Hospital repository for radiological parameters registration of health professionals

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Abstract

The dosimetry control of the health professionals is very important, as it constitutes a form of prevention of the effects arising from exposure to ionizing radiation. The lack of an information system capable of performing the management of all dosimetric information complicates the whole monitoring process and access to the information. This paper presents the architecture of an autonomous information system, which can be replicated by other hospitals and with the possibility of being used through a central application for monitoring and report production at a national level.

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1. Introduction

Technology and medicine are two areas in constant evolution. Their junction has a large scientific driven mainly with respect to diseases treatment's technics and consequently its cure. One such technique involves exposing the patient to ionizing radiation.

Since the X-ray was discovered by Wilheln Rontgen in 1895, ionizing radiation is used in medicine, with enormous success, not only in support of diagnosis, but also in performing treatments [1]. Radiation is used in radiology, interventional radiology, nuclear medicine and in radiation therapy, particularly in the treatment of cancer diseases. However, is not only the patient who is exposed to ionizing radiation. The professional performing the technique is also exposed, but in a safe and controlled way. The Individual Dosimetry is the evaluation of the dose of ionizing radiation received by a professional exposed during their professional practice, and consists of making measurements of the greatness that will be used to estimate the effective dose or the equivalent dose in an organ or tissue [2,7]. The values obtained from the measurements are very important for radiological protection, as they serve to check if the control the doses received by professional during their professional practice are lower than the annual limits established by Decree-Law No. 222/2008 [9,10,11].

In health, the professionals who in their day-to-day interact with sources of ionizing radiation are required to use specific devices for measuring the radiation to which they are subject (dosimeters). These devices accumulate radiation for a period of time, depending on the exposure category of the professional. These values are in turn obtained by specialized laboratories and delivered to the employers entities (hospitals). The study of the results obtained through the measurements by dosimeters allow to see if professionals to regard the safety standards defined and produce some reports like what services and / or hospitals have the highest levels of radiation exposure.

The Health Information Systems are increasingly becoming a reality. Every day new computer applications are create to try and improve the National Health System, in order to better respond to the population [3,5,6,8]. It is in this type of systems that we can include this project.

Currently, at the Center Hospital of Trás-os-Montes and Alto Douro (CHTMAD), as well as other national hospitals, control of the radiological exposure of professionals is effected only by the registration paper backing. This greatly hampers the effectiveness of any monitoring or statistical studies.

This paper is organized as follows: in section 2 we presents the objectives for the development of the system; in Section 3 we present the proposed solution, which includes the design of the architecture, its specification and implementation and in Section 4 we present the conclusions drawn from the system development.

2. Objectives

Taking into account the reality of professionals, it was decided in CHTMAD, to develop an information system capable of overcoming these limitations, capable of storing all the information on the Individual Dosimetry and aiding the monitoring and implementation of statistical reports. This platform should be accessible via the intranet of CHTMAD, or from another hospital unit in which it is published, and where each professional will only have access to information concerning to their doses. To interact with the database it is necessary to develop a web application with several functionalities to manage the information on the Individual Dosimetry of the professional exposed to ionizing radiation during their professional practice. This application will allow record data on dosimetric readings of several professionals through appropriate forms. The application should contain mechanisms which will trigger alerts to be fired when the date of exchange of
The dosimeter is near or whenever new results of dosimetric readings are available and whenever the value of doses approaching the limits set by law.

3. Proposed Solution

In CHTMAD, all of the dosimetry control is performed in an automated process involving a limited number of participants whose steps are illustrated in Figure 1. It starts with the exchange of dosimeters (1), in which the professional responsible for the exchange collects the used dosimeters and gives a new one to the professional. After being collected (2), the dosimeters are sent to the laboratory to proceed with their reading / analysis (3).

![Fig. 1 - Currently process existing in CHTMAD](image)

As soon as the laboratory performs reading (4), it sends their results (5), in paper, to the professional responsible by their reception at the hospital. After receiving of the records, the professional in charge informs the others professionals and archive the records (6).

![Fig. 2 - Proposed process](image)

The whole process is repeated after the last collection period values dosimetry, from month to month for professional exposure category A and every three months for category B.
The proposed solution (Fig. 2) does not intend to change the flow of the existing process, but intend to provide the officer a number of ways to speed up some tasks, such as file readings (6), notification of new doses and delivery thereof (7) notification and exchange dosimeter (9). This proposal streamlines, also the query of readings by the professional (8).

3.1. Architecture

The CHTMAD, such as other hospitals, contains an intranet service supporting various specialties operating in its facilities.

In this intranet are housed various information systems to support medical and administrative activities such as SONHO, to facilitate the administrative work in Portuguese hospitals, the SAPE, which constitutes a tool to support the professional practice of nurses, and SAM, which is oriented to clinical practice in order to computerize the activities performed daily by medical teams[4].

![Conceptual architecture of the solution presented](image)

The existing information systems in CHTMAD, focus primarily on patients. This fact prevented the use of any of these systems as a solution to the problem, because their main focus is the health professional and not the patient.
Currently, there is no knowledge of the existence of an Information System (IS) capable of store and manage all information concerning the Individual Dosimetry. As such, and in order to meet existing needs in CHTMAD, which currently stores information on the Individual Dosimetry on paper, it is now presented an architecture designed to solve the local problem, and also designed to allow its expansion to several hospitals, taking advantages of the benefits arising there from. Figure 3 illustrates this architecture through the conceptual model of the system, where we can perceive the constituents of each hospital unit (all equal to each other) and the central unit, capable of aggregating all the information on specific reports.

In each of the hospitals, the information management is autonomous and confined to the professional community who work there and resulting only of the activities carried out there. It is known that there are professionals who exert their activity in more than one health unit. In these cases, despite the information being accessible only through the intranet of hospital units, the central unit will allow the professional to consult all your own dosimetric information in all existing units where he/she might work.

The application of each hospital is published on the intranet as a standalone application, and its integration is made through an existing authentication system, provided by LDAP protocol from active directory by service, for the use of existing identities, allowing professionals to use them to authenticate in the application now developed.

3.2. Specification

Given the identified requirements, it was specified a web interface application capable of provide the users involved, the functionalities required to manage dosimetry information. Figure 4 illustrates the functionalities to be provided by the main application to each different user profiles has. All profiles are associated with users that require authentication.

To use this application, various actors were identified, some linked to administrative tasks (administrative officer) and to the operational management of the application (system manager) and others who are the professionals exposed to ionizing radiation (professional). There is no defined an actor to the entity that represents the laboratories because these are not direct participants in the application (by decision).

Profile "System Manager"
If the user is encompassed in the profile system manager, he will be responsible for managing all the
information that underpins the management of Individual Dosimetry. This information includes data related to system professionals, services and hospitals, professional groups and laboratories responsible for performing reading dosimeters. The management of this information includes professional services management, management of hospital units, categories management and laboratories management professionals and consists of inserting, editing and viewing information.

Fig. 5 - Specification System (Entity-Relationship Diagram)
Profile "Administrative Officer"
If the user profile is encompassed administrative officer, he will be responsible for managing all the information on the Individual Dosimetry, from the management of dosimetric readings until the sending of alerts. This kind of user will have access to all this information, being will be responsible for their inclusion in the system and issuing the remaining user profiles who will only have access to personal dosimetric information and not accessing the information of third parties. This restriction occurs because the dosimetric information is considered sensitive personal data, and the law says that only the manager of that information and the person to who the information concerned can have access to it. Besides the management of dosimetric readings, this user is responsible for sending alerts related to dosimetry of professionals. These alerts are sent if the exchange date dosimeter approaches or if new readings have been entered in the system.

Profile "Professional"
If the user is encompassed in the professional profile, when performing the authentication he is forwarded to a page where you are given your personal data and their dosimetric readings.

The data model defined (see Fig. 5) contemplates the identified entities that allow the complete cataloguing of managed information, being the most important ones the professional, the exposure category, the readings, the doses and values.

3.3. Implementation

The application at the hospital has been fully implemented, having been used ASP.NET MVC framework and C#, going against a prerequisite defined by CHTMAD.

![Fig. 6 - Application (detail view of dosimetric reading)](image-url)
In the developed information system has been implemented the operations required to manage information of Individual Dosimetry. This management includes all functionalities for the insertion, editing and viewing of information, and even sending alerts.

The data base which supports the whole application has been implemented in SQL Server and is composed of 18 tables. Figure 6 illustrates the visualization of information about a dosimetric reading, on the profile "Administrative Officer". On the image one can see the menu of functionalities that it has access through it profile has to access. The figure illustrates the operation "details" of reading in the "Dosimetric Readings" (1) which presents the identification of data readings, the professional to whom it concerns, date of insertion, date of reading lab responsible for reading and employee responsible for the insert (2) and the data values obtained by reading the dosimeter (3).

This system is published on the CHTMAD's intranet and is already filled with real data and integrated with Active Directory from the hospital through the LDAP service. After its implementation, training activities were conducted with users of the target application. These were intended to inform them about the developed application and to show how users can access and interact with it.

Conclusions

Currently the developed system is already implemented in the CTHMAD and is already in production and information relating to all professionals target. The implemented system is structured in order to meet the needs of dosimetric data analysis from the departments of medicine and safety at work and cabinet quality, inserting this application in a framework that CHTMAD is developing in the area of quality. The goal of CHTMAD is to use these data in conjunction with hospitals that are in the process of re-accreditation under the Joint Commission International (JCI).

The training conducted with professionals allowed the assessment of a positive opinion by the same, about the application in general. Nevertheless, it is not possible now to present the results of an evaluation of the application by these professionals because their access to the application is being designed in phases so it only will be possible to present results when all users are able to access and evaluate.

It is expected that the concentration of all information in a single database, will enable the long-term studies related to exposure dosimetry of healthcare professionals, which will work as the example to relate their exposure to possible pathologies that they may develop, especially oncological or to compare exposure levels of the same professional services in different hospitals.

References


