non-governmental organisations about disease epidemiology, demographic information, etc.

The EHR tool must also have a multilingual interface. The official language of Ethiopia is Amharic and only a small proportion of the population can speak and read in English. At the infrastructure level, three kinds of problems are identified: i) the instability of basic infrastructures, and in particular of the electric power supply; ii) the limitation of the network bandwidth, which, is often misused, in particular by e-mail accounts hosted out of the country; and iii) the unavailability of reliable connectivity beyond large cities.

**Requirements gathering**

One of the main requirements for this EHR system was the capability to allow collaborative work between clinic and laboratory members. The main objective was to explore the workflow, and evaluate ICT infrastructure and software solutions, if available. A deeper understanding of the processes showed that the centre urgently needed a patient management system to automate internal operations. Another problem was faced in communication between laboratory and clinic, where currently all transactions were paper-based. The routine workflow of LRTC was observed and analysed in order to implement the EHR system. User requirements were gathered, the clinical staff interviewed, available equipment checked, and infrastructure verified. All registration books in both the clinic and the laboratory were analysed. The result of analysis in the field led to the identification of the functional requirements of the application, which can be generically summarised as:

- Patient information management (i.e. appointments, registrations, diagnostics, prescriptions, treatments)
- Laboratory management information system
- Indoor and outdoor patient management
- Laboratory and clinic integration (information exchange)
- Generation of dynamic reports
- Secure accounting management
- Multi-lingual, web-based and offline capabilities.

**EHR implementation**

It was required that the OS EHR be capable of long term growth, be able to support a range of health services, and be able to facilitate health services research. We identified the most important functional and non-functional requirements (easy customisation, strong developers’ community, and minimal hardware requirements) for the OS EHR system. Based on the literature review, we have installed and tested five different systems, looking for features that best fit established requirements: GNU Health, OpenEMR, FreeMED, OpenMRS, and Bahmni. From this comparison the OpenMRS was chosen as the base platform, due to the provided wide-ranging features, and a strong community of implementers with deployments all over the world, particularly, in LMICs. Moreover, we decided to use Bahmni, an enriched distribution of OpenMRS that includes a customisable laboratory management system (OpenELIS).

The core of the platform is a centralised dictionary of concepts, which are meta-data of given entities, defined by name, data-type, appropriate attributes and relationships to other concepts. These are used as models that can latter instanced to provide the desired functionality for each use case. A modular platform and standardised APIs play a major role in its extensibility and easy configuration, allowing to define the modules to use or extend. Another important feature of the platform is the ability to work offline, i.e. it provides offline data entry for failed interactions, circumventing problems with poor Internet connection and unstable power supply in low-resource areas. A browser extension also gives the possibility to fill forms and other user-interface functionalities without an active connection to the server. The data produced with this functionality is saved locally on the device and can be uploaded at after establishing a connection to the server. Overall, the deployed OS EHR solution, combining OpenMRS, Bahmni and OpenELIS allowed fulfilment of all the requirements. The LRTC EHR implementation is available at https://bioinformatics.ua.pt/bahmni/.

**Conclusions**

This paper describes the steps in the choice and the implementation of an open-source EHR in the Leishmaniasis Research and Treatment Centre, Gondar, Ethiopia. While several solutions have been shown to be appropriate for low-resource settings, the management of the Leishmaniasis centre introduces its own specificities. To address this challenge we have compared several systems, namely concerning their coverage of established requirements. At result, we have deployed a complete solution to support patient data and laboratory management, which is currently being used by clinical staff.

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Conflict of interest. The author declares no conflict of interest.

References


