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Evaluating the Prophylaxis of the Risk of Deep Vein Thrombosis Using Business Intelligence

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Abstract

Deep Vein Thrombosis (DVT) consists in the formation of a blood clot within the deep veins of the lower limbs. This study explores the data and information collected from the Electronic Health Record of a Health Care Institution. Several concepts such as Data Warehouse, Extract-Transform-Load and Business Intelligence were applied and the use of these technological systems was aimed at obtaining indicators that provide a comprehensive overview from the data collected and assist in decision making. Of all the patients analysed, 11,042 did not obtain any type of prophylaxis, 4508 received pharmacological prophylaxis with low molecular weight heparin (LMWH), 1260 got mechanical prophylaxis and 1119 had to contact the Haematology department. The results achieved allow building a system able to identify low use of prophylaxis and the need to alert health professionals to the importance of these measures in prevention of the DVT disease.

Keywords: Electronic health records; Decision support systems; Data warehouse; Business intelligence; ETL; Deep vein thrombosis; Prophylactic measures

Background

Health Information Systems (HIS) are formal and technological systems that are used in an institutional context in the health area [1]. HIS are used, not only for health care purposes, but also for administrative and management purposes, both in hospitals, public and private, as well as in clinics, pharmacies, service providers related to ancillary diagnostic tests, nursing services and therapies to support treatments [1-3]. Hence, the implementation of unsuitable HIS can jeopardize the success of organizations [2,3]. HIS should use standards that allow integration with other systems and information comparison [2]. Indeed, they should ensure the security and confidentiality of data and information. Moreover, HIS should be the support for key elements, including decision-making bodies; promote education and training; improve citizens' access to health services and raise the quality and speed of services provided; significantly reduce the risk of errors arising from the lack of information indispensable to the professional at the time and place of the clinical decision [1,4]. In this work is presented an approach to collect, treat and present data from physician's registries in the Electronic Health Record (EHR) during patient incomes. It is used an Extract-Transform-Load (ETL) process to build a star schema Data Warehouse (DW) and the final data is fed to Microsoft PowerBI to be presented as quick and interactive dashboards [5].

Venous thromboembolism (VTE) is a frequent and complex disease of multifactorial etiology, manifested as either Deep Vein thrombosis (DVT) or Pulmonary Embolism (PE), is an extremely common medical problem, occurring either in isolation or as a complication of other diseases or procedures [6]. Yet, despite its frequency, much remains to be learned regarding the pathogenic mechanisms that initiate VTE, about tailoring its treatment to the individual with her/his specific set of risk factors for recurrence, and about its medical management when associated with specific disease entities, such as cancer [6]. Deep Vein Thrombosis consists in the formation of a blood clot (thrombus) within the deep veins of the lower limbs. The clot blocks the correct flow of blood and causes an increased pressure inside the vein. This disease is also the largest cause of in-hospital deaths in the world and, paradoxically, the most preventable. In the United States, in 2010, an estimated 900,000 cases of thromboembolism were reported annually and one third of them evolved to death [7]. DVT is a disease that does not only concern vascular surgery or general surgery, cardiology, internal medicine or pulmonology, that is, all physicians should be aware of the possibility of their occurrence, especially when some patients have risk conditions. Rapid diagnosis, the timely provision and treatment, are crucial to a successful outcome, both immediate and later in the medium and long term, avoiding complications ranging from death to the incapacitating post-thrombotic syndrome [8]. It is of extreme importance that HIS can provide a quick understanding of the information collected and present them easy and clear, as well as presenting preventive/prophylactic measures to avoid the occurrence of DVT disease.

Materials and Methods

Patient is everyone who suffers, falls ill and needs medical care. A clinical patient is one who does not need surgical intervention. Hospitalized is the quality of one who was admitted for treatment in a hospital unit. The data collected initially contained 30,222 patients divided into three classes: patients undergoing medical treatment, patients undergoing surgical treatment, and patients undergoing obstetric treatment. In the period from November 3, 2015 to March 6, 2017, a prospective study was conducted with 14,085 patients in the medical treatment category. The patient's ages ranged from 1 to 107 years (mean of approximately 65 years), with 7464 males and 6621 females. Hospital patients were studied in 107 different services of the hospital units, such as Gynaecology, Clinical Haematology, Dermatology, Endocrinology, Physiatrist, among many others. After medical release, each patient underwent a careful clinical evaluation

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by the consulting physician and a standard checklist was filled out, including the risk factors for Deep Vein Thrombosis, signs, symptoms and a possible treatment or prophylactic measure.

The first technical step was to conduct an ETL process to collect data from various sources, transform the data depending on business rules/needs and load the data into a destination DW. The need to use ETL arises from the fact that in modern computing business data, these reside in multiple locations and in many incompatible formats [9]. According to Santos, a decision support system can be defined as an organized and systematic process where organizations collect, analyse and disseminate information from internal and external sources that are important for making decisions and business activities [10]. Thus, the implementation of a decision support system becomes a differential in a health institution, since it provides conditions for management levels to define processes based on consistent data.

From the collection of information elements from the database, it was identified the terms of the dimensions and the table of facts. After this analysis, the construction of a multidimensional architectural model of DW was conceived. The framework schema used in this project was the star schema. This model has five dimensions that are related to the fact table, where the dimensions represent the filters for the high reports and, according to the selections made, a set of data is formed that respond to the values chosen by the user. For the creation of the dimensional model, the MySQL Workbench tool was used, this one having an editor to create the relationship of the dimension tables with the facts table, as well as filling the columns of those tables. Figure 1 illustrates the architecture of the DW multidimensional model. The multidimensional model was implemented according to the information obtained in the research, which was stored in a Microsoft Excel file, also with excerpts in XML of the medical report made to each patient.

It is important to know the integrity of the data in order to transform it in the most efficient way possible. In the transformation process, in Microsoft Excel, the source data was transformed to ensure integrity. First step is eliminating duplicities and correcting some formatting errors to follow the standards defined in the dimensional model. Next, the derivation of a new value was calculated (i.e. Age=Current_Date-Date_birth). Data from different sources was merged and, finally, the separation of a column by multiple columns (the separation of a date field of type 'aaaa.mm.dd hh:mm:ss' into 'aaaa', 'mm', 'dd', 'hh', 'mm', 'ss').

Results

A total of 14,085 patients were studied, of which 7464 (52.99%) were male and 6621 (47.01%) were female. Of these 14,085 patients, 3857 were hospitalized again (2282 men and 1575 women). Of all the patients analysed, 11,042 didn't obtain any type of prophylaxis, 4508 received pharmacological prophylaxis with low molecular weight heparin (LMWH), 1260 got mechanical prophylaxis and 1119 had to contact the Haematology department. Figure 2 shows the dashboard that presents the outcomes registered in the EHR.

One of the major data collected is patient's birthdate, which allows to identify the ages and to relate the age group to both, the number of hospitalized individuals and also the frequency of responses. Table 1 represents the answers frequency by age group.

As expected, most individuals (11813) are 60 years of age or older and the age group with the least hospitalized patients (27) ranges from 0 to 15 years. As can be seen from Table 1, as age increases, the frequency of answers from prophylactic measures also increases. All patients under the age of 15 don't have any type of prophylaxis. In the age range between 15 and 30 years, the predominant is that no prophylaxis is given, but there are already several patients with pharmacological prophylaxis (mainly used by female patients (344)) and mechanical prophylaxis (mainly used by male patients (12)). With respect to patients between the ages of 30 and 60 years, it can be seen once again that most don't benefit from any type of prophylaxis and the most frequent prophylaxis is pharmacological (422 male patients and 312 female patients). Finally, for patients over 60 years of age, the frequency of responses behaves in the same way as in the previous age groups in which most individuals don't have any type of prophylaxis and it´s used more frequently the type pharmacological. In this last age group, there are more women with pharmacological prophylaxis (1968), mechanical prophylaxis (508) and consequently there are a bigger number of males without any type of prophylaxis (3735 males and 2417 females without prophylaxis).

Discussion and Conclusions

With this work it is possible to identify the need for the usage of Business Intelligence tools as a daily practice, not only for decision makers and managers but also by physicians. The presented results allowed, for example to identify that the prophylaxis is not used every time it is recommended, however, all seem to know the importance of

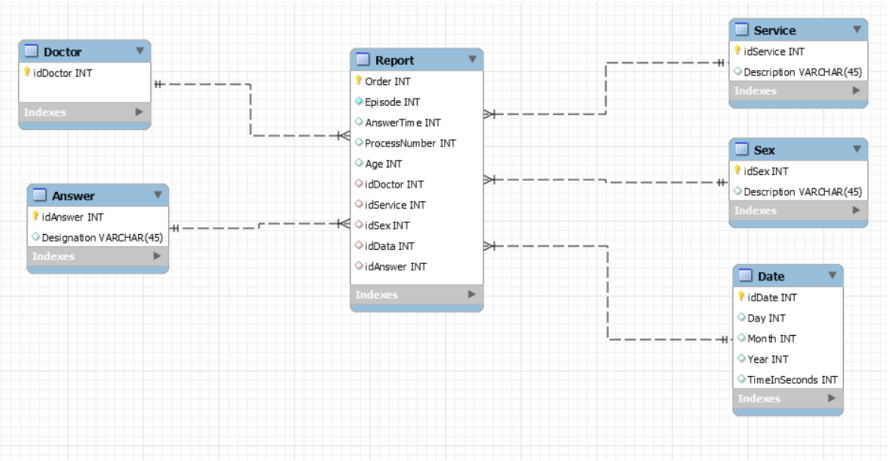

Figure 1: Multidimensional Model of the Data Warehouse.

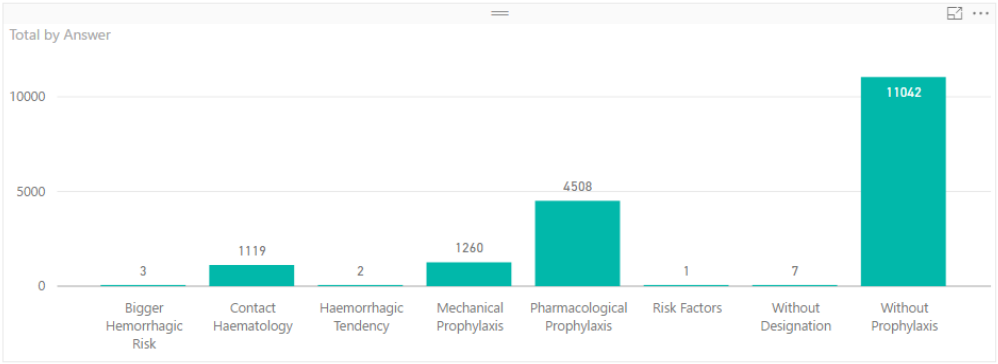

Figure 2: Total of patients studied by answer.

	Age	[0-15]		[15-30]		[30-60]		≥ 60	
	Gender	M	F	M	F	M	F	M	F
Answer	Contact Haematology	0	0	5	1	77	55	505	476
	Pharmacological Prophylaxis	0	0	37	46	422	312	1723	1968
	Mechanical Prophylaxis	0	0	12	6	171	91	472	508
	Bigger Hemorrhagic Risk	0	0	1	0	0	0	1	1
	Without Prophylaxis	14	13	259	344	2305	1953	3735	2417
	Risk Factors	0	0	0	0	0	0	0	1
	Haemorrhagic Tendency	0	0	0	0	0	0	1	1
	Without Designation	0	0	0	0	1	2	2	2
	Total by Gender	14	13	314	397	2976	2413	6439	5374
	Total by Age Group	27		711		5389		11813	

Table 1: Answers frequency by age group.

these measures for the prevention of the risk of DVT and PE. It also allowed understanding the age distribution from the population and identifying that most of the hospitalized population is in the range of 60 or more years old and it is the one that most prophylactic measures receive. The increase in age is related to the increase in risk factors and, consequently, it makes sense that these individuals are the ones who most need prophylaxis. In this age group, it is observed that there are a greater number of women taking advantage of prophylaxis, even though there are a greater number of men with the same ages hospitalized. Not only age affects the achieved results, but gender has also an important role. The system achieved could be used as a system monitor to identify end point out relevant information that could go unseen in the middle of the amount of data present in a health care unit. Through the analysis of the results, it was verified that these indicate information where it is possible the identification of individuals sick or predisposed to suffer from risk of Deep Vein Thrombosis in medical domain and it is through these aspects that it will be possible to build programs for prevention and control of this pathology. Of a low use of prophylaxis, important for preventing DVT and EP in hospitalized patients, is suggested the implementation of an educational program and encourage the use of prophylaxis. The objective of the educational program would be to increase the use of prophylaxis and consequently decrease the number of individuals with the DVT disease. Therefore, the usage of HIS as a base for data dissemination could help those responsible for the services associated with the DTV risk in the medical field become aware, that some reforms in the preventive diagnosis must be made in order to reduce the high mortality and motor incapacity rates in the world.

Acknowledgments

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