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HEALTHCARE ANALYTICS: SCOPE AND TRENDS

Sanchi Dhingra¹, Pramod Damle²

Symbiosis Institute of Digital and Telecom Management,
Symbiosis International (Deemed University), Pune, India.

Email: pdamle@sidtm.edu.in

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ABSTRACT

Healthcare industry is excessively dependent on huge amounts of unstructured and structured data leading to increased utilization of data mining and analysis techniques. Even when the world is fighting with pandemics like Coronavirus, the healthcare quality provided by various hospitals is a major concern making it necessary to streamline the process with trending technologies and algorithms. This descriptive research focuses on the contemporary scenario and the future scope of analytics in this field. It includes analysis of the current technologies like Big data, predictive and prescriptive analytics for narrowing down the process of data usage. The data is based upon patients' demographics, history, insurance, payment and therefore can be visualized efficiently by optimizing Data collection, requirement gathering, and feedback-based improvement techniques. The paper examines the scope of advanced decision-making done by using various available technologies like electronic health records and cloud computing. Its objective is to reduce the time of data analysis, with increasing the cost-effectiveness in order to benefit the Healthcare field, thereby simplifying the medical care process for institutions as well as for common people. This study concludes with a comparative position of a few applications in the related function available in the market.

1. Introduction

The Healthcare industry is an economically important industry that is facing several challenges and barriers. To survive in such hard times of facing situations like COVID-19, the industry needs to come up with innovative

competitive strategies, consumer satisfaction and sustainable maturation of healthcare services.

The importance of excellence in imparting medical education through medical colleges and embedding analytics from the start will be an innovative solution to a lot of challenges. There is a great need for technically skilled experts who can help in situations where a patient cannot come physically for treatment and the use of medical history can be implemented. [1]

With medical history for years, the data which is associated with healthcare is huge and the requirement for its maintenance, backup and cleaning is of utmost importance. Storage of data and then analyzing the data as per the need is core for Healthcare analytics. [2] Proposed techniques of using tools will reduce time and complexities by increasing efficiency and decision-making systems.

Data mining refers to studying all the information from different viewpoints and concluding the results and observations. There are various techniques and algorithms to go ahead with the analysis and visualize the findings for future predictions and prescriptions.[3] The analysis of any sector can improve by considering Customer feedback, as it provides live insights, service reviews and scope of improvements. Data can also be collected from smart wearables used to track the health informatics of patients

The use of business analytics conceptualizes, interprets and optimizes the multidimensional inputs into an operationalized output by taking into consideration all the functionalities, constraints. In healthcare, the valuable knowledge by using different tools effectively can increase the efficiency of various medical units. Digital health has overall improved the experience for patients by providing portals for gathering information on medical services, monitoring applications and scheduling appointments. There are applications to conduct online appointments with medical staff. Regular server uploads and updates provide opportunities to physicians and staff for real time patient data with all the required history of patients.

With the ever-evolving treatment models, pharmaceutical services and payment systems, the demand for exploration of patients' symptoms, characteristics, insurance have increased with huge dependency on data.[4] Poorly structured data and fragmented health records are one of the major issues which leads to inaccurate service deliveries.

The research paper aims to find all the current execution of analytics in the medical industry, with the scope of future trends and how analytics can improve the overall sustainable advantage for the industry and consumers.

2. Big Data Analytics

A. Importance

The amount of data stored is in various formats of structured, semi-structured, and unstructured which requires large storage platforms.[4] All the information will lead to the right innovative solutions for medical symptoms stored for patients. According to Sunil Kumar, in the present scenario, most of the data is stored physically in the form of files and scripts. It is high time that the data should be digitally transformed into cloud-based storage for effective retrieval

and storage. Big Data Analytics revolves around finding outputs from a large set of input data which is difficult to store traditionally.[5]

B. Volume

The volume refers to the amount of data collected for various purposes in the medical industry as feedback, insurance, medical records, prescriptions, medical reports and doctors' comments with patients' history. It is required for exploration and prescriptive analysis for future growth and cure [4]. With a great amount of quantity comes the responsibility of maintaining quality by cleaning the data, reducing redundancy and empty set of records.

C. Velocity

The speed at which the data is increasing is fast, and there are millions of patients being cured in a single day.[4] The system handling all the data requests should be robust to store and manipulate data. Decisions are also taken at a fast pace, with the requirement of storing the decisions also.

D. Variety

The data being acquired by different means of pharmacy, hospitals, clinics, online appointments, etc. is of various types and all of them are required for data-based decision-making.[4] Different types of data must be synchronized to be stored in a systematic and congruent manner so that it is easy to retrieve it.

E. Veracity

It implies the consistency and accuracy of data being used for the industry from various resources.[4] Healthcare is an important industry as the lives of people are at stake so poor quality or uncertainty of data being used for analysis can prove to be fatal. Reducing error residuals will lead to trustworthy analysis algorithms for efficient results.

3. Predictive Analytics.

The analysis of useful insights from the data to improve the precautionary steps taken for achieving the right results is Predictive Analysis. Various factors influence the results for predicting health outcomes like socio-economic conditions, obesity, urban outdoor air pollution levels, drug reaction history, and lifestyle. [6]

This approach can be of great benefit to aid in the discovery of drugs, optimizing costs for insurance, help in taking decisions related to health, improve care facilities and monitoring, provide assistance for staff, facilitate the management of diseases and reduce fraud.

A. Electronic Health Records

Electronic health records are digitally stored medical records of patients of their history and details. It is maintained by the authorized healthcare

organization. Only doctors and staff with access to the record can edit and view the details.[7]

EHR requires quality and security assurance from time to time, for effective execution. Billing details and coding for appointments should be entered cautiously as they are necessary for the next visits. Confidentiality and privacy of patients' data should be maintained, as personal data is stored, and everyone has a right to their content. Passwords, biometric and medication used should be maintained with expert security.

EHR has various use cases and applications in the industry like effective coordination at the administrative level, reducing data entry, increasing the productivity of lab results and records, maintaining clinical records of staff and doctors.

These are the major data points for analysis and have a huge impact on the output of patients' prescriptions.

B. Medical Image processing

The use of raw medical pixels and images from lab reports and machines to reach a conclusive predictive prescription is termed as Medical Image Processing.[8]

Image partitioning and segmentation are used to divide the image into parts that can be read differently and then collectively give a result. The images can be used from MR and CT scans. The accuracy is difficult to achieve but it is necessary for correct outcomes.

Structural and statistical methods are used for the segmentation of the image. Thresholds are assigned and the labels of the partitioned images are compared with the assigned threshold levels for conclusion on the image.

C. Applications

Predictive analytics has various benefits in the healthcare industry:

I. Scoring risk for chronic diseases and estimating fatality- This can help in preserving population from communicable diseases and stopping the progression of communicable diseases.

II. Remaining steps ahead for predicting patient's recovery-In serious conditions of a patient being admitted to ICU or on a ventilator, analytics will help to reach outcomes which can result in taking precautionary steps for patient's revival.

III. Avoiding missed appointments- There are various times when patients don't show up for an appointment without informing in advance, predictive analytics can identify these appointments well in advance and save a lot of time.

IV. Preventing self-harm or suicides- there are weak moments in which patients take major steps out of depression and anxiety. A well-defined study of symptoms shown by patients can help in preventing mishaps like suicides.

V. Optimizing the supply chain- Healthcare industry required various products like medicines, machineries, reports, and equipment forming complex

supply chains. Analytics can identify gaps in the chain and increase the time and cost efficiency.

4. Prescriptive Analytics.

In comparison to traditional business strategies, prescriptive analytics deals with increasing consumer satisfaction by analyzing huge datasets. It deals with predicting future outcomes or diagnosis pertaining to the healthcare industry. It uses dependent and independent variables for predicting outcomes. [9]

This analysis focuses on multiple possibility scenarios to know the advantage of one point on another. It reduces cost constraints and increases the efficiency of reaching out to the diagnostics and prescription of any disease. The decisions taken are optimized by taking all the causes and symptoms into consideration. It also leads to integration of different lab results into a collaborated result. It is an event-based analysis which gives accurate and reliable actionable results for taking preventive measures before reaching out to a final solution.

The results are actionable suggestions which empowers to take corrective steps in a process. It also helps in taking sound financial options according to the requirement of patients.

Algorithm used for predictive Analytics are:

- I. Classification: deciding the outcome variables on classifying dependent and independent variables to multi-variables and clusters for decisive results.
- II. Clustering: Dividing similar elements and factors into subgroups based on distance shared between centroids. This helps in predicting the cluster for a new entering element.
- III. Association rule: Finding rules which lead to a result from different premises. These are generally used in market-basket analysis, where predictions are made about what the customer will buy, based on his previous buying patterns. Likewise, it can be used in the healthcare sector for finding the diseases one can be prone to, based on the patient's history.
- IV. Regression: It deals with predicting the numerical outcomes based on trend analysis and dependency of multi-variables. It uses prediction models for the analysis.

5. Sentiment Analytics

The analysis includes gathering data from various sources like feedback, social media platforms, E-mails and product reviews and mining the sentiment of aspects formed with natural language processing.[11]

This helps in finding out what is satisfying the consumer and patients and also what are the dissatisfying aspects. The surveys can also include staff workers, doctors, nurses, etc. to find out the requirements and gaps in providing quality healthcare solutions to the patients.

Social media channels are important marketing platforms which increase the reach of any organization or service to a larger set of the target audience. With numerous online websites providing medical services to patients, reviews and ratings on these platforms is also a major cause of concern.

The overall comment, blog and reviews can be automatically tagged to be positive, negative or neutral, by the help of sentiment analysis. This helps in estimating the number of positive and negative aspects.

Once the responses are recorded and tagged according to the polarity of their response, they can be converted into clusters which can help in analyzing repeat patients or customers who are not satisfied. The top-rated feedback can be selected for viewing positive and negative aspects. These aspects can be used to improve the overall service provided by the units. The surveys can also include questions as to how a particular service can be improved for a better experience.

Sentiment analysis can be performed through various techniques like Text analytics, document-level analysis, sentence-level analysis, aspect-based analysis, lexicon-based analysis and Voice-based analysis. [11]

6. Data Visualization

After analyzing the data from different data points, it is important to present the conclusions in graphical reports and pictorial form for better understanding. It is important to transform tabular information to graphs and nodes which can help in analyzing the outcomes. [10] There are numerous ways of showing data in a pictorial format like bar graphs, histograms, pie-charts, heat-maps, correlation tables, clusters, hierarchical trees, dendrograms, bubble-charts and line charts.

There are various tools used for data visualization, which are:

- I. R programming: It is a basic programming open-source tool that has features of manufacturing data and displays data in different graphics.
- II. Tableau: It has numerous options for depicting data in forms of graphs, bar, pie, maps, timelines and clusters.
- III. Google Charts: It helps visualization by live histograms, cross filter, basic distribute filter and high portability.
- IV. SAS Visual Analytics: It has user interactive options like auto-chart suggestions, can be deployed on cloud storage, and discovers data of multi-dimensions.

7. Applications of Healthcare Analytics

A. Clinical constraints on operations

By systematic storage of data and retrieval means, the techniques, time and benefits of clinical operations can be optimized. The cost incurred by patients for various repetitive tests can be reduced.

B. Research and Development

If all the historical data, with images, facts and proper references are stored systematically, it can help in better results forming. The accuracy of the research can be increased.

C. Medicine diagnosis

Future predictions on what prescriptions to be given based on past lab reports and medical history can effectively make the whole process of check-ups time effective. The drugs which have previously been beneficial on a particular patient can be recorded as a positive drug for that patient and can be used as a reference in the future.

D. Genomic analysis

Studies based on genetic history and sequencing can be useful in finding diseases prone to an individual. It can also be used to find out the drugs and medicines which are effective for one. Family history can be used as data to reach the output.

E. Monitoring of devices and Machines

Analysis of timely services required to each machine and also the track of maintenance provided to them can be used to keep the machines from deteriorating. IoT devices can be a source of various data points.

F. Profile analytics

A file with all the details and history of services, diseases, specialization and education can be maintained for all the health workers. Likewise, profile management can be done for patients from different health sections. This will help in proper segmentation.

8. Services and Utilities

Various cloud computing services and network utilities are available which can enhance the quality of data usage in the Healthcare Industry. Big data can be stored efficiently and it reduces the complexity of processing and storage of data. Some of the tools are explained below.

A. Microsoft Azure

It is a cloud computing service for structuring, quality assurance, and controlling applications through central data centers. A lot of industries are already using the service for gaining agility, trust, streamlining interoperability, and improving operations.

The service uses the power of strong data on the cloud and focuses on innovating the services. The service enables the connection between health data intelligently, to find trends and predict precise outcomes.

Security constraints are maintained by complying with ISO 27001, 27018, CSA Gold certified, HIPAA, and HITRUST standards. Cybersecurity experts regularly monitor the services for enhanced security features.

The important features of the service are:

- I. Precision medicine service for clinical and operational efficiencies
- II. Delivering technology-enabled patient connected advance artificial intelligence and Machine learning offerings

III. Executing business intelligence projects at a faster pace through analytics, SaaS services

IV. Offering better insights to staff through IoT and edge services

V. Providing remote monitoring solutions

VI. Virtual health assistance by audio-based artificial intelligence.

It provides the option to connect different file types like electronic health records to various devices for recording and monitoring. This enables better research of datasets that are internally connected. Analysis of clinical and operational data improves the actionable intelligence of medical information. Patients' experience is improved by IoT connected devices.[12]

B. Apigee healthcare APIx

It is a service provided by Google, for cross-platform cloud storage using API (Application program interface). It is recognized progressively four times by the Gartner magic quadrant for efficient API management.

The service is known for creating and monitoring applications. It also optimizes costs and scalability. Productive decisions are taken using the analytics and machine learning capabilities of the service.

The operations provided are functional in a hybrid cloud environment which leads to wider domains for capturing data. The different applications of the consumer side like partner, employee, patients' databases can be connected for a rich experience. In the backend, technologies like IoT, database management and analytics work together to provide security, monitoring, governance and mediation.

Apigee healthcare API is connecting various healthcare professionals for delivering services through digital medium.

The basic operations of the API based service are:

I. Risk management in all the patients' data transitions

II. Providing digital services like personalized targeted wellness for various medical services

III. Improved management of chronic conditions by connecting professions with patients

There are different pricing models according to the usage of the service. The plans are categorized into evaluation, standard, enterprise and enterprise plus. Options to customize, design, publish, analyze and monitor APIs are also available. Developer portals are available for exploring and accelerating the growth through APIs. [13]

C. IBM Watson Health

IBM Watson Health is dedicated to creating a smarter health ecosphere. It is achieved by achieving advancements through improved care and procedures. In the digital transformation era, industry experts and analytics are working together for producing actionable awareness.

The service has analytical, cloud, Artificial intelligence and Blockchain capabilities. These technologies provide security, transparency, speed and scalability in sharing healthcare information. They improve communication

with patients. The control and storage of data are monitored to reach for actionable insights.

Services provided are:

- I. Identification of best-fit plan according to monetary requirements
- II. Analytics embedded business visualization of the data for better understanding
- III. Employee specific plans are suggested by implementing analytics
- IV. Goals are tracked according to the technology environment
- V. Social programs are managed by reducing cost and wastage for better living standards
- VI. Frauds are reduced by embedding analytics
- VII. Research and development facilities are improved for development of clinics, advance studies and database management
- VIII. Identifying and tracking more patients with the same symptoms in less time
- IX. Precise oncology programs for identifying genomics pattern
- X. Advance customer support for reducing communication complexities

Consulting service is provided by health experts and partners. All the data connections are made to assist digital transformation. Guidance is provided to enterprises for efficient operations to make improvements by considering fiscal and time constraints. Decision making support for pharmaceutical companies is provided by research for policies and compliances. Financing solutions are also delivered. [14]

9. Conclusion

The Healthcare industry is of utmost importance as it directly affects the life-expectancy rate, development and economy of any country. The rapid increase in costs for facilities provided by the medical industry leads to higher expectations in the experience and efficiency of services provided. The growing population is also a concern as a large set of people need to be examined at the same time. All these constraints lead to opening doors for Analytics in the healthcare industry for welfare and better examination of patients.

Costs can be controlled through analyzing competitive insurance pricing which will be a fair system for both insurance providers and consumers, as one will apply for insurance depending on the requirements and propensity to consume. By using big data analytics, predictive analytics, prescriptive analytics, semantic analytics and data mining techniques, the ability of data storage, retrieval and usage can be maximized.

Visualization tools can provide aid by forming self-explainable reports which can be easily understood in the medical industry. The error rates can be reduced by analyzing faulty trends and the probability of a machine going down using trend analysis.

Services provided by IT Companies for storing and retrieving data productively is an efficient solution for data-management.

Using cloud systems to store the analysis for future use, one can track down the journey of communicable and non-communicable diseases. Analytics can

analyze staff performance individually. Machine and resource wastage identify the risk and cause of various diseases and also segment patients on the basis of demographics, diseases, medical history. It can be an informative source for research and development in the field of medicines and science.

Analytics can be used to provide medical help to larger segments by cutting down costs as a lot of under-privileged sections of our country do not have easy access to medical help. It can be applied to prevent and detect epidemics like COVID-19, which has its spread worldwide.

The research was focused on how analytics can improve the healthcare industry's operations and benefit the consumers

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