

A Patient Referral and Counter-Referral Management System for Hospitals

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Abstract. The increasing demand for superior medical attention, in addition to the low amount of resources in many of our country's health care institutions, has made patient referral and counter-referral an important administrative process that begins with a referral from a lower capacity institution to one with more complex assistance and diagnoses, and ends with a counter-referral to the original institution, with a specific diagnosis, information on the services administered and indications for further assistance. Poor communication among hospital professionals can sometimes result in unnecessary costly referrals and late transfers that can prove deadly. This article presents an informatic system developed with Free Open Source Software technology that encourages an efficient usage of Dr. Noel H. Sbarra Specialized Hospital services, to improve the interaction among professionals of the health care network, in order to increase the capacity of the primary health care center and, thus, avoid the unnecessary transfer of younger patients.

Keywords: Free Open Source Software (FOSS), J2EE, referral and counter-referral, medical records.

1 Introduction

In Argentina, certain public hospitals, both provincial and national, have a staff of reputable specialists and medium-to-high complexity technology that distinguishes them from the rest of the health institutions. It is important to clarify that our health system has been designed in levels of increasing complexity in order to optimize the use of resources. That is, as a way of preventing diseases and attending to the prevalence of some pathologies, there is a greater supply of primary care at the base of the pyramid, and, progressing upward in technological sophistication and professional expertise, the offer is reduced, and therefore concentrated in only a few referral centers such as those mentioned before. The absence of certain technical

and human resources in small towns and provinces other than Buenos Aires is thus explained by the pyramidal logic used for our health system [1].

For this reason, these centers receive consultations and patient referrals which mainly come from polyvalent hospitals, ambulatory care centers and educational and social development institutions, where lack of resources and specialists can sometimes make it difficult for patients to obtain accurate diagnoses and adequate treatment. Statistics also show that the number of patients treated at Sbarra Specialized Hospital has increased in recent years: in 2008, 409,677 patients were treated at the Hospital, whereas the figure rose to 433,910 in 2009, and reached 493,074 in 2010 [2].

The human and material resources used to respond to the referrals and transfers mentioned above could be employed more efficiently through informatic systems, which are limited at the moment. These systems would enable web interaction to obtain an efficient professional assessment and avoid unjustified transfers, reducing time and costs. For this reason, last year and after many meetings with medical professionals from the Neurology area of the Sbarra Specialized Hospital [3], we began to implement a system for this institution together with students from the Workshop on Software Production Technologies [4].

This development basically pursues the optimization of the resources in the crowded pediatric hospital, in order to make it easier for the professionals in the primary care centers to solve problems on site, aiming at improving the service quality in all care levels.

This system provides, among other things, support and infrastructure for the process known as patient referral and counter-referral. This process, as its name indicates, consists of an initial stage, the referral of patients, during which a child is transferred from a smaller institution to one of greater complexity for adequate care, where they remain until discharged or transferred again to the original institution to seek the recommended treatment. This stage is known as counter-referral. The system facilitates the process, but also encourages early distance communication between the professionals involved. This web application is the first approach to the concept of bringing medicine to the point of primary care [5], i.e., bringing the most suitable tools to the doctors in the point of primary care to give them advice about therapeutic methods, diagnoses, protocols, experiences and to help avoid unnecessary referrals.

2 Setting

The Sbarra Specialized Hospital is one of the most qualified health centers for children and adolescents in La Plata. It receives patients from different parts of the province of Buenos Aires, the most populated province in Argentina. Patients from far away places -and their families- travel many kilometers to reach the institution and gain access to specialized attention and complex equipment, as the hospitals

and health care centers they are transferred from are normally general-purpose facilities with very few pediatric specialists.

On the other hand, unnecessary and late patient transfers are not infrequent and produce undesirable consequences.

A system that facilitates interaction among professionals from the Sbarra Specialized Hospital (internal doctors) and professionals from local and zonal hospitals (external doctors) would eliminate the frustration these consequences bring. This interaction would facilitate: (i) consultations between internal professionals—doctors, psychologists, speech therapists, and others—and external professionals in relation to therapeutic methods, diagnoses, protocols, etc.; (ii) avoiding transfers, by means of adequate information (iii) enabling/speeding urgent transfers. However, there are always extemporaneous patient transfers with irreversible clinical situations, and, in these cases, frustration is inescapable.

An informatic system would enable fluent communication among professionals. In consequence, external professionals would be able to consult internal specialists and receive advice on the treatments they can apply in the point of primary care before requesting patient transfer. From point of view of the patient, being surrounded by their family and friends favors progress; and from the point of view of the specialized hospital, *human resource management would improve*—meaning more availability for children who really need it. *Hospital resources would also improve*, meaning more availability of complex equipment for situations that require them.

The system would also mean the first significant step towards the generation of a case knowledge base. This could help, in the future, to solve similar cases, as well as to observe, with efficient, adequate and updated medical information, the evolution of different treatments. This case base could be used by external professionals for similar pathologies.

3 System Features

Access to the system requires a computer with Internet access, a web browser and an authorized account with access to one of the system user profiles. With these minimum requirements, it is easy for doctors to gain access to the system from the hospital, from their office or even from their home. Among future work planned for this year, we have considered making the system accessible through handheld devices and other mobile technologies, which would facilitate, for example, updating the medical history of a patient while at their bedside [6]. Below is a detail of the features associated with the three user profiles in the system.

3.1 Manager Profile

A manager is an informatics professional responsible for maintaining the system data, creating users, granting permissions and carrying out all the tasks related with the data and the correct functioning of the system.



Fig. 1. System tables management screen

Figure 1 shows the screen for the management of professionals. From this screen, managers can add, modify and delete professionals, as well as list them by any of the visible columns, and export them to OpenOffice spreadsheets or .pdf files for printing. These management features are the same for all of these tables.

3.2 External Doctor Profile

An **external doctor** is a professional who is responsible for one of the entities external to the Sbarra Specialized Hospital. Basically, they can make distance consultations, make referrals to the specialized hospital and consult the health of the referred patients through the system.

Figure 2 shows the screen used to create a new distance consultation. This form enables a doctor to send studies and questions about a patient to another doctor or to hospital services. Consultations work similarly to internal mail systems. Users can specify the text of the message and select the addressee out of a list of the professionals and services of the Sbarra Specialized Hospital. This service allows for the attachment of files (x-rays, clinical examinations, clinical history, etc.) and the definition of keywords for future search.

SISTEMA DE REFERENCIA CONTRARREFERENCIA

HOSPITAL ESPECIALIZADO DR. NOEL SBARRA - EX CASA

Inicio Referencias Pacientes Consultas Casos Salir

CREAR CONSULTA

Para*:

Tema*:

New Project 1.vmp

resumen HC

Mensaje*:

Palabras Claves:

VOLVER

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Fig. 2. Distance consultation form

3.3 Internal Doctor Profile

An **internal doctor** is a professional who works at the Sbarra Specialized Hospital, and is basically allowed to receive and answer consultations, generate counter-referral of patients in the Hospital, redirect the consultation to an internal service and follow the health of the counter-referred patients to evaluate their progress and eventually make suggestions to the head doctor.

When internal professionals access the system, new information is shown to them, including: (i) new consultations, (ii) unanswered referral requests, (iii) follow-ups scheduled for that day and (iv) appointments for patients in their practice. The system home has direct links to all of these news items. Figure 3 shows the homepage of a doctor, who has 4 new consultations, and on top of that image, the message inbox of the same doctor with the new messages.



Fig. 3. Home and message inbox displays

4 Applied Technologies

The *Workshop on Software Production Technologies* aims at introducing students into a context of realistic software production, using state-of-the-art technology in Java and free software. Over the course of the subject, students explore the various libraries that are part of the standard Java platform for distributed application development, known as Java EE or Java Platform, Enterprise Edition [7].

Java EE is a standard developed and maintained under the Java Community Process or JCP¹. It includes several API specifications, such as Servlets, JavaServer Pages, Enterprise JavaBeans, Portlets and various web service technologies which are analyzed and used in practical applications in order for students to become familiar with the wide variety of Java technologies. This subject also teaches students to use free software tools such as Web containers, the Java EE container, database engines, development environments and frameworks for Java. In the next few paragraphs, we will synthesize the open technologies selected for the development of our Counter-Referral System, SRC:

- **Java Servlet Technology and JavaServer Pages (JSP pages)** are the server-side technologies that have dominated the server-side Java technology market; they have become the standard way to develop web applications [8].

¹ Software development community led by SUN. The URL with specifications is http://es.wikipedia.org/wiki/Java_Community_Process

- For data persistence, we used *Java Persistence API or JPA*, the standard management interface for persistence and object/relational mapping of the Java Enterprise Edition 5.0 (JEE 5) platform. JPA is part of the EJB 3.0 specification [9],[10] and it is supported by most providers of Java EE containers.
- The *Apache HTTP Server* is a project of the Apache Software Foundation [11]. The goal of this project is to provide a secure, efficient and extensible server that provides HTTP services in sync with the current HTTP standards. Apache is an open-source HTTP Server and has been the most popular web server on the Internet since April 1996.
- Tomcat is a Java Servlet and JSP container and web server from the Jakarta project of the Apache Software Foundation [12]. Currently, we are using *Tomcat 5.5* which is the implementation for the Servlet 2.4 and JSP 2.0 specifications.
- *Eclipse* is an open source integrated development environment or IDE [13]. A Java development often requires access to tools that support HTML, XML, Javascript, SQL, and an installation of Eclipse may be enhanced by plugins to support all these technologies.
- To synchronize the software versions developed by different programmers, we used the version control system *Subversion or SVN* [14]. This tool is an evolution of the first concurrent version manager -CVS or Concurrent Versions System with the following optimizations: efficient use of bandwidth at the time of the information transfers over the network, improved creation of branches and labels, optimized management of binary files, etc.
- *Mantis* is a free web-based bugtracking system [15] that provides traceability and resolution of bugs throughout the software development, thus contributing to improving software quality and collaboration of the various components of a project. They are necessary when working in teams with different functions and working in a distributed manner as in this project.
- For information storing, we decided to use *MySQL* [16], a data base engine that gained popularity in the open source community. This engine is available under both the GPL license and commercial ones. Also, the use of Java JPA technology allows for independence between the application and the database engine used for persistence, facilitating the migration to any other Relational Data Base Management System (RDBMS).
- Using a framework for developing a web application not only speeds up the development process but also promotes best practices for implementation. Considering the skills of the average student in our subject, we decided to teach *Struts 2* [17], [18], a framework for the development of web applications that implements the MVC (Model-View-Controller) design pattern and is also compatible with the Java EE platform that is seen throughout the course of the subject.

The Referral/Counter-Referral System (SRC) is a multitiere web application where all the technologies described above are applied. In the scheme of implementation shown in Figure 4, two modalities for the client layer are shown: one using desktop technologies and another using mobile technologies. In the middle layer, the front-end is a web server—Apache—to avoid most of the security problems, followed by a web container—Tomcat—to support the execution of Servlets and JSP Pages which also has a JPA engine to access the database engine using object/relational mapping.

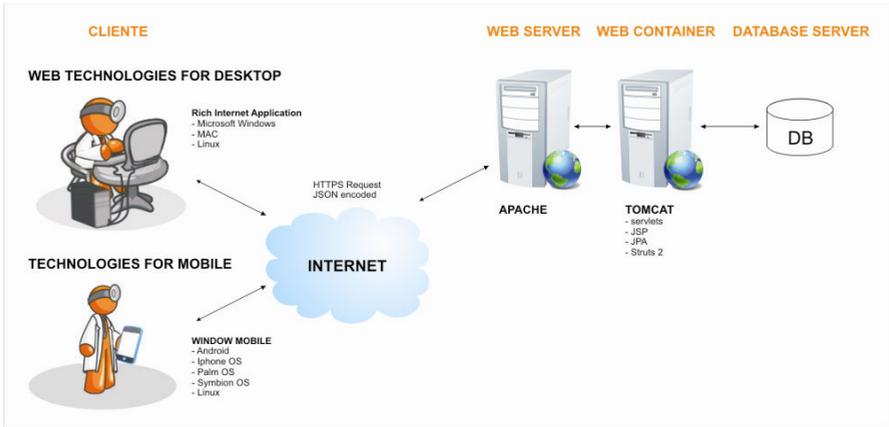


Fig. 4. Implementation outline

5 Current State and Expectations

At the beginning of this year, we were given space in the Sbarra Hospital monthly seminar, where the most difficult cases of each month are presented, to introduce the doctors in the different services of the Hospital to the new system. During the presentation, we simulated the referral and counter-referral process for a fictitious patient, showing the entire process, from the successive distance consultations to the follow-ups after the counter-referral.

During this presentation, the doctors were able to internalize the characteristics of the system and were able to ask questions related to information privacy and coordination with high-recording system in connection with outpatient follow-ups. The professionals behind this initiative hope that the implementation of this system and its increasing use will help strengthen the formation of health care networks. Currently, both students and teachers are training health care professionals in the use of the system.

6 Conclusions

In this article, we present the experience of a university extension activity for public hospitals. As a result of this, the Dr. Noel H. Sbarra Specialized Hospital and its contact network will have a modern, web-based system to manage the process of patient referral/counter-referral and distance consultation among doctors. The system, as already stated, uses free technologies, so that any medical professional with Internet access will have access to the service.

We observed that students were highly motivated with the development of a system that would later be used by a hospital in our city. In addition to the development of a system with social impact, the students were also able to experiment with open technologies and interact with real users of a system before their graduation.

Future work will mainly focus on improving the management and the security of the information in the medical records. We want to incorporate digital signature to carry

out the provisions of the recent 26.529 Act [19] in relation to digitalized medical records, which seeks to ensure “...the integrity, authenticity, age resistance, durability and recoverability of the data contained therein in a timely manner” (Article 13 of the cited Act).

Another important aspect is the creation of a version for PDAs. The fast evolution of mobile devices and their recent availability in our country, added to the documented results—in developed and developing countries—that reveal that mobile technology improves efficiency in sanitary care [20], we have decided to extend the SRC by implementing a new system version for mobile phones, smart phones, PDAs, and other such devices. This alternative access will provide health professionals with more freedom to focus on their daily work, as they will have a portable, practical and agile tool that will enable access to precise information wherever they need it.

Finally, we hope the use of the SRC increases the amount of health care choices at the point of primary care and avoids unnecessary transfers of young patients.

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