Leveraging Big Data in Healthcare for Improved Patient Outcomes

By Chetan Sapkal, BE

The healthcare industry is experiencing a transformative shift, largely driven by the proliferation of big data and advanced analytics technologies. With the increasing volume of healthcare data being generated daily, from electronic health records (EHRs) to wearable devices, the potential for improving patient care and outcomes has never been greater. In this article, we explore how big data is being harnessed to revolutionize healthcare delivery, personalized medicine, and population health management. Healthcare organizations are now accumulating vast amounts of data from various sources. EHRs contain patient records, treatment histories, and diagnostic information, while wearable devices continuously collect patient-generated data. The integration of these disparate data sources allows healthcare providers to gain a comprehensive view of a patient's health and history, enabling more informed decision-making.

Introduction:

Medical facilities use both structured and unstructured data in their practice. Structured data has a predetermined schema, it is extensive, freeform, and comes in variety of forms . In contrast, unstructured data, referred to as Big Data (BD), does not fit into the typical data processing format. Big Data is a massive amount of data sets that cannot be stored, processed, or analyzed using traditional tools. It remains stored but not analyzed. Due to the lack of a well-defined schema, it is difficult to search and analyze such data and, therefore, it requires a specific technology and method to transform it into value . Integrating data stored in both structured and unstructured formats can add significant value to an organization. Organizations must approach unstructured data in a different way. Therefore, the potential is seen in Big Data Analytics (BDA). Big Data Analytics are techniques and tools used to analyze and extract information from Big Data. The results of Big Data analysis can be used to predict the future. They also help in creating trends about the past. When it comes to healthcare, it allows to analyze large datasets from thousands of patients, identifying clusters and correlation between datasets, as well as developing predictive models using data mining techniques.

Technology is not enough to achieve these goals. Therefore, changes should be made not only at the technological level but also in the management and design of complete healthcare processes and what is more, they should affect the business models of service providers. The use of Big Data Analytics is becoming more and more common in enterprises . However, medical enterprises still cannot keep up with the information needs of patients, clinicians,

administrators and the creator's policy. The adoption of a Big Data approach would allow the implementation of personalized and precise medicine based on personalized information, delivered in real time and tailored to individual patients.

Predictive Analytics and Early Intervention:

One of the most significant benefits of big data in healthcare is its capacity for predictive analytics. Advanced algorithms can analyze historical patient data to predict disease risks and identify patients who may benefit from early intervention. For instance, predictive models can flag individuals at high risk of developing chronic conditions like diabetes or heart disease, enabling healthcare providers to initiate preventive measures before symptoms manifest.

Considerations on use Big Data and Big Data Analytics in the healthcare:

In recent years one can observe a constantly increasing demand for solutions offering effective analytical tools. This trend is also noticeable in the analysis of large volumes of data (Big Data, BD). Organizations are looking for ways to use the power of Big Data to improve their decision making, competitive advantage or business performance. Big Data is considered to offer potential solutions to public and private organizations, however, still not much is known about the outcome of the practical use of Big Data in different types of organizations .

As already mentioned, in recent years, healthcare management worldwide has been changed from a disease-centered model to a patient-centered model, even in value-based healthcare delivery model. In order to meet the requirements of this model and provide effective patient-centered care, it is necessary to manage and analyze healthcare Big Data.
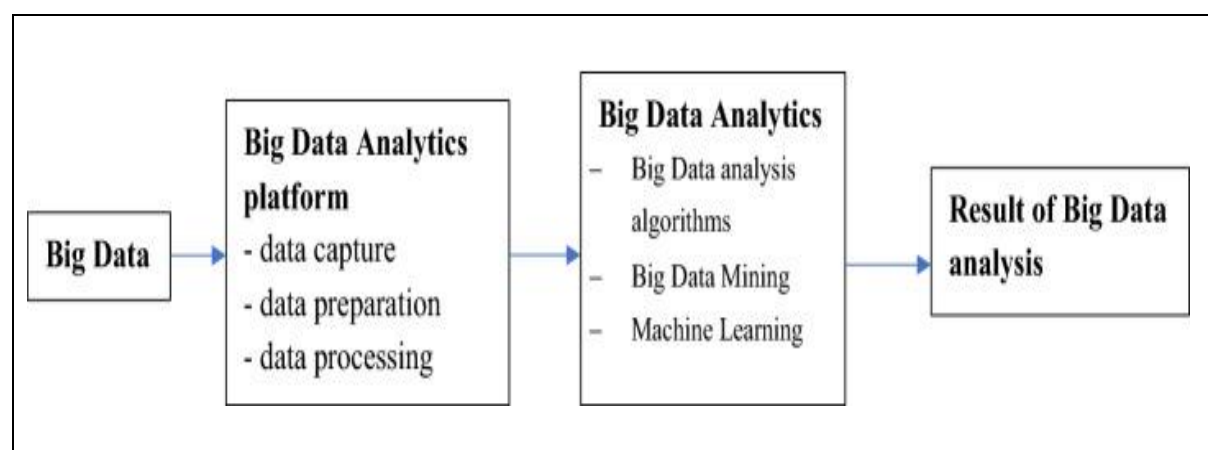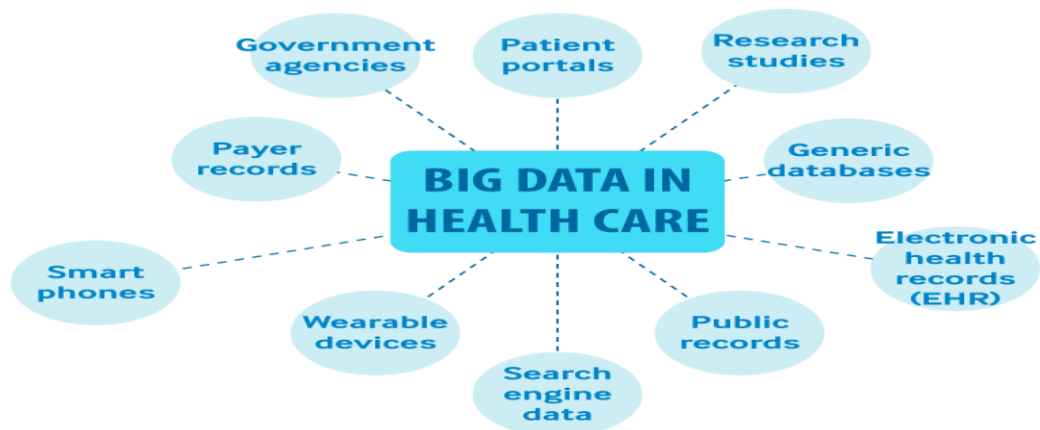

Fig.Process of Big Data Analytics

Sources of Big Data in Health Care

Government agencies · Patient portals · Research studies · Payer records · BIG DATA IN HEALTH CARE · Generic databases · Smart phones · Wearable devices · Search engine data · Public records · Electronic health records (EHR)

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The Big Data concept is constantly evolving and currently it does not focus on huge amounts of data, but rather on the process of creating value from this data. Big Data is collected from various sources that have different data properties and are processed by different organizational units, resulting in creation of a Big Data chain . The aim of the organizations is to manage, process and analyze Big Data. In the healthcare sector, Big Data streams consist of various types of data, namely:

- Clinical data, i.e. data obtained from electronic medical records, data from hospital information systems, image centers, laboratories, pharmacies and other organizations providing health services, patient generated health data, physician's free-text notes, genomic data, physiological monitoring data.
- Biometric data provided from various types of devices that monitor weight, pressure, glucose level, etc…
- Financial data, constituting a full record of economic operations reflecting the conducted activity.
- Data from scientific research activities, i.e. results of research, including drug research, design of medical devices and new methods of treatment.
- Data provided by patients, including description of preferences, level of satisfaction, information from systems for self-monitoring of their activity: exercises, sleep, meals consumed, etc.
- Data from social media.

Overcoming Challenges: Data Privacy and Security:

While the benefits of big data in healthcare are profound, there are significant challenges to overcome, particularly in data privacy and security. Protecting patient data from breaches and ensuring compliance with regulations like HIPAA is paramount. Robust cybersecurity measures and ethical data handling practices are essential to maintain trust in the healthcare system.

The Brilliant Future for Big Data in Healthcare:

Just as executives in commerce and industrial sectors declare their big data initiatives have been successful and transformational, the outlook for healthcare is even more exciting. Below are a few areas where big data is destined to transform healthcare.

   i.   **Precision medicine,** as envisioned by the National Institutes of Health, seeks to enroll one million people to volunteer their health information in the All of Us research program. That program is part of the NIH Precision Medicine Initiative. According to the NIH, the initiative intends to "understand how a person's genetics, environment, and lifestyle can help determine the best approach to prevent or treat disease. The long-term goals of the Precision Medicine Initiative focus on bringing precision medicine to all areas of health and healthcare on a large scale."

   ii. **Wearables and IoT sensors**, already noted above, have the potential to revolutionize healthcare for many patient populations—and to help people remain healthy. A wearable device or sensor may one day provide a direct, real-time feed to a patient's electronic health records, which allows medical staff to monitor and then consult with the patient, either face-to-face or remotely.

   iii. **Machine learning**, a component of artificial intelligence, and one that depends on big data is already helping physicians improve patient care. IBM with its Watson Health computer system has already partnered with Mayo Clinic, CVS Health, Memorial Sloan Kettering Cancer Center, and others. Machine learning, together with healthcare big data analytics, multiply caregivers' ability to enhance patient care.

Conclusion:

As we move further into the digital age, big data is poised to revolutionize healthcare in unprecedented ways. The ability to harness vast amounts of data for predictive analytics, personalized medicine, and population health management holds the promise of significantly improving patient outcomes and the overall effectiveness of healthcare delivery. However, it is crucial to balance these opportunities with a steadfast commitment to data privacy and security to ensure the trust and well-being of patients remain at the forefront of this transformative journey.

In conclusion, the healthcare industry's adoption of big data represents a seismic shift towards a more patient-centered, data-driven future. Embracing this transformation can lead to healthier populations, reduced healthcare costs, and ultimately, improved patient lives.