

Market Overview: Big Data Analytics and its Impact on the Healthcare Industry

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Abstract

The healthcare industry is witnessing incredible challenges, and overcoming these plays a pivotal role in its growth. Integration of big data technology in the healthcare systems is expected to revolutionise the industry, with businesses exploring and rediscovering different ways to be beneficial. The convergence of wireless information, advanced databases and influential computing technologies ensures easy processing and an increase in the probability to process big data (Hamilton, 2012, September). To analyse the vast array of information, market players nowadays, are focusing on digitising the records and augmenting their research & development segment. The article illustrates the competitive advantages and initiatives offered and implemented by different market players to streamline their services. The article also contemplates the factors propelling the market demand for big data analytics in the healthcare industry along with the different challenges and opportunities impacting the same. Further, it also emphasises the latest trends and technologies transforming and escalating the market dynamics across the globe.

Keywords: Big Data, Analytics, Healthcare, Technology, Market

Introduction

In today's scenario, the entire healthcare business is witnessing several revolutionising trends in analytics and technology. Less patient retention, huge treatment costs and lack of efficient patient care are a few aspects bolstering the need for analytics in the healthcare industry. It has become essential for the healthcare clinics, businesses and researchers to focus on the solutions to comprehend clinical frameworks, find new

treatment possibilities and avoid future health issues (Schroer, 2023).

Developments in proficiencies of data generation, from DNA sequencing to health watches, have led to an upsurge in technologies, such as big data (Tabata, 2021). The concept of big data analytics (BDA) in the healthcare industry discusses data amassed from sources such as medical imaging, electronic health records (EHRs), payor records, genomic sequencing, medical devices and pharmaceutical research. In the healthcare industry, big data refers to using descriptive, predictive and prescriptive analytics services to gain profound insights. Well-utilised data in the healthcare sector are an impetus for patient-centric developments in almost each segment, with a rise in disease prevention and optimisation of costs, thereby benefitting a larger number of people. This technology has proficiently proven its efficiency and effectiveness in forecasting new diseases and saving the lives of people as well.

Analytics in healthcare enables businesses to uncover significant insights, into their data and helps them recognise different avenues to offer efficacy and quality at an optimised cost (IBM, n.d.). Apart from generating opportunities with the latest offerings, factors such as customisation of medical services, sharing of data and digital consultation are engaged in producing large volumes of data. Analysis of large datasets, helps healthcare providers to seamlessly identify patterns and trends, thereby focusing on the aspects impacting wellness and disease.

The technology owes the potential to change the way, healthcare providers use sophisticated technologies to gain insight from their clinical and other data repositories and make informed decisions. It mainly emphasises on leveraging the operational data, and augmenting the clinical outcomes, thereby, bolstering the overall productivity.

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However, with diversified contexts, formats and types, merging big healthcare data into traditional databases, poses to be a challenging task for the market players. In addition to these, security issues related to sensitive patient-related information along with the high rate of execution and deployment are also expected to restrain the market growth.

Hence, envisaging a forthcoming role for big data in healthcare focuses on balancing the benefits of enhancing patient outcomes with the probable drawbacks. The companies offering services for clinical transformation and healthcare analytics contribute towards profitable results. Key players are thereby engaged in an exceptional amalgamation of solutions to lead to an impactful change, in terms of health and safety.

Research Questions

RQ1: Need for BDA in the healthcare industry.

RQ2: Use cases of big data in healthcare and the key players adopting the same in their businesses.

RQ3: Recent factors and trends for big data technology in the healthcare industry.

RQ4: Risks associated with the implementation of the technology.

Purpose of the Article

This article provides an outline of BDA, its need and its applications in the healthcare segment. This paper illustrates the factors boosting and hindering the market growth of big data in the healthcare industry. Further, the paper also discusses the future potentialities of the technology with a brief analysis of the different strategies adopted by the key businesses.

Key Findings in the Research

The amalgamation of innovative solutions and big data systems has led to an accurate medical diagnosis and enhanced patient treatment. Adopting big data technology in the healthcare sector will significantly transform the industry, shifting it from fee-for-service to value-based care.

Literature Review

Over the past few years, the healthcare industry is expected to witness a tremendous rise in terms of IT-driven innovative technologies. The shifting surge from population health management to value-based care in the healthcare domain, along with the digitisation of health-related information is expected to generate larger volumes of primary and secondary information.

With medical data witnessing a rise every second, the need for BDA is expected to gain traction in the industry. The evolvement of the healthcare data analytics sector also signifies the quick adoption of big data in the healthcare sector. With a lot of administrative, financial, R&D, operational, financial and clinical data available in the healthcare sector, technologies such as BDA offers insights to augment the overall efficiency and profitability of the business.

Analytics in the healthcare domain emphasises on completely revolutionising and unleashing new sources of solutions in the industry. BDA is one of the most advanced technologies which poses to offer life-saving results in terms of treatment, patient education and others. BDA refers to huge volumes of data generated by the implementation of digital technologies which gather patient-related medical records and further, analyse the same to prevent diseases, minimise the costs of medical treatment to the patients and improve the overall quality of life (Softech, 2019). Effective usage of data helps healthcare organisations to support public health management, disease surveillance and clinical decision-making.

The incorporation of this technology enables various tools to collect, analyse and integrate huge volumes of structured, semi-structured and unstructured data being offered by the healthcare systems. It further, empowers the professionals and stakeholders in the industry to focus more on generating patient-driven healthcare solutions in different ways. A few of these include:

- Authorising the patients to have easy accessibility to their own medical records.
- Optimising the medical aid and treatment costs.
- Restructuring the administrative processes, and enabling the administrators to make well-versed

decisions regarding the distribution of required resources and funds in between and within the health institutions.

- Exercising the information-driven results to forecast and resolve health issues prior to the previous (Tulane University, 2021).

Hence, BDA owes immense potential, particularly in the aspects of optimising costs, saving lives and enhancing the quality of overall medical care (Harerimana, 2018). Taking out from this mesh of trends, patterns and rules allows the stakeholders and the health service providers to provide precise diagnoses of problems, preventive medicine, effective monitoring, personalised treatment and enhanced quality of patient care (Batko, 2022).

Need for Big Data Analytics in Healthcare

The healthcare industry is witnessing several revolutionary changes, with the older versions of systems and processes being substantially replaced by potentially new technologies. The transition varies from a treatment-based and reactive approach to a preventive and an integrated approach. These fundamental changes are expected to be driven by the growing connectivity of assets and information prevalence. Healthcare professionals and stakeholders nowadays are emphasising towards generating data-driven services to enhance their performance outcomes.

Technologies such as big data help to get insights from the vast amount of data that otherwise have no usage because of the amorphous composition. BDA and real-time monitoring allow the providers to offer specific patient-centric services. These technologies pose to be an influential means to attain actionable ideas from an enormous amount of information that otherwise poses to be latent and of no use owing to the configuration of the same (Bharti, 2022). This technology in the healthcare industry is essentially a method to discover market trends, customer preferences, hidden patterns and unidentified correlations, which can help organisations make informed clinical and business decisions.

Integration of BDA in the healthcare sector helps collect information in an automated and easily readable manner. The technology offers clarity in understanding the clinical

data, and simplifies the overall decision-making process with relevance to the diagnosis, treatment or prevention of the diseases (Batko, 2022). Intelligent usage of information bolsters the growth of tailored methods to enhance patient engagement, with better compliance, thereby enabling the providers to develop practices with profitable results. Big data provides the healthcare sector with prospects for an archetype shift, which focuses on referring to the extrapolation of an entire population to understand an individual's requirements. Hence, healthcare BDA, enables the organisations to reveal dynamic data insights, thereby distinguishing the offerings with better quality, efficacy and value-driven care at an optimum cost.

The healthcare industry creates a vast amount of data related to each patient, however, accessing and interpreting that data poses to be critical, to create insights in terms of efficiency and care. Combining big data generated by EHRs with cutting-edge analytic methods enables medical researchers to create models with different applications, such as forecasting heart failure, substance abuse and post-surgical complications (Lee, 2020).

There is an incredible potential need for big data in healthcare, and this article explains the significant ways big data leverages this industry.

Reduction in Costs for the Patients and the Healthcare Providers: Predictive analytics enables the healthcare providers to make precise clinical decisions, thereby gaining a competitive edge in the market. The technology enables the large health organisations, to offer better care to the patients at optimal costs. Hence, intelligent allocation of resources with clear identification of health-related concerns and relevant treatment plans helps strategise the overall cost accordingly.

Expansion of Diagnostic Service: The technology empowers patients with better accessibility to professional care. A few apps, such as Aetna's Triage, recommend the patients based on their medical condition via aggregated data and further, advise them for the required care as per the inputs received (Catalyst, 2018).

Improved Research: Big data offers medical researchers unparalleled access to a huge volume of data and data collection methods. In addition to this, this technological concept owes the potential to drive significant medical breakthroughs to save lives.

Use Cases of Big Data in Healthcare

BDA enables the medical researcher, an unparalleled access to a huge volume of data and the data collection methods. This technology is expected to propel significant medical innovations which can save lives. It helps the clinicians and researchers discover advanced solutions to enhance patient care and bolster the quality of treatment. One such solution driven by big data was created by “Philips” in partnership with “Radboud University Nijmegen Medical Center”. This is a prototype solution that is engaged in uninterruptedly monitoring the COPD patients. It collects the vital signs from the patients via a wearable sensor and helps the patient enter into the eCare companion mobile application (Philips, n.d.).

A few of the applications of big data in the healthcare industry can be illustrated as:

Treatment of Cancer

The usage of BDA enables the oncologists to come up with accurate high-level treatments. A few companies engaged in paving the way for big data in the treatment of cancer include:

Tempus

Overview: Tempus is a Chicago-based technology company, founded in 2015. It is engaged in advancing precision medicine via the real-world application of Artificial Intelligence (AI) in healthcare. The company enables physicians to make data-driven decisions, provide customised patient care and facilitate the seamless distribution and development of optimal therapeutics.

Solutions: The company offers comprehensive solutions for all precision oncology segments (Tempus, n.d.). These include:

- *Genomic Profiling:* This includes a wider range of sequencing services—RNA sequencing, tumor-normal matched profiling, liquid DNA profiling, tumor tissue, as well as germline and somatic testing.
- *Algorithmic Tests:* The algorithmic test platform powers the clinician network, CAP/CLIA lab, as well as clinical and molecular databases to unfold the tests which would help notify the treatment of cancer patients.

- *Clinical Trial Matching:* The proprietary trial matching methods and software, helps identify open and relevant clinical trials customised according to every patient’s clinical and molecular context.
- *Artificial Intelligence and Digital Pathology:* Emerging AI capabilities help discover actionable biomarkers to identify probable clinical trials and therapeutic options for patients.
- *Tempus One:* The proprietary AI-enabled platform helps gain real-time access to patient insights anywhere and anytime.
- *EHR Integration:* The company offers an integrated and secure platform to collect, generate and structure the essential data to personalise the therapeutic options and the treatment plan of the patient.

Oncora Medical

Overview: Oncora Medical, headquartered in Pennsylvania was founded in 2014. It is a digital health company engaged in the integration of machine learning and big data into radiation oncology. The company is engaged in offering products that emphasise on improving the oncology results for the patients (Medical, n.d.). A few of the solutions offered include:

Solutions: The data analysis tools of the company enables the oncologists to quickly compile the data and add relevant information to the individual’s health records. It also helps review a patient’s pathology and radiology history, thereby providing personalised care to the patients in an efficient way.

- *Oncora Patient Care*
- *Intelligent Interface for Oncologists:* The intelligent patient timeline showcases critical data via pathology and radiology reports, thereby saving time and offering effective results and care.
- *Automated Oncology Documentation:* The company is engaged in generating billing-compliant clinical documents, and sending them spontaneously into the utilisation management platform, oncology information system and EHR to back up prior authorisation.
- *Pragmatic Machine Learning:* Oncora Medical is engaged in training and deploying predictive models for the identification of emergency case patients. It also allows the staff to identify and

assess the patients who need supportive care, with value-based care initiatives.

- *Oncora Analytics*

Oncora Medical's visual analytics software links clinicians and researchers with real-world information across dissimilar data systems, thereby propelling the clinical discoveries.

Early Disease Detection

The discovery of drugs depends on the data to assess the effectiveness and viability of treatments. Key players using big data for research and development to help augment pharmaceutical companies include the following:

PeraHealth

Overview: PeraHealth, founded in 2010, is headquartered in Charlotte. PeraHealth is an innovator of the peer-reviewed "Rothman Index", which is a universal scoring system for the patient's health. This score takes the information within nursing assessments, lab results, as well as EHRs, to keep a track of all the details and avoid complications. The company focuses on offering actionable and precise insights at both population as well as patient levels.

In February 2023, Spacelabs Healthcare announced the acquisition of PeraHealth, a company engaged in developing predictive enterprise software based on the Rothman Index (Healthcare, 2023).

Solutions: The software developed by the company gives a score to quantitate patient perception. These solutions warn clinicians about any unplanned patient transfer to the ICU and boost timely beneficial and palliative care consults to help reduce in-hospital mortality.

- *The Rothman Index as an Early Warning System:* The Rothman Index offers advance warning to clinicians, which goes beyond vitals-based monitoring, with constant surveillance for any unit, any patient or any disease. The Rothman Index outperforms other systems, thereby augmenting the operational efficiencies and performance of value-based procuring programs.
- *The Rothman Index for Palliative Care:* The Rothman Index empowers the care providers to

envision the patient's perception regarding their past and present stays at the hospital.

Integration of Spacelabs' digital health portfolio and PeraHealth's powerful analytics, helps the healthcare organisations deliver enhanced outcomes, at minimal costs.

Prognos Health

Overview: Prognos Health, headquartered in New York, was established in 2010. The company leveraged its analytical and clinical proficiency to develop a solution that transforms transactional and diagnostic data into understandable information. Key segments catered by the company include commercial analytics, observational research, Key-World Evidence, HEOR along with HCP and precision marketing.

Solutions: The company emphasises on integration of de-identified patient-relevant information from different sources, such as medical claims, prescriptions and lab results, thereby offering real-data insights. The data offered helps manage, build and apply transactional information with unprecedented efficiency to enhance the outcomes.

The company focuses on cost-effective and flexible ways to explore and monetise patient-specific pre-integrated real-time data and boost the implementation of downstream and upstream strategies. Prognos Health delivers in-depth insights (for clinical, commercial and HEOR/RWE) into the factors accelerating value and impacting the patient's journey in all aspects (Health, n.d.).

Health Records

In terms of healthcare, risk plays a vital role in the way patients access care. A few examples of how companies use big data to amass insights in terms of accuracy and risks are illustrated below:

Particle Health

Overview: Particle Health, based in New York, was established in 2018. The company emphasises on new standards for data exchange at an Application Programming Interface (API) platform. Particle Health

offers scalable infrastructure products and innovative data-driven solutions to healthcare professionals.

Solutions: Particle Health offers secure and fast access to condition-specific health insights, records and data products.

- *Specialty Care:* In specialty care, the *specialty search* finds the records, comprising of those from out-of-state treatment providers and clinics, for key specialties.
- *Primary Care:* In primary care, *Particle Health FHIR R4/C-CDA API*, enables the providers to digitally recover the entire medical records, within seconds.
- *Platforms + EHRs:* The company emphasises on offering a seamless flow of processed data to businesses with industry-leading interactivensess.

BluByrd

Overview: Blubyrd, founded in 2021, is headquartered in Northville, Michigan. The company offers an effortless alternative for coordinating critical patient surgeries, for which the manual processes pose to be exhausting.

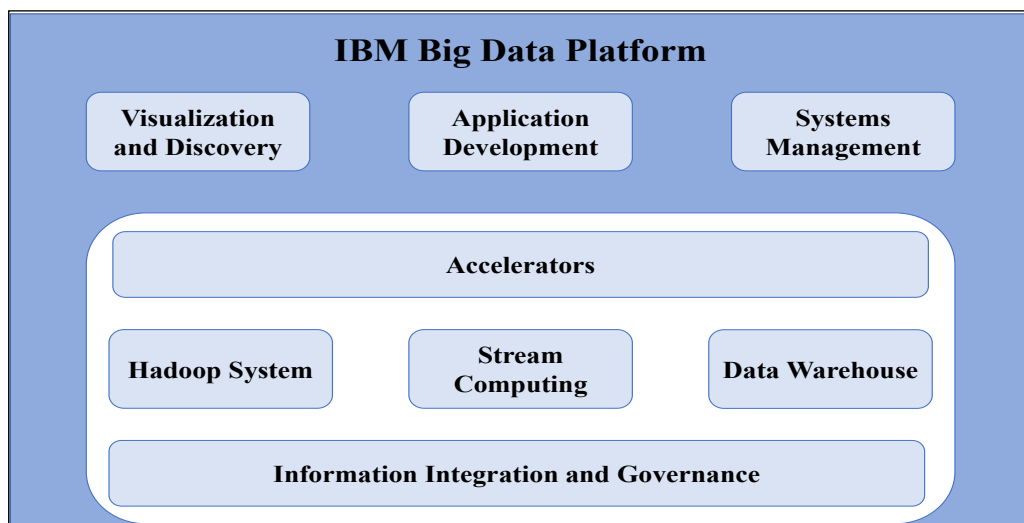
Solutions: Blubyrd helps clinical practices and surgical facilities to efficiently compile and exchange data (such as equipment inventory, procedure codes and appointment schedules), thereby offering integrations to easily collaborate and communicate and get surgical cases in record time. The company enables surgery centres and clinics to seamlessly schedule patient procedures.

Competitive Landscape

The healthcare and pharmaceutical businesses are witnessing a cutting-edge transformation with the increasing usage of advanced analytic solutions. Key market players are engaged in the incorporation of various strategic initiatives such as research and development, partnerships, as well as mergers, and acquisitions to gain a competitive edge in the market. The article enlists two major players: IBM and Microsoft Corporation and the solutions offered by the same to address the spectrum of big data challenges in the healthcare industry. These players offer platforms or solutions which leverage effectual big data analytic technologies, to analyse the increasing variety, velocity and volume of data for larger insights.

IBM

IBM Business Analytics enhances the managerial process with predictive insights, thereby shaping the forthcoming outcomes in an efficient way. It offers enhanced productivity and cost performance at an unprecedented resiliency and scale via end-to-end data management. Open-source software such as Apache Hadoop, the entire Hadoop ecosystem and, Apache Spark are flexible, cost-effective data processing tools intended to handle a large volume of data being generated. The figure mentioned below (Fig. 1) illustrates the big data platform by IBM. IBM has introduced an enterprise-class big data platform that offers a balanced and broader view of BDA and its needs.



Source: (Dhiraj, 2013).

Fig. 1: IBM – Big Data Ecosystem

In addition to this, these analytic solutions enable businesses to access and analyse a large volume of data to gain new insights. Analysing the data from sources such as logs, web, devices, sensors, video, social media and transactional applications enables the businesses to be data-driven (IBM, IBM, n.d.).

A few solutions offered by IBM can be illustrated as:

IBM and Cloudera - Cloud Data Solutions: Cloudera and IBM in partnership offer enterprise-grade, AI and data services with the help of open-source ecosystems. The partnership offers the following advantages:

- Augmented categorisation of hybrid multi-cloud AI and data solutions with shared governance and security.
- Support and sales services of Cloudera apps and products underneath a multiyear contract.
- Migration aid to forthcoming Cloudera services and products with AI and data expertise.

The *Cloudera Data Platform Private Cloud* helps attain quick time to value with containerised data facilities and increases the time to insight for data analytics. This solution performs integrated analytics from the edge to AI with an inclusive on-premises platform that measures processing, ingest, deployment, experimentation and analysis. This platform unifies state-of-the-art analytic technologies into data management systems and is available via IBM deployment, support and licensing.

IBM Big Replicate for Hadoop: IBM Big Replicate is an enterprise-class data duplication software platform that keeps the data consistent in the hybrid cloud (NoSQL and SQL databases), on-premises and disseminated environment. This solution is driven by a high-performance integration engine that uses consensus to keep unformed data consistent, accurate and affordable in various locations. This real-time duplication technology is non-invasive, and shifts the big data procedures from lab settings to production settings, across numerous Hadoop disseminations and from on-premises to cloud settings, with nominal distraction or downtime Problem.

IBM Watson Studio: IBM Watson Studio enables the analysts, developers and data scientists, to manage and build the AI models, thereby optimising the decisions at any place on IBM Cloud Pak for the data. The platform

brings together open-source structures such as scikit, TensorFlow and PyTorch and its system tools for visual and code-based data information.

IBM Watson Health emphasises on providing a connected and smarter healthcare system that helps clinicians deliver better quality care and services. The solutions offered by IBM healthcare enables the businesses to integrate with new partners for a personalised, sustainable and an efficient system.

Microsoft

The analytic solutions offered by Microsoft garner insights and forecast the results by analysis of the datasets.

The company has announced the release of “*Azure Health Data Services technology*” for the Protected Health Information in the cloud (Thomas, 2022). The solution helps manage, ingest and revolutionise the amalgamation of MedTech, imaging and clinical data formats into data standards such as Digital Imaging and Communications in Medicine and Fast Healthcare Interoperability Resources (FHIR).

Azure Health Data Services offers a holistic view of the patient by streaming the data and merging diversified datasets from various medical devices.

Factor Boosting Usage of Big Data Analytics in the Healthcare Industry

Increasing Demand for Analytic Technologies for Population Health Management

Identification of the patients phasing down from maintenance protocols or the ones at high risk of emerging chronic diseases is a significant aspect of the value-based care environment. Developing an inclusive picture of a patient’s social, financial and clinical risks, requires the healthcare providers to amass key data from the care spectrum before leveraging target involvement and risk scoring framework to the individuals.

Population healthcare is engaged in the introduction of latest trends of remote health monitoring, mHealth and telemedicine to lessen the occurrence of various kinds of

illnesses and develop an efficient system. The concept of population health is engaged in studying the different conditions and patterns impacting the overall health of individuals. With the rising advancements in health Information Technology (IT), the population healthcare management is becoming effective and accurate.

Technologies such as Big Data play a significant role in understanding the population's health, owing to the fact, that without analytics it becomes difficult for businesses to determine the patterns. It also enables the organisations to assess the patient's needs and accordingly offers care and services, thereby catering to gaps, if any. Hence, effective population health management necessitates healthcare providers to depend profoundly on big data deduced from business partners and healthcare IT systems (McNemar, 2021).

Factors Restraining the Implementation of Big Data Analytics in the Healthcare Industry

In today's scenario, healthcare businesses face several challenges in the implementation of technologies such as BDA. A few of these challenges include the policies related to it, data standardisation, managerial issues (such as ownership and governance) and inaccuracies in the data.

Managerial Issues: Comprehending the potential of BDA in healthcare needs organisations to regulate their ways of doing business. It increases the requirement of the data scientists along with the IT staff, with essential skill sets to run the analytics department. It also becomes vital that, data stewardship and ownership needs to create roles in businesses involved in the implementation of big data, with the necessity of partnerships to be brokered at the time of sharing of information (Fernandes, 2012) (Sepulveda, 2013) (Baker, 2014) (Youssef, 2014).

Data Standardisation Issues: Even though Electronic Health Records, share information in the same organisation, the EHR platforms are uneven, at best. At times, the data is stored in certain formats which are not well-suited to all technologies and applications (Raghupathi, 2014) (Hsieh, 2013). Lack of standardisation is expected to cause difficulties in the transfer of data (Chawla, 2013)

(Mohr, 2010), thereby, complicating data cleansing and acquisition (Mancini, 2014).

Inaccuracies in the Data: One of the vital aspects is to maintain the consistency of data collection. Also, keeping the information precise as well as in the latest format is another significant challenge (Kruse, 2016).

Conclusion

An effectual analysis, and interpretation of big data offers avenues for the healthcare sector. Strong integration of healthcare and biomedical data poses to be transformative. New technologies such as telehealth platforms, prescription support applications and AI-driven diagnostic tools are engaged in generating huge amounts of data, thereby propelling the demand for BDA in the healthcare industry. The substantial growth of medical data from different domains has enabled computational professionals to strategise innovative designs and interpret the huge amount of data in, a given, time span (Dash, 2019).

Businesses nowadays are emphasising on the implementation of a data-driven approach to cater to the existing challenges in the industry. Implementation of BDA in the healthcare industry leverages the gap between unstructured and structured data sources. Flexible data storage and processing tools allow organisations to save costs, both for analysing as well as storing the data.

The study addresses the research questions related to the real use cases and the trends of BDA in healthcare. It provides a brief analysis of the real-use case applications and a few players involved in re-imaging the healthcare segments, with the incorporation of the technology in their businesses. The article also illustrates the factors propelling and hindering the implementation of BDA in the industry.

The large volume of medical datasets gathered across different heterogenous platforms poses to be a challenge to the data scientists for cautious implementation and integration of the same. Hence, the impending work must cater to the grouping of analytics, health informatics and bioinformatics to encourage effective and personalised treatments. In addition to this, new technologies and strategies need to be developed in order to, understand

the volume, complexity and nature of the data to deduce significant information.

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