LEARNING ABOUT THE DEVELOPMENT OF PREECLAMPSIA WITHIN VIRTUAL COMMUNITIES

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Abstract

The involvement of big data analytics in healthcare enhances education by offering an improved assessment of the health cases where several virtual communities contribute with knowledge and data. In the current paper big data is used to study the appearance of preeclampsia during pregnancies and how it can be treated for positive outcomes, as well to be prevented and to cut down the costs. The clinical professors, including their university students who study medicine investigate the case of every patient in order to treat preeclampsia at an early stage. Healthcare data analytics helps at the creation of a comprehensive patient file and aims to collect the archives about every one of them from every visited hospital and clinic. The cost of gathering much big amounts of medical data implies high costs and it is time consuming, but the technologies of today can offer educational solutions and ease the life of many persons. The virtual learning environment uses big data analytics to find treatments, keep track of past records and empower patients by involving them to take care of their own health. The students have access to the input data which is loaded from the system's ontology about diseases, medicine, symptoms and treatments into the Hadoop file system. Apache Hive is used for querying and managing patient history, the test results, the treatment options, genetics and protein datasets inside the distributed environment. After gathering this data, the patient is monitored and the treatment is adjusted, being a source of knowledge for the virtual communities, namely the clinical professors and for their students. This analytics tool helps the clinical professors and their supervised students to understand the process of treating a patient and to enhance their digital skills. The proposed system is a distributed one and it can be deployed around the world at different healthcare hospitals and clinics for learning about the innovative treatments for preeclampsia and educating the novice doctors.

Keywords: Big data, preeclampsia, distributed healthcare system, analytics tool, virtual communities.

1 INTRODUCTION

Health virtual communities have a significant role for the clinical professors, their university students, as well as for the registered patients. As the population of the globe increases, the labour costs rise and the diseases become more complex. A study done on a Facebook community consisting of 121 pregnant women showed that the persons who were to give birth for the first time, as well as the ones who were assisted by a technology treatment proved to be more interested about this facility [1]. An Internet based service for public maternity care developed in Finland, Net Clinic, allows the virtual communities to know more about similar situations and to provide support [2].

A virtual community platform developed in Canada for the patients who suffer from chronic kidney disease allows the treatment to be medically validated, to monitor and report medical events to ensure medication accuracy and care at home [3]. A study done in the same country shows that 14.4% of the patients experience readmission within 30 days [4]. Readmissions cause a demand of the hospital staff and have a financial impact, due to which virtual communities prove to be very useful.

In USA, follow-up calls where done by nurses after hospital readmissions for the patients who had been subject to neurosurgery services [5]. The results showed that the patients who were monitored while being at home stayed away from the hospital for a longer amount of time.

In the whole world, each year about 140 million women give birth [6]. Preeclampsia appears among women at a gestation age of over 20 weeks and it is manifested by high blood pressure [7]. This illness is one of the major maternal death causes.

800 women die daily because of pregnancy complications [8]. High blood pressure and angiogenic biomarkers [9] play a significant role in predicting and determining the presence of preeclampsia [10].
In some countries, more than 10% of the pregnant women present preeclampsia [11]. According to a study performed in California during the year 2011, 79% of the deaths caused by preeclampsia were generated by poor management [12].

In Romania has been done a study for 8 years, during 2007 and 2014, which demonstrated that for the deliveries of teenagers and young women with the age lower than 24 years, preeclampsia and eclampsia were present similarly [13]. Another study performed in Romania on 35 pregnant women who suffered from preeclampsia, but didn't have any cardiac or medical diseases and other 30 pregnant women were normotensives [14]. It was found that the patients suffering from preeclampsia had subclinical cardiac systolic dysfunction compared to the normotensive patients.

The causes of preeclampsia are the impaired trophoblast differentiation [15], abnormal placentation [16] and oxidative stress [17]. The proposed virtual community will help to examine the factors which determine the occurrence of preeclampsia, as well as to find the best suited treatments for each patient, to manage the part health records and to enhance the learning process of the medical school students. An analysis of doctor-patient communication within online health communities during the year 2017, showed that 87.6% of the users found the community useful, while 69.3% of the patients were satisfied by the outcomes [18].

The aim of this research is to empower patients who suffer from preeclampsia while being away from hospital. The virtual community gathers the patients with the medical staff, the family members, along with the clinical professors and the medical school students, being an efficient tool for the management of preeclampsia. The medical staff, as well as the family members monitor the health state of the patient. Studies confirm that students enhance their understanding of healthcare by using virtual communities [19].

In the next section are presented the general overview of the system and the virtual community platform through which is done the learning about preeclampsia using big data processing tools. Sectors 3 describes the outcomes of the proposed platform and presents the functionalities which can be used by medical school students, as well as for the patients. The last section outlines the conclusions.

2 METHODOLOGY

Pregnant women are empowered to take care of their health while being away from the healthcare unit via the virtual communities to which have access the medical staff, clinical professors, medical school students, as well as their family members. Based on an Irish study, where within a cohort of 1774 women, 3.8% presented preeclampsia, the average cost of a pregnancy when the illness is present, reaches €5243 per case [20]. The normal cost in Ireland for treating preeclampsia is €6.5 million per year, when 5% of the pregnancy present this complication [20].

The virtual community platform helps to identify the patterns and medical events which drive the preeclampsia outcomes based on the registered patients. It also enhances the examination of the factors which sustain self-management, education for the medical school students and the proper management of the cases where the illness is present. The existence of such a platform is important because it supports the pregnant women, providing them the pace of searching more information about the illness on the Internet, avoiding the invalid information which exists online [21].

The lack of proper information implies high costs, decreased productivity, leading even to the death of the mother and infant. The communication between the patients and the medical staff is enhanced. The virtual communication aims to have good outcomes, because it has been proven a good relationship between counseling, monitoring the women suffering from preeclampsia, self-care prevention and control [22].

2.1 System features

Based on the previous research [23-25], the virtual community consists of a personalized self-management feature, patient tracking and a decision support feature. The personalized self-management feature provides the patients the ability to link their smartphone with the smart bracelet which monitors the blood pressure and the heart rate of the person. The measured parameters are sent using the Bluetooth technology from the smart bracelet towards their mobile phone. The patient can add via the mobile application her relatives and the medical staff who is related to her medical
All the associations between the patient and another person are stored inside the system's database.

The patient tracking feature offers an insight regarding the blood pressure and heart rate measurements. The values are monitored based on a set of indicators for alerting the patient, the associated medical staff and relatives, in case of hypo or hypertension, respectively bradycardia or tachycardia. The factors which influence the heart rate are age, physical activities, dietary products, smoking activity, cholesterol, diabetes, emotions, weight and medication [26, 27].

The decision support feature empowers the pregnant women to manage their health based on the result of the automatic analysis done using the input data which is provided by the system's ontology that comprises information about diseases, medication, symptoms and treatments. The associated medical staff can provide further information about the patient who is linked to them by providing HL7 medical records or by writing a description about their health state. The description is analyzed using natural language processing and the system's ontology. All the triggered information is stored for the specific patient and is used for further analysis.

The aim of the virtual community platform is to reduce admissions and readmissions to the healthcare unit and to support the patients who are outside the hospital or clinic.

2.2 Learning about preeclampsia using big data

As the healthcare industry develops, big data technologies started to be used for enhancing the quality of the medical services [28]. In order to manage high volumes of data in a system which is enlarging each year, four types of analytics are used [29]. Descriptive analytics provides information about the event occurrence. Diagnostic analytics explains the reasons due to which the event happened. Predictive analytics is based on the use of machine learning and offer trends regarding the outcomes. Prescriptive analytics provides the right actions which will enhance the proper decisions.

The contribution of the current paper is to present a healthcare platform which incorporates a virtual community in order to store, process and analyze big amounts of data. The architecture of the virtual community platform is depicted in Fig. 1. The virtual community platform has the view developed in AngularJS. The controller is based on Node.js. The input regarding the diseases, medication, symptoms and treatments are stored as concepts, along with their relationships inside the MongoDB database. Moreover, the illnesses, medication, symptoms and side effects belong to the DrOn [30] and SYMP ontology [31]. They are also stored inside the MongoDB database.

![Figure 1. Preeclampsia virtual community platform architecture.](image)

The input HL7 messages and descriptions about the health status of the patient, along with the diagnostics and treatments provided by the medical staff, are analyzed using Elasticsearch. The
registered patient who has the system's smart bracelet will also send in an encrypted format the blood pressure and heart rate values.

All the input descriptions are added into a memory array of the Kafka technology. Every description, diagnosis and treatment is stored inside Elasticsearch based on the information taken about illnesses, medication, symptoms and side effects which exist inside MongoDB.

The data from Elasticsearch is visualized by the platform admin using Kibana. Elasticsearch for Apache Hadoop (ES-Hadoop) allows the indexation of Hadoop data into Elastic Stack, having as outcome an increase in the processing speed of Elasticsearch. With ES-Hadoop, data is moved in both directions between Elasticsearch and Hadoop.

The Hadoop Distributed File System (HDFS) serves as backup for Elasticsearch. ES-Hadoop indexation and querying of Elasticsearch is done using Hive [32]. The architecture of the virtual community platform comprises the Elastic Hadoop connector for integrating Elasticsearch with Hadoop, as well as in case of disasters and for recovery means.

3 RESULTS

The virtual community platform uses Elasticsearch for Apache Hadoop in order to process in a distributed manner the health state descriptions, diagnostics and treatments using the Apache Hive technology.

Hive queries patient data, test results, diagnostics and treatments, along with genetics and protein datasets. In this way, the clinical professors and university students who study medicine analyze the appearance of preeclampsia and the treatments are adjusted based on the existent knowledge base. Moreover, the complications can be treated at an early stage. All the past records regarding the health state descriptions, diagnostics and treatments are kept as a backup inside HDFS.

By having access to the virtual community, pregnant women can manage their health, while the overall costs and readmissions are lowered. Unneeded visits to the hospitals and clients are cancelled, because along with the posts coming from the patient and medical staff side, the blood pressure and heart rate measurements are delivered to the system. Based on the gathered measurements, it is determined if the patient suffers from hypo or hypertension, respectively bradycardia or tachycardia.

The virtual community can be used by any person, not matter the geographical position or the ethnicity. A study done in the rural Romania outlined several such experiences [33]. The main scope of the platform is for the pregnant women to keep in touch with their medical staff while being away from the healthcare unit and to give birth safely. Virtual communities platforms can be used for better advising the farms regarding the animal science management [34-37].

4 CONCLUSIONS

The patients and the medical staff are empowered to use a virtual community platform to be more connected, informed and manage properly the appeared health conditions during pregnancy. The platform allows the patients to introduce descriptions about their health, as well as to share the measurements results regarding their blood pressure and heart rate, by using the system's smart bracelet.

Based on the collected data, the medical staff investigate the patient’s status and provides feedback which contains information about the diagnosis and treatment. This is used to build the database of records which is involved during a later stage for the decision support tools that are good for the clinical professors, as well as their students.

The platform can be used in an ambulatory or healthcare unit setting. Pre and post health care services enhance the clinical decision making.

REFERENCES


