FluxMED: An Adaptable and Extensible Electronic Health Record System

Alessandra C. Faria-Campos[1,2], Lucas Hanke[1], Paulo Henrique Batista[1], Vinícius Garcia[1], and Sérgio Campos[1]

[1] Universalization Access Laboratory, LUAR, Department of Computer Science, Universidade Federal de Minas Gerais
Av. Antônio Carlos, 6627, Pampulha, 30123-970, Belo Horizonte, MG, Brazil
[2] INMETRO, Instituto Nacional de Metrologia, Qualidade e Tecnologia
Av. Nossa Sra. das Graças, 50, Xerém, 25250-020, Duque de Caxias, RJ, Brasil
{alessa,scampos}@dcc.ufmg.br,
{hankelucas,batista.phs,vingarcia00}@gmail.com

Abstract. The amount of data generated by medical and laboratory services grows each day. The number of patients is increasing, modern examination methods generate large amounts of data and the growing specialization of the medical profession makes the problem of storing and managing this data very complex. Computer applications known as Laboratory Information Management Systems (LIMS) have been proposed as tools to address this issue. In this work we propose the FluxMED system, a fully customizable EHR system with an easy to adapt interface for data collection and retrieval. FluxMED can easily be customized to manage different types of medical data. The customization for a new disease can be done in a few hours with the help of a specialist. We have used FluxMED to manage data from patients of three complex diseases, neuromyelitis óptica, paracoccidioidomycosis and adreno-leukodistrofy. These diseases have very different symptoms, different exams are performed to come to a diagnostic and have different treatments. However, FluxMED is able to manage these data in a highly specialized manner without any modifications to its code.

Keywords: Electronic Health Record, Laboratory Information Management Systems, Workflow.

1 Introduction

The storage and management of large amounts of laboratory and medical data has been frequently discussed as the need for software tools that support the entire life cycle of data (collection, storage, analysis, reporting and archiving) is increasing on a daily basis. One of the solutions proposed to address this issue is the use of Laboratory Information Management Systems (LIMS). LIMS are computational tools developed to integrate and manage laboratory data that give emphasis to quality assurance and aim to generate results in a consistent and reliable way [6]. Several LIMS are available nowadays as academic, proprietary

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and open source applications. Some examples include SQL LIMS [1], LabSoft LIMS [3], LabWare LIMS [14] (proprietary applications), FreeLIMS [4] an open source application developed by Labmatica and the academic systems developed by Hendrick [5], Quo [10], Tharayil [15] and Sanchez [12]. Melo [9] has proposed a new system — SIGLa — a workflow based LIMS designed to allow it to adapt its activities and processes to various types of laboratories. A workflow can be defined as a sequence of steps and tasks executed according to a set of rules and procedures in order to complete a process.

The need for specific LIMS is particularly important for medical laboratories and facilities since for medical applications, existing systems are frequently focused on maintaining the doctors schedule and keeping general annotations on the patients conditions. As a consequence, the data stored cannot be used for a detailed analysis and cannot be easily integrated with other systems.

Existing systems tend to fall in one of two categories: They can be too rigid in the types of data that can be stored, limiting severely the symptoms, exams, diagnostics that can be recorded. As a way of compensating for this problem, the other type of system is too generic, allowing the doctor to enter free text describing the patients consultation. Data entered in this way is very difficult to analyze since data from different consultations often cannot be compared [2],[13].

FluxMED takes a different approach, defining the types of data entered in the workflow. These can be changed easily, incorporating new knowledge without changes to the system. It can be used in very flexible ways, for example, if different doctors follow different diagnostic strategies, that is, ask different questions, and request different exams, the workflow can incorporate both methods, and let the doctor choose which one to use.

Data entered in this way is structured to make it easy to analyze it later. Data is not entered in free text format, but in formats that have fixed types and requirements, which simplifies posterior analysis.

We have used FluxMED to develop EHR systems for three different diseases that are complex, difficult to diagnose and to treat. But because they are not common diseases, EHR systems aimed at them are non existent or very difficult to access. FluxMED has been able to model data from patients of neuromyelitis óptica, paracoccidioidomycosis and adrenoleukodistrofy and enable doctors to use the system to treat their patients. Data from these datasets will later be used on data analysis systems to identify patterns and conditions that can help treating the patients and improving their life.

An important aspect of the FluxMED system is that creating a workflow for a new disease takes only a few hours with the help of a specialist. There is no need to change the system in any way. With some training the doctors can themselves specify the workflow and create the EHR system. Moreover, new systems can be integrated with existing ones, so one EHR system can serve several specialities, making it simpler to maintain the data, train users and extend the system. FluxMED allows users to compare data between different but related diseases in search of common aspects that can be considered for a treatment, but which would have been very difficult to identify if no integrated system is available.