Application of Analytics to Big Data in Healthcare

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Abstract- *In the current age of smart phones and wearable devices, vast amounts of patient health data files forming Big Data are being placed into large databases where they can be accessed by multiple users including doctors, caregivers and patients. The estimated spending on healthcare in 2015 in the U.S is around $3.2 trillion, which triggers the question of improvement of patient care while containing the costs. The objective of the present study is to review a few applications of analytics of Big Data in the healthcare field and the associated outcomes. Big Data is generally characterized by the volume, velocity, variety and veracity of complex data. Many hospitals have applied analytics to big data from various sources including patient health records to achieve overall improvement in healthcare. Operationally, most of the pertinent data of patients are made available on demand so doctors can see how other treatments have worked globally and apply relevant results to facilitate better decision making and interventions. Making proper use of big data analytics in healthcare can lead to improvement in care delivery coupled with significant cost savings. Concurrent challenges to be addressed include accessibility, privacy, security, usability, implementation costs, transportability, interoperability, and standardization. In conclusion, employing efficient and streamlined analytics to big data will contribute to quick and accurate diagnosis, appropriate treatment, reduced costs and improved overall healthcare quality.*

I. Introduction

In the current age of smart phones, wearable devices and IoT, large amounts of health data files forming "Big Data" are being placed into databases where they can be accessed by multiple users including doctors, caregivers and patients. Big data analytics in Healthcare (BDAH) is envisioned to become the new norm as it will streamline the process of input and retrieval of healthcare information. In order to reduce the enormous healthcare costs and to improve the outcomes, BDAH involving proper analysis of huge amounts of patient data in conjunction with the knowledge of treatments must be carried out in hospitals. The objective of the present study is to review the applications of big data analytics in healthcare.

II. Background

Big Data is generally characterized by the velocity, volume, variety and veracity of complex data [1]. BDAH used to treat one patient can potentially be used to treat another patient with the same or a similar illness. The steps in the BDAH process will allow care delivery to thrive both in diagnosing patients and coming up with new treatments. Many hospitals and clinics have taken advantage of electronic health records (EHR) and their utilization has contributed to positive results as evidenced in many hospitals and clinics globally.

It has been reported that there are over 5 million patients with heart failure, costing around $32 billion annually in the U.S [2]. In the U.S. alone, it is said that around $3.2 trillion will be spent on healthcare in 2015. An estimated amount of about $300 billion can be saved each year for U.S. healthcare if big data analytics is used [3].

III. Healthcare Applications of Big Data Analytics

Using BDAH is one solution to the problem of spending in healthcare. Analytics of Big data can be applied in the diagnosis of diseases, in the treatment of illnesses and can help reduce the amount of readmitted patients that go to hospitals. A few examples of application of analytics to big data in healthcare for disease diagnosis, treatments and readmissions of patients are given in the following section.

A. Diagnosis

IBM's PureData Solution for Healthcare Analytics is integrated software that helps hospitals and clinics to use healthcare analytics [4]. This software is built to deliver rapid results while minimizing risks. Currently, Seattle's Children's Hospital is using big data analytics to improve diagnosis and patient care. They are doing this by using IBM's Big Data technology to help diagnosis in the cases of their estimated 350,000 patients. This system can detect commonalties between patients, making diagnosis and treatment easier and more accurate. The system pulls data from 10 different sources throughout the hospital, look back at the hospital's history to see where additional resources are needed for faster and more accurate diagnosis.

A group of researchers from Massachusetts General Hospital and MIT have developed a computer model that can distinguish between different types of lymphoma [5]. This new model analyzes large sets of data from thousands of cancer patients to come up with a specific course of treatment. In order to simplify the model, the researchers converted the pathology results into graphs that can help track trends and diagnoses and incorporate with WHO guidelines. The technology is expected to reduce 5 to 15% of misdiagnosed or misclassified lymphoma, and use the resources for diagnostics for other patients [5].

B. Treatment

BDAH can track results and outcomes of various patients and also map their DNA information to come up with new treatments for cancers and other diseases. The Collaborative Cancer Cloud platform developed by Intel and Oregon Health and Science University will allow hospitals to share important patient information in order to more precisely treat cancer [6]. Doctors can also access other cancer patients' DNA and compare it with their own patients' DNA. BDAH facilitated analysis of trends and commonalities across patients enabled the doctors to come up with better treatments. The approach is extended to Alzheimer's, autism and some genetically related diseases.

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The Division of Cardiology at UCSF is employing data from multiple devices such as AliveCor's portable ECG linked to a smart phone, apps that track diet and exercise, and body composition and genetic information to learn more about heart disease while coming up with better ways for treatment. Apps and programs are created to alert the patients regarding when they should be exercising more, eating better, etc. About 4,000 adults are enrolled in the program globally [7].

IBM's Watson Health is a supercomputer that allows health firms to create their own applications, products and data analytics [8]. Watson Care Manager (WCM) is a system that uses Apple's health applications to collect and share relevant information with physicians to achieve better diagnosis and treatment. At Boston Children's Hospital, WCM is applied in the case of pediatric patients for heart health, personalized medicine and critical care. Columbia University's cancer center is using Watson to decode DNA and come up with personalized cancer treatments.

BDAH is employed at Beth Israel Hospital with MIT and Aptima using Risky States to enable physicians to predict what patients are at risk for developing complications while in the ICU, and make appropriate proactive decisions [9].

C. *Readmission*

Readmission of patients can be caused by mismanagement, misunderstanding and lack of access to all the pertinent data, and the socioeconomic status of the patient. When doctors are treating preventable readmissions, part of their time to be spent on new patients is lost and there is a loss of revenue to the hospital. Using predictive analytics, Intel and Cloudera have reduced readmissions by 6,000 people, saving around $4 million in Medicare penalties and $72 million in medical service costs, while freeing physicians' times [10].

Piedmont Healthcare's Patient First has led to a 50% improvement in the length of stay of cardiovascular patients, a 10% reduction in readmission rates of heart failure patients and a 12% reduction in readmission rates in heart attack victims, while saving more than $2 million in consulting services [3].

IV. Challenges with Big Data Analytics in Healthcare

While big data analytics is useful for patient care, challenges such as loss of privacy, data security, user friendliness, implementation costs, transportability and interoperability are encountered. In order to ensure the privacy and infallibility of big data and BDAH, adherence to standard guidelines and procedures is required [11].

Due to the wide range of data and the demand for access, fragmentation must be avoided. Due to the high volume of data being processed, the timeliness of patient care could be compromised when trying to analyze vast amounts of data for making appropriate care delivery decisions.

V. Recommendations to Address BDAH Challenges

Using a secure BDAH system with ways to prevent access by unauthorized persons and hacking to the extent possible is recommended. Some of the ways to prevent cyber-attacks on medical devices include changing the password to something only the user knows and ensuring the device is only used on secure Wi-Fi networks, updating related security applications and patches, and making sure that the devices are used for their intended purposes. Acceptable standards must be followed so as to reduce system vulnerabilities that could allow access to the data by unauthorized people [12].

In order to create the correct modules combined with necessary precautions, it is critical to understand the objectives of the database and what information will be used and analyzed. Cost savings can be accomplished over a long term. Ensuring that the quality of the data is in conformance with applicable standards will allow for the best possible patient care and treatment. The benefits of BDHA outweigh the challenges encountered. Through remote consultations, more lives can be saved globally. BDHA provides greater and faster access to patients' medical history, and reduces the risk for mistakes in treatment, thus improving efficiency and timeliness in diagnosis and treatment while also reducing costs due to readmission and other preventable mistakes.

VI. Conclusion

In conclusion, employing healthcare analytics with efficient organization, streamlining and analysis of big data, will ensure prompt and accurate diagnosis, reduction in preventable mistakes, and appropriate treatment, thus proving to be beneficial to the overall healthcare delivery.

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