Big Data Analytics in Healthcare: Transforming Patient Care, Operational Efficiency, and Stroke Management

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Abstract

A significant amount of sensor data and patient health data files are being created in the current era of smart phones and wearable technology. Big data analytics is crucial to resolving problems and obstacles in the healthcare industry. The healthcare industry generates enormous amounts of data that big data can handle. Every day, a variety of devices generate petabytes of data, which, when examined, can provide insightful and practical data-driven solutions for patient care. This paper provides an overview of the various healthcare applications of big data analytics, along with an analysis of the associated problems and potential tools and technologies for healthcare clouds. Big data has the power to transform the healthcare sector and enhance clinical trial monitoring quality and operational efficiency.

Keywords: Big Data Analytics; Healthcare; Stroke Data Dashboard; Challenges; applications;

1. Introduction

Every day, a vast amount of data is generated globally, with the healthcare industry being one of the main contributors to this data. IOT, wearable technology, smart gadgets, and electronic medical records (EMR) are all being used more often. Data is expanding at an unmanageable rate in the modern era. Digital data pertaining to health is being generated in various forms, such as clinical data and insurance claims.

A large portion of healthcare data is both structured and unstructured. Thus, processing healthcare data effectively is beyond the capabilities of standard database systems. In order to get meaningful insights from the copious amounts of data being generated, the healthcare industry must now incorporate big data analytics, tools, and approaches. Analytics has completely transformed the way healthcare is provided, giving health a new definition.

Big Data analytics is capable of analyzing a wide range of intricate, abundant data features and producing insightful results. When used in the healthcare sector, it can reveal latent patterns and trends that result in higher-quality care at lower costs, allowing for quicker decision-making. Big data analytics in healthcare also makes it simple for hospital administrators and physicians to enter and retrieve patient data.

Big data comes from a variety of sources in the healthcare industry, such as lab results and drug research, social media, patient records and claims, mobile apps, remote monitoring, etc. In the past, the healthcare sector produced a large amount of data that was derived from patient treatment and record-keeping. There is currently a tendency towards the vast amounts of data being rapidly digitized. Big data's rise will likely present more opportunities in the healthcare industry. Big data analytics allows us to extract data and transform it into insightful knowledge. By lowering healthcare costs and utilizing high performance computers, useful insights can assist improve healthcare and give patients better care. Finding effective and secure methods for processing data is one of the industry's biggest challenges.

In this study, we will focus on the use of big data analytics in healthcare, its advantages and disadvantages, and the need for high-performance computers in the field.
Context: Big data is commonly referred to as "Big" due to its volume, generating speed, variety, and validity of complicated data. When big data analytics are applied to healthcare, a patient's condition may be treated in a way that benefits another patient. The several stages in the procedure would aid in the patient's diagnosis and in the

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identification of other people who may have the same illness. Based on available reports, it is possible to estimate that the US might save approximately $300 billion annually on healthcare costs by implementing big data analytics.

2. Literature Review

[1] Big data analytics is critical to healthcare in areas like rapid epidemic detection, better patient management, and patient diagnostics. The purpose of this profiling study is to provide an overview of the dynamics of big data analytics publications in the healthcare industry and to stimulate discussion in this field of science using relevant cases. In order to compile the literature review, a large number of papers have been examined and analysed. The detection and treatment of high-risk patients, the use of large data sets, the use of Hadoop and cloud computing in genomics, and the creation of mobile applications for illness management are all topics covered in well-cited publications. The study of enhancing illness prediction by examining patients' medical outcomes through sophisticated analysis (such as segmentation and predictive modelling, machine learning, visualisation, etc.) is also significant.

The use of big data analytics in the healthcare industry is growing daily due to the massive amount of data being generated in this sector. As a result, the healthcare industry is implementing tools and technology that need to handle large amounts of data. With the insights from big data analytics, decision makers in healthcare organisations will be able to act appropriately for the circumstances. About 30% of research publications addressed and clarified the application of big data analytics in the healthcare industry to enhance patient care and hospital operations.

Big Data Analytics (BDA) in healthcare is a transformative force, enhancing patient care, operational efficiency, and stroke management through the analysis of large and complex datasets. The literature reveals that BDA can significantly improve patient outcomes by personalizing care, advancing treatment options, and fostering better provider-patient relationships [10]. It also plays a crucial role in shifting healthcare towards a patient-centric model, offering high-quality care at an affordable price [11]. In the context of stroke management, BDA facilitates the rapid and efficient improvement of healthcare services by evaluating clinical data to enhance physicians' practices and patient care [12][13]. Healthcare professionals leverage BDA and machine learning to make informed decisions about personalized medicine and treatment plans, which is particularly relevant in acute medical conditions like stroke [14]. Operational efficiency is another area where BDA has a significant impact. By addressing disease diagnoses and prevention, BDA helps healthcare institutions improve service delivery while managing resources more efficiently [15]. Moreover, the integration of BDA with cloud computing and biometric systems further strengthens its role in enhancing operational efficiency in healthcare [16]. However, the adoption of BDA in healthcare faces challenges, including data security, privacy issues, and the need for actionable objectives to maximize its value [15][16]. Despite these challenges, the potential benefits of BDA in improving service delivery, reducing costs, and managing patient care are well-recognized [17]. The literature also emphasizes the importance of addressing technical issues in current health data analytics platforms to ensure the effective collection, aggregation, processing, analysis, visualization, and interpretation of health data [18]. Finally, the healthcare industry's increasing demands highlight the need for improved data governance, strategy formulation, and IT infrastructure to support the application of BDA in healthcare [19]. The literature suggests that BDA is a key driver in transforming healthcare by enhancing patient care, operational efficiency, and stroke management. While challenges exist, the continued evolution of BDA technologies presents opportunities for significant advancements in healthcare delivery and management.

3. Application of Analytical Methods

Big data analytics has numerous prospects in the healthcare industry to improve the calibre of different healthcare elements through the application of analytical methods such as descriptive, predictive, and prescriptive.

a) **Medical diagnostic:** Making a diagnosis based on historical data can assist identify an illness early on and lessen treatment-related problems.

b) **Community healthcare:** By informing individuals about infectious illness outbreaks, preventive measures can be done in advance of the population's anticipated risks of chronic disease.

c) **Hospital Monitoring:** Real-time hospital monitoring could assist the government in guaranteeing the highest level of service quality.

d) **Patient care:** By employing big data analytics, hospitals may provide patients individualised patient care services that will help them feel better quickly.

3.1 Frequent Difficulties in the Region

While big data analytics presents benefits in the healthcare industry, it also presents certain obstacles. There are not many obstacles in the way of using big data analytics in healthcare. Among the frequent difficulties in the region are:

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(a) Initial expenditure: Deploying the infrastructure needed to fully utilise the advantages of big data involves a significant initial expenditure.

(b) Data Quality: Because big data is a relatively new topic, there aren't as many experts in it.

(c) Quality of insights: There are a lot of inconsistencies and low quality medical healthcare data being generated.

(d) Privacy and Security - It is extremely problematic to allow unauthorized parties, including government agencies or insurance firms, access to and disclosure of patient data.

3.2 Obstacles Encountered in the Healthcare Sector

3.2.1. Health tracking: In the era of IOT, simple wearables may monitor and identify a patient's heart rate, sleep patterns, level of exercise, distance travelled, and other factors. i.e., daily readings of these elements can be monitored. In addition to these, modern medical advancements include pulse oximeters and blood pressure monitors, among many other things. Healthcare organizations can prevent hospitalization by identifying potential health issues early on and providing care before conditions worsen thanks to continuous body monitoring and sensor data collecting.

3.2.2. Cutting Costs: Hospitals often overbook or underbook staff members because they are unsure of how many employees they actually need. Hospital expenses can be reduced with the use of big data analytics. By anticipating patient admission rates and assisting with staffing levels, predictive analytics can help address this problem. This will enable the institution to get the most out of their investment. The healthcare sector also thinks that predictive analytics would result in 25% higher yearly cost savings for businesses.

3.2.3. Helping High-Risk Patients: Data can be used to comprehend the trends of numerous patients if hospital records are digitalized. This would aid in comprehending the chronic problems of the patients who come to the hospital on a regular basis. This knowledge can improve patient care in hospitals and offer guidance on corrective actions to cut down on patients' recurrent hospital visits. Additionally, by keeping a list of high-risk patients, healthcare organizations may monitor them and provide them with individualized care.

3.2.4. Preventing Human Errors: It has frequently been noted that medical personnel either give patients the incorrect prescription or accidentally give them the wrong drug. Physicians who see a large number of patients in a given day can benefit from big data analytics. Both user data and prescription medication are analysed by big data tools. In order to prevent errors and save lives, this can validate the data and authorise the recommended prescription.

4. Methodology

[4] Clinical and genomic data, as well as data from a variety of devices, are the sources of healthcare data. There are two types of data: semi-structured and unstructured. Together, big data and cloud computing enable the processing of unstructured data. Data is gathered and processed using data-intensive programming paradigms, such as the MapReduce distributed storage system, on a variety of cloud computing platforms.

There are numerous cloud providers for the open-source Hadoop technology, including Cloudera and AWS (Amazon Web Services). Since they're all cloud versions, huge data can be handled with them. MongoDB and HBase are only two examples of NoSQL databases. These are open source and cost-free, however they don't have as many features as databases in the cloud. Big data analytics are applied in the healthcare industry using open-source cloud platforms such as MapReduce and Hadoop. Terabytes of streamlining data, including text, audio, video, image, and sensor data that are generated and efficiently processed, are used by healthcare applications.

5. Result and Discussion

A lot of study has been done to confirm the use of big data analytics in the medical field. Big data analytics in the healthcare industry aids in exposing the obstacles and uncovering untapped potential. Information retrieval success is based on the organization's data security, privacy, and quality. Utilising cutting-edge technologies like cloud computing, artificial intelligence, and in-memory databases, it is now also possible to receive smart healthcare services that enhance the overall effectiveness of the healthcare system. [2]

Big data analytics capabilities in healthcare encompass a wide range of applications, providing valuable insights and improvements across various aspects of the healthcare ecosystem. Here are several key capabilities:

5.1. Electronic Medical Records (EMRs):

It is the most extensively used big data application in medicine. Each individual possesses a digital dossier containing personal details, medical background, allergy information, test results, and more. Providers from the public and private sectors can access and share records using secure information systems. Since each record

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consists of a single editable file, physicians can make changes over time without having to worry about paperwork or data replication.

EMRs can also track prescriptions to determine whether a patient has been adhering to doctor's recommendations, or they can trigger cautions and reminders when a patient has to have a fresh blood test.

5.2. Real Time Alerting:

[9] Real-time alerting in healthcare refers to the capability of a system to generate and deliver immediate notifications or alerts to healthcare providers or relevant stakeholders based on certain predefined conditions or triggers. These alerts are designed to promptly inform healthcare professionals about critical events, changes in patient status, or other important information, allowing for timely intervention and improved patient care. Real-time alerting systems can be integrated into Electronic Health Records (EHRs) or other healthcare information systems.

For instance, in the event that a patient experiences an unusually high blood pressure reading, the system will immediately notify the physician, who will then take appropriate action to contact the patient and use pressure-lowering techniques.

5.3. Predictive Analytics In Healthcare

Predictive analysis has been identified as one of the major developments in business intelligence for the past two years, but its prospective uses are not limited to the commercial world; they extend far into the future. In order to build a database for predictive analysis tools that would enhance the provision of treatment, Optum Labs, a US research partnership, has gathered the electronic health records of over 30 million patients.

[9] Online business intelligence for healthcare aims to improve patient care by enabling physicians to make data-driven choices quickly. This is especially helpful for people who have complicated medical histories and several ailments. Additionally, new BI tools and solutions would be able to anticipate, for example, who is at risk of diabetes and recommend further screenings or weight management as a result.

5.4. Reducing fraud and enhancing security

Reducing fraud and enhancing security in healthcare is crucial to safeguard patient information, maintain the integrity of healthcare systems, and prevent financial losses.

5.5. Telemedicine

Telemedicine refers to the use of telecommunications technology, such as video calls, phone calls, and secure messaging, to provide remote healthcare services. It allows patients to consult with healthcare professionals, receive medical advice, and even undergo certain diagnostic and monitoring procedures without being physically present in a healthcare facility. Telemedicine has become increasingly popular due to advancements in technology, improved internet connectivity, and the need for convenient and accessible healthcare services.

5.6. Integrating big data with medical imaging

Integrating big data with medical imaging involves leveraging large-scale datasets and advanced analytics techniques to extract valuable insights, improve diagnostic accuracy, and enhance patient care.

6. Usage of Big Data in Healthcare

6.1 Big Data in Healthcare Applied on a Health Care Stroke data dashboard

This Health Care Stroke data dashboard below provides you with the Condition of stroke patient. Gathering in one central point all the data on every aspect of the Patient, the age, gender, its nature, etc., you have the big picture of your facility, which will be of great help to run it smoothly.

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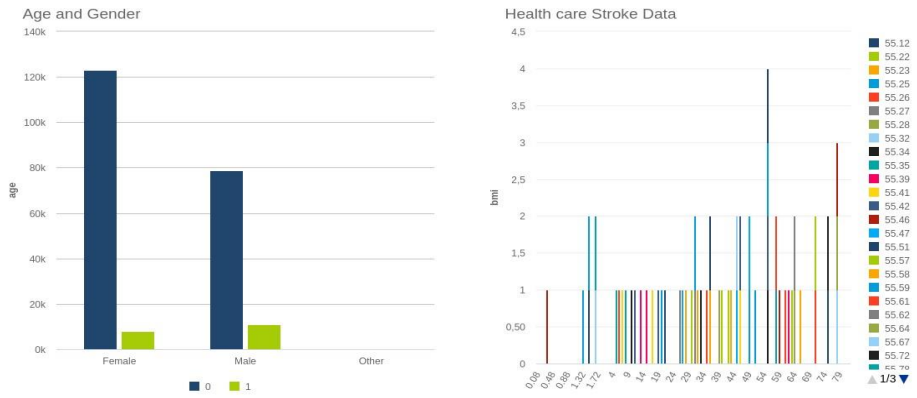

Figure 1: Big Data in Healthcare Applied on a Health Care Stroke data dashboard

7. Conclusion

Investigating the uses, advantages, and difficulties of applying big data analytics in healthcare is the goal of a systematic review. Numerous research articles undergo extensive reviews and analyses. The results of the study demonstrated the critical role that BDA plays in raising the effectiveness of healthcare organizations operations. Big data analytics is becoming a more exciting area in healthcare, offering insights from very huge datasets and lowering costs while improving results. Accurate disease diagnosis, less errors and costs, Medicare treatment that is appropriate and overall healthcare delivery would all be greatly benefited by using healthcare analytics with effective organizations, streamlining, and big data analysis. However, data security and privacy issues provide a significant barrier to the use of big data in the healthcare industry. It would be beneficial for BDA to consider employing more sophisticated instruments and technology to close these gaps. Examining the use of big data tools and technology in healthcare is the main goal of this article. Insights into how to give data-driven services to the public and how to leverage Hadoop and Spark to do so. Massive data analysis outcomes will be produced by big data technology and tools that are necessary to advance the health sector.

References

[1] Shankar Krishnan Ph.D. Biomedical Engineering, Wentworth Institute of Technology, 550 Huntington Avenue, Boston, “Application of Analytics to Big Data in Healthcare”, 32nd Southern Biomedical Engineering Conference - 2016

[2] Sachin S. Kamble, Angappa Gunasekaran, Milind Goswami & Jaswant Manda, “A systematic perspective on the applications of big data analytics in healthcare management”, International Journal of Healthcare Management – 2018

[3] Gande Akhila,Hemachandran K,Juan R Jaramillo. "Indian Premier League Using Different Aspects of Machine Learning Algorithms." Journal of Cognitive Human-Computer Interaction, Vol. 1, No. 1, 2021 ,PP. 01-07.

[4] Sayantan Khanra, Amandeep Dhir, A.K.M Najmul Islam & Matti Mantymaki, “Big data analytics in healthcare: a systematic literature review” - 2020

[5] A.Rishika Reddy, P. Suresh Kumar, “Predictive Big Data Analytics in Healthcare”, Second International Conference on Computational Intelligence & Communication Technology - 2016

[6] Raghunath Nambiar, Ruchie Bhardwaj, Adhiraaj Sethi, Rajesh Vargheese, “A Look at Challenges and Opportunities of Big Data Analytics in Healthcare”, IEEE International Conference on Big Data- 2013

[7] Nishita Mehta, Anil Pandit, “Concurrence of big data analytics and healthcare: A systematic review”, International Journal of Medical Informatics - 2018

[8] Wullianallur Raghupathi, Viju Raghupathi, “Big data analytics in healthcare: promise and Potential”, Raghupati and Raghupati Health Information Science and Systems - 2014

[9] Ashwin Belle, Raghuram Thiagarajan, S. M. Reza Soroushmehr, Fatemeh Navidi, Daniel A. Beard, and Kayvan Najarian, “Big Data Analytics in Healthcare”, Hindawi Publishing Corporation BioMed Research International Volume – 2015.

[10] https://www.datapine.com/blog/big-data-examples-in-healthcare/

DOI: https://doi.org/10.54216/JCHCI.080101
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[11] Lidong Wang, Cheryl Ann Alexander, "Big Data Analytics in Healthcare Systems", International Journal of Mathematical, Engineering and Management Sciences, Feb 1, 2019.

[12] Anil Pandit, Nishita Mehta, Meenal Kulkar, "Elements of Healthcare Big Data Analytics", Symbiosis International University, October 2, 2019.

[13] GUNASEKAR THANGARASU, K. R. V. Subramanian, "Big Data Analytics in Healthcare Services", Science Proceedings Series, Kolej Universiti Linton, Universiti Teknologi Petronas, Apr 24, 2019.

[14] K. R. V. Subramanian , Gunasekar Thangarasu," Big Data Analytics for Improved Care Delivery in the Healthcare Industry", International Journal of Online and Biomedical Engineering (iJOE), Petronas (Malaysia), Kolej Universiti Linton, Jun 27, 2019.

[15] Ashok Kumar M ,Abirami A,Sindhu P,Ashok Kumar V D ,Rani V. "Modern Medical Innovation on the Preferred Information about the Medicine using AI Technique." Journal of Cognitive Human-Computer Interaction, Vol. 1, No. 1, 2021 ,PP. 8-17.

[16] Fernando Rogelio Simonato, Federico Del Giorgio Solfa,"Big Data Analytics in Healthcare: Exploring the Role of Machine Learning in Predicting Patient Outcomes and Improving Healthcare Delivery", International Journal of Computations, Information and Manufacturing (IJCIM), Jun 23, 2023.

[17] Brenda Eschenbrenner, Rachel Brenden "Deriving Value from Big Data Analytics in Healthcare: A Value-focused Thinking Approach", AIS Transactions on Human-Computer Interaction, Sep 30, 2022.

[18] Cheryl Ann Alexander, Lidong Wang , "Big Data Analytics in Biometrics and Healthcare", Journal of Computer Sciences and Applications, Jun 4, 2018.

[19] Ajit Kumar Roy, "Advances and Scope in Big Data Analytics in Healthcare", Current Trends in Biomedical Engineering & Biosciences, Sep 22, 2017.

[20] D. Sridharan, M. Ambigavathi, "Big Data Analytics in Healthcare", Anna University, Chennai, Dec 1, 2018

[21] Shreyas Nopany , Prof. Manonmani S, "Applications of Big Data Analytics in Healthcare Management Systems", Journal of University of Shanghai for Science and Technology, Jun 19, 2021.

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