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Computer system for the management of hospital information on acute myocardial infarction (RHIMA)

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ABSTRACT

Introduction: The difficult gathering of information on the prevalence and development of acute myocardial infarction makes it impossible to measure the quality of treatment during the course of the disease in a given group of patients.
Objective: To develop a computer system that allows the management of hospital information on acute myocardial infarction in the Department of Cardiology.
Method: The variables required for making the registry were identified. They were divided into blocks related to prehospital care, acute coronary syndrome, coronary care units and discharge. A computer system that uses NetBeans as an integrated development environment, Apache as a web server and a MySQL database was created. The programming language used was PHP with Yii framework on the server side and Java-Script with ExtJs 4.1.1 framework on the user side. ER/Studio was used as database modeler.
Results: A Hospital Registry of Acute Myocardial Infarction (RHIMA by its acronym in Spanish) was devised for implementation at the Gustavo Aldereguía Lima Hospital in Cienfuegos, Cuba. It was possible to obtain immediate statistical data that allowed an analysis of the healthcare of patients with this disease.
Conclusions: A web computer system which is capable of managing the information on acute myocardial infarction was developed. Its design, which is in keeping with the National Health System in Cuba, takes into account the epidemiological and demographic characteristics of the Cuban population and provides quality indicators in therapeutics for the recording of information on acute myocardial infarction in accordance with the recommendations of the main Clinical Practice Guidelines.
Key words: Acute myocardial infarction, Hospital registry, Medical Informatics

Sistema informático para la gestión de la información hospitalaria del infarto agudo de miocardio (RHIMA)

RESUMEN

Introducción: La difícil recopilación de información sobre la prevalencia y desarrollo del infarto agudo de miocardio imposibilita medir la calidad del tratamiento durante

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la evolución de la enfermedad en un determinado grupo de pacientes.

Objetivo: Desarrollar un sistema informático que permita la gestión de la información hospitalaria del infarto agudo de miocardio en el Servicio de Cardiología.

Método: Se identificaron las variables necesarias para la confección del registro, divididas por bloques relacionados con la atención prehospitalaria, el síndrome coronario agudo, la atención en Unidades de Cuidados Coronarios y el egreso. Se creó un sistema informático que utiliza NetBeans como IDE de programación, Apache como servidor web y la base de datos en MySQL; como lenguaje de programación se utilizó PHP con la infraestructura digital (*framework*) Yii del lado del servidor y JavaScript con el *framework* ExtJs 4.1.1 del lado del cliente. Como modelador de base de datos se utilizó ER/Studio.

Resultados: Se conformó el Registro Hospitalario de Infarto Agudo de Miocardio (RHIMA) para su aplicación en el Hospital Gustavo Aldereguía Lima de Cienfuegos, Cuba; se lograron obtener datos estadísticos inmediatos que permitieron realizar un análisis de la atención a los pacientes con esta enfermedad.

Conclusiones: Se desarrolló un sistema informático web capaz de gestionar la información del IAM. Su diseño, acorde al Sistema Nacional de Salud de Cuba, tiene en cuenta las características epidemiológicas y demográficas de la población cubana y brindan indicadores de calidad en la terapéutica para el registro de la información del IAM, ajustadas a las recomendaciones de las principales Guías de Práctica Clínica.

Palabras clave: Infarto agudo de miocardio, Registro hospitalario, Informática médica

INTRODUCTION

The treatment of acute myocardial infarction (AMI) is continuously undergoing significant changes based on evidence from controlled clinical trials and guidelines developed by cardiology societies. Although excellent studies have been conducted, there are results that are still open to interpretation, may not be applicable to all clinical areas, and the treatment options may be limited by lack of resources. All this evidence suggest the need to identify indicators of good clinical practice that reflect the real practice[1,2].

High quality registries can help us understand whether the knowledge derived from clinical trials are properly applied and whether the results are reproduced in daily clinical practice[3].

Cardiology Societies in other countries have designed registries with variables that are adjusted to the recommendations of the main Clinical Practice Guidelines and specific strategic plans. They use registries with prospective observational character, where patients with a diagnosis of AMI are admitted.

In Cuba, so far, it is not known the existence of any record for AMI. This situation affects the collection of information on its prevalence and development, as well as the associated risk factors and other variables of interest. Similarly, it is impossible to measure the quality of treatment during the course of the disease.

Therefore, the aim of the study was to design a computer system that allows the management of hospital information on AMI in the Department of Cardiology of the Gustavo Aldereguía Lima Clinical-Surgical University Hospital, in order to speed up the collection and analysis of data from admitted patients.

METHOD

The variables necessary for making the registry were identified, and divided in blocks related to prehospital care, acute coronary syndrome, coronary care units and discharge. A computer program was created to achieve a uniform collection of data from patients with AMI, allowing for an immediate statistical analysis of the different indicators. Data were collected through a form.

This computer system uses NetBeans as an integrated development environment, Apache as a web server and a MySQL database. The programming language used was PHP with Yii framework on the server side and JavaScript with ExtJs 4.1.1 framework on the user side. ER/Studio was used as database modeler.

For the development of the computerized system, the design flow and implementation was carried out according to the guidelines of the Scrum methodology for this type of program, where several artifacts that showed the features of the system were used. Finally,

as a result of the stages of design and implementation, a system design was obtained.

Scrum is recommended for the development of information technology projects, as it is an agile process used to manage and control software construction. The development is done in an iterative (repetitive short course of construction) and incremental way[4].

It focuses on prioritizing the work based on the value for the business, to maximize the usefulness of what is built and the return of investment. It is specially designed to adapt to changing requirements, so that the product that is being built may be adjusted in real time to customer needs. Therefore, it is possible to create a software product that really meets the needs of the users, and increases their satisfaction[5].

The representation of information in the system is regulated by the Unified Modeling Language (UML), which allows you to model, build and document the elements that make a software product which meets the object-oriented approach[6].

UML is not a programming language but a general-purpose language for object-oriented modeling, and it may also be considered a visual modeling language that allows an abstraction of the system and its components[7].

Nowadays, PHP is used as a programming language of general use of code on the server side, originally designed for web development of dynamic content. The code is interpreted by a web server with a PHP processor module that generates a web page. This language has evolved, so now it also includes a command line interface that can be used in standalone graphical applications. Also, it can be used on most web servers and in almost all operating systems platforms at no cost.

RESULTS

The clinical and epidemiological analysis of AMI was carried out in search for variables that provide quality indicators in therapeutics. Those variables that were in line with recommendations of the main Clinical Practice Guidelines were defined for the registry.

- General information about the patient: Name, age, skin color, sex, origin (municipality), health area, medical record number and date of admission.
- Past medical history: hypertension, diabetes mellitus, ischemic heart disease, dyslipidemia, congenital heart disease and chronic obstructive pulmonary disease.

- Toxic habits: Alcohol, smoking, coffee.

The variables that assess the development of acute coronary syndrome are divided into 6 different blocks:
1. Pre-hospital: Date, time and place of the first medical contact (Emergency Intensive Care Unit [ICU], primary health care, other), date and time of the first electrocardiogram (ECG) and the onset of symptoms; transportation (health, advanced life support, etc.), and if the patient had a cardiac arrest.
2. Treatment, before the ICU (Health area): ECG, aspirin, clopidogrel, beta blockers, angiotensin-converting-enzyme inhibitor, calcium channel blockers, nitroglycerin, opiates, inotrope, anti-arrhythmics.
3. Emergency ICU: Date and time of admission to the Emergency ICU, the first ECG in the ICU, and if the patient had a cardiac arrest. Furthermore, variables related to the treatment, identical to the previous point.
4. Acute coronary syndrome: Initial symptom (typical pain, atypical pain or painless), initial blood pressure, heart rate, reperfusion method, date and time of thrombolysis and place (primary health care, emergency ICU, coronary ICU) where it was performed, initial ECG (ST segment elevation or depression, inverted T wave, left bundle branch block), catheterization, initial functional class (Killip) and arrhythmias at admission.
5. Coronary ICU: Date and time of admission, Killip in the unit, final diagnosis, location, treatment and complementary tests (cholesterol, triglycerides, initial blood glucose, hemoglobin, hematocrit, total creatinine, creatine phosphokinase (CPK) and its isoenzyme MB, and the ejection fraction by echocardiography.
6. Discharge: Outcome at one month, indication of rehabilitation, procedures and complications during hospital stay, discharge status (alive or deceased), direct cause of death (if applicable) and GRACE prognostic scale[8].

MAIN INDICATORS THAT CAN BE GENERATED WITH THE REGISTRY
- Interval from the onset of symptom to the first health care
- Door-to-needle time
- Emergency-ECG time
- Percentage of patients with thrombolysis, adminis-

tration of antiplatelet agents, anticoagulants, beta blockers, angiotensin-converting-enzyme inhibitors, statins, among other drugs
- Average length of stay and hospital stay
- Hospital mortality at 28 days
- Bleeding complications
- Percentage of echocardiography in the ICU.

Features of the product
The system uses the model-view-controller (MVC) architectural pattern, which separates the interface that presents to the user (view), the business logic (controller) and stored data (model). This separation allows the interface or display to take different forms with a slight modification to the application code[9].

The main factors that were considered in developing the system were its usability–considering that it is easy to understand–, capacity of use, and the satisfaction with which people are able to do their tasks using the product; factors that are based on the user-centered design.

The product meets various requirements of reliability because maintains a specified level of performance when used under specific conditions.

Recovery
The software should easily recover after a failure (the program may be re-opened without any problem). The users should be allowed to work with the software product the necessary time and the reset speed must be quick (it takes no more than a minute).

Fault tolerance
- It takes into account how often a fault occurs, even if the user operates the program incorrectly
- The software should provide an explanation and options for a solution when the failure occurs.
- The flaw remediation options should solve the problem.
- The failure that does not offer explanations is resolved by restarting the computer (if it is paralyzed, the solution is to turn off and turn on the computer again).

During the creation of the system, it was of utmost importance ensuring the integrity of the data being stored. This information must be consistent; therefore, validations that limit the entry of false data are used, as well as mechanisms of turning back on critical processes that are abruptly ended and may produce inconsistent statements of information; which will be available to users at all times.

The computer system for the management of hospital information on IAM, developed on the Yes-it-is (Yii) and Extension JS frameworks, is multiplatform regarding the operating system. Therefore, it is available for any Linux distribution, the versions of Windows (over Windows XP) and Solaris, which achieves the necessary interaction to provide the users with a system that meets their needs. The system has three modules: user management, hospital information on AMI and help.

User management module
This module allows the entry of authorized personnel to access the information in the system. The access is controlled by a username and a password that allows authorized staff to interact with the information contained in the registry.

There are three groups of users in the roles of administrator, manager and researcher.
- Researchers: have access to the data and may use the database as a source for research.
- Manager: have access to data, can enter patients into the registry and use the database.
- Administrator: is the basic working group that created the software and has authority over the update and use of the registry.

Module of management of hospital information on AMI
It is responsible for managing the information of patients diagnosed with AMI. The authorized user must insert the required variables in the registry indicating the patient's progress, accessing, in a parallel way, to the patients' stay in the unit and after their discharge. Various analyzes may be performed through this module as the information of all the variables is available to researchers in tabular and ordered form. The search is easy, as well as filtering and the combination of variables. It provides a summary table with indicators selected for any study. The result obtained can be stored in digital form in different formats or may be printed (**Figures 1 and 2**).

Help module
By using the components provided by technology platforms it is possible to organize the various subjects,

which provides the users with the help manual of the system to facilitate the analysis of the variables in case of any doubt. It is accessible from all modules of the system. In addition, a manual of procedures for the filling of the registry was devised.

DISCUSSION

The creation of computerized hospital registries with immediate analysis of quality is included in the program to reduce mortality and complications from AMI in coronary care wards of the Gustavo Aldereguía Lima Clinical-Surgical Hospital.

The Hospital Registry of Acute Myocardial Infarction (RHIMA by its acronym in Spanish) has a group of advantages over traditional printed medical records[10].

The RHIMA guarantees that the information is reliable because the data include the date and time when they were recorded and the user who accessed the registry. Besides, the RHIMA has restrictions that detect changes in the information at the time of recording an entry. Another important advantage is the availability of RHIMA, as it is always available for consultation, as long as the user has permission to access it.

The RHIMA integrates all the information into one system; so it gives the possibility to access all patient information in a clear and simple way. This registry represents a dramatic change in terms of information management by medical staff. A disadvantage of installing RHIMA is the need for computer equipment and a staff in charge of operating it. This hospital has the equipment and the information technology personnel necessary for its functioning.

CONCLUSIONS

A web computer system which is capable of managing the information on AMI was developed. Its design, which is in keeping with the National Health System in

Figure 1. RHIMA. Input and edition of patient′s data.

Figure 2. RHIMA. Data Query.

Cuba, takes into account the epidemiological and demographic characteristics of the Cuban population and provides quality indicators in therapeutics for the recording of information on AMI in accordance with the recommendations of the main Clinical Practice Guidelines.

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