Big Data Analysis: Big Way Forward in Dentistry- A Review

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Abstract:
Big data are those types of data that are so large, varied, and complicated that managing them and deriving value and hidden information from them requires new architecture, methodologies, algorithms, and analytics. Three things distinguish this data: it is large in quantity, it cannot be organised into conventional relational databases, and it is produced, collected, and processed fast. It uses a variety of data mining methods to find patterns and correlations in huge pre-existing databases, which may be described as the automatic extraction of meaningful, frequently undiscovered information from enormous databases. The objectives of data mining may be summed up as description, identifying relationships and patterns that can be understood by humans, and prediction, predicting a particular reaction of interest. Data mining pertaining to Public Health Dentistry involves the application of this to public oral health problem. Big data analysis might provide crucial insights to improve oral health in developing countries like India with limited resources, but with huge disease burden paving the way for effective oral health strategies and policies.
Key words: 1. Big Data 2. Health care 3. Public Health

Introduction:

Big data are the data whose volumes are large, diverse in nature and the data collected at real time are enormous in amount. Variability, diversity and complexity plays a need for the precise analytics for meaningful interpretation of the big data. With the global population exceeding 7.2 billion, around 2 billion people are already connected to internet. Adding to the scenario, smart gadgets are used by over 5 billion people worldwide. Dental profession is not an exception for the same. Due to the exponential growth of data brought about by the switch from paper medical records to electronic health records (EHR) systems, physicians, epidemiologists, clinicians, and policymakers now have a fantastic opportunity to make data-

driven decisions that will ultimately improve patient care, research, and community-specific health care. As a result, the "big data" age offers enormous potential for study in the health sector and for the development of policies. The 21st century is properly referred to as the "era of big data" since it encompasses all facets of human existence, including biology and medicine. The cases we confront and the treatment decisions we make have a long-term influence on the wellbeing of the person in particular and community as a whole. (Baroet al., 2015).

Big data on the whole is neutral, interpretation and its analysis fills meaning to the big data, as a result Big data analysis or analytics plays an important role in correct utilization of the neutral data.To find hidden patterns and correlations in huge data, statistical analysis must be used more often in the big data age. Big data need medical/ Dental experts, computational statisticians working in hand with computer scientists.

The advent of big data has revolutionized various industries, including healthcare. With the exponential growth of data due to electronic health records and increased connectivity, the field of dentistry is also experiencing a data-driven transformation. This article discusses the opportunities presented by big data analysis in the dental profession and its potential for enhancing patient care, research, and policy making.

Review of Literature:

The era of "big data" offers huge opportunity for technical advancement and scientific discovery, and it has the potential to have a significant influence on public sector research and development (Coakley et al., 2013). A McKinsey (2013) research estimates that 5 billion people use various mobile devices. Due to the technological development, these millions of individuals are using these gadgets more frequently, which is creating enormous volumes of data.(Khan *et al.*, 2014). Thus, big data analysis makes big sense in modern era.

There have been several studies conducted on the application of big data in dentistry. According to a study done by Joda *et al.*(2021), big data has been applied in various domainsincluding oral health surveillance, dental practice management, clinical decision support systems, and patient-centered care. The study highlighted the potential benefits and challenges associated with big data analytics in dentistry.

In the research done by Jain *et al.*(2021), the key role of big data in dentistry is well established.The findings in this study shows that dentists may assist patients in achieving better health, early disease detection, and individualised dental treatment by analysing big data.The study reviewed the literature on predictive models in dentistry, such as predicting dental caries, periodontal diseases, and treatment outcomes. It highlighted the potential of predictive analytics to support personalized treatment planning and preventive interventions in dentistry.

According to a study done by Finkelstein *et al.*(2020), Big Data analytics revolutionise population oral health by analysing real-time data, opening the door for precision medicine. Precision oral health will be facilitated by the integration of big data and data science practises into normal clinical oral healthcare as well as the infrastructure for dental research.

According to the systematic review done by Favaretto *et al.*(2020), ethical issues regarding big data involved patient privacy, confidentiality and anonymity, data security, and informed consent.

In the research done by Schwendicke*et al.*(2021), an overview of big data analytics applications in dentistry. The study explored the use of big data analytics in areas such as oral health surveillance, disease prediction, treatment planning, and public health interventions.

These studies provide insights into the various ways big data analytics can be applied in dentistry, including prediction models, treatment planning and public health interventions. They highlight the potential advantages and challenges associated with leveraging big data in dental research and practice, paving the way for further exploration and implementation in the field of dentistry.

Historical considerations:

The concept of big data has roots dating back thousands of years, with early examples including the use of data to record crop growth and mortality rates in ancient civilizations. However, the modern era of big data analysis emerged in the last decade, driven by advancements in technology and data collection methods.

Bulk of data was created in recent 10 years. O'Reilly media introduced it in 2005. But large data utilisation dates back 7,000 years. When accounting was first used in Mesopotamia society 7,000 years ago Big data was utilised to track the expansion of livestock and crops. John Graunt used big data to capture all of the mortality rates statistics for London in 1663. His book titled Natural and political Observation provides great information about mortality rates in London.

Along with improvements in data gathering and processing, the use of big data in dentistry has evolved. The majority of dental records were kept on paper in the past, making it difficult to use data for insights and decision-making. However, a plethora of dental data has been available for analysis as a result of the digital transformation of dental practices and the use of electronic health records (EHRs). This development has made it possible to use big data in dentistry to advance patient care, research, and public health programs. (Beatrice., 2021).

Basic understanding and method:

Big data are data that are so large, diverse, and complicated that managing them and extracting their value and hidden information from them requires novel architecture, methodologies, algorithms, and analytics. (Lee*et al.*,2017).

Big data has the following characteristics: (i) a wide range of data; (ii) rapid data flow; (iii) challenges with veracity; (iv) challenges with all workflow aspects; (v) challenges with computational methods; (vi) challenges with extracting meaningful information; (vii) challenges with sharing data; and (viii) challenges with locating human experts. The following terms are related to big data: (i) data reuse; (ii) erroneous knowledge discovery; and (iii) privacy concerns (Baro *et al.*,2015).

Ten times more information is created every five years. Through 60 analogue and digital technologies, the global capacities for technological data storage, computation, processing, and communication were monitored from 1986 to 2007. In 2007, general-purpose computers had storage capacities of 2.9 1020 bytes (optimally compressed) and 2.0 1021 bytes. Additionally, these computers could process 6.4 1018 instructions per second. However, general-purpose computers' computational capacity is growing at a pace of 58% each year.(Khan *et al.*, 2014).

Big data analysis makes use of a variety of data mining algorithms, which are used to find patterns and correlations in massive pre-existing databases. Data mining is the automatic extraction of useful, frequently undiscovered information from large databases or datasets. Data mining's tasks may be summed up as description, identifying relationships and patterns that can be understood by humans, and prediction, which involves predicting a particular reaction of interest(Lee*et al.*,2017).

Core content (methods and types, advantages, disadvantages):

The primary subject matter of big data analysis is examined in this part, along with its techniques, varieties, benefits, and drawbacks. Data mining methods are used in big data analysis to draw out valuable information from huge, complicated databases. It includes activities like describing, identifying patterns and relationships, and making predictions. Big data analysis has several advantages, including the ability to see patterns and make data-driven choices, but it also has drawbacks relating to data quality, privacy concerns, and processing needs.

Methods and Types:

Big data analysis employs a range of strategies and instruments to glean insights and value from sizable and complex datasets. The following are a few typical methods for huge data analysis:

1. Data mining: Applying statistical and machine learning methods to huge datasets in order to uncover patterns, correlations, and insights is known as data mining. It aims to find knowledge and facts that may be used for making decisions.
2. Machine Learning: Without explicit programming, computers can learn from data and make predictions or take actions thanks to machine learning algorithms. These algorithms are used to examine large amounts of data, anticipate outcomes, or categorise data according to patterns and trends.
3. Natural Language Processing (NLP): NLP methods are used to unstructured text data processing and analysis. To extract meaning and insights from textual data, activities including sentiment analysis, topic modelling, and text categorization are used.
4. Visualisation: To show complicated large data in an aesthetically pleasing and intelligible way, data visualisation techniques are used. Charts, graphs, and interactive dashboards are examples of visual representations that aid in efficiently expressing and comprehending findings.(Beatrice., 2021).

Advantages:

Big data analysis has a number of benefits across a variety of fields, including:

1. Improved Decision-Making: Big data analytics provide insightful information that facilitates wise decision-making. Organisations can see trends, patterns, and connections that might not be obvious using conventional analytical approaches by analysing huge and diverse datasets.
2. Enhanced Operations and Efficiency: Big data analytics can optimise workflows, increase resource management, and boost operational effectiveness. To get better results, organisations can spot bottlenecks, restructure operations, and make data-driven changes.
3. Customised services: Big data analysis helps businesses comprehend customer preferences, behaviours, and wants. By using this data, personalised services, suggestions, and marketing tactics may be provided.
4. Innovation and research: By giving academics access to enormous volumes of data for investigation and discovery, big data analysis fosters innovation. It aids in the discovery of new areas for study, the execution of extensive investigations, and the facilitation of scientific discoveries.(Dash*et al.*, 2021).

Disadvantages:

Big data analysis presents a number of difficulties and drawbacks in addition to its benefits, including the following:

1. Data Quality and Reliability: The accuracy and validity of the analysis results might be impacted by the quality and reliability of the big data. Data that is incomplete, inconsistent, or biased might provide incorrect conclusions and judgements.
2. Risks to privacy and security: Big data frequently includes sensitive and private information, which raises questions about privacy and security. Potential hazards that need to be handled include unauthorised access, data breaches, and misuse of personal information.
3. Complexity and Infrastructure Requirements: To manage the amount and complexity of the data, big data analysis demands specialised knowledge, cutting-edge equipment, and a strong infrastructure. For organisations, putting the required systems and knowledge in place may be expensive and difficult.
4.Ethical Considerations: The use of big data poses ethical questions about privacy, permission, and data ownership. To guarantee ethical and responsible use of data, organisations must abide by ethical rules and norms. (Alabdullah*et al.*, 2018).

Practical implications:

Big data has the potential to significantly reduce costs, significantly shorten the time required to complete a computation, and to provide new services. With the development of big data, we can now obtain knowledge and insight from data, answer issues that were previously unanswerable through study, and even increase corporate efficiency while adding significant value to the global economy (Fang*et al.*, 2015).

Big data analysis has applications in dentistry as well as other fields. Researchers and clinicians may learn more about oral health trends, treatment results, and the efficacy of public health programmes by analysing huge databases. It permits the creation of specialised oral health initiatives for particular groups and decision-making that is informed by evidence. Identifying risk variables, forecasting illness development, and optimising treatment strategies are further ways that big data analysis may improve personalised patient care.

Application of Big Data in Dentistry:

The delivery of oral healthcare might be revolutionised, patient outcomes could be improved, and public health initiatives could be strengthened through the use of big data analytics in dentistry. Some significant features of big data in dentistry include:

1.Electronic Health Records (EHR): The use of EHRs in dentistry has resulted in the production of enormous volumes of data. EHRs record data about patients, including demographics, medical history, radiography, and more. From these records, dentists can get important insights that can be used to personalise treatment recommendations based on past data, discover trends in treatment outcomes, and identify hazards to oral health.

2.Clinical Decision Support Systems: include big data analytics to give dentists advice based on empirical data. Large datasets may be analysed by CDSS to help in the diagnosis of oral problems, the recommendation of suitable treatments, and the warning of doctors about possible medication interactions or allergies. The precision and effectiveness of clinical decision-making are enhanced by this.

3.Oral Health Surveillance: Big data analysis provides population-level oral health surveillance, enabling doctors and public health authorities to track oral health trends, recognise at-risk groups, and create focused treatments. Patterns of dental illnesses, access to care, and inequities in oral health may be found by analysing data from dental clinics, insurance claims, and public health programmes, which paves the way for more successful public health measures.

4.Precision Dentistry: Big data analytics can help with precision dentistry as genetic studies and personalised medicine improve. Dentists can pinpoint genetic markers that predispose people to oral illnesses or affect treatment outcomes by combining patient genomic data with clinical and environmental data. Personalised preventative care and treatment strategies can be made easier with the use of this information.

5.Research and Development: Dental researchers may examine enormous volumes of data using big data analysis to find fresh patterns, correlations, and relationships. Large datasets from research studies, clinical trials, and electronic health records may be analysed to provide new information on risk factors, treatment results, and oral health outcomes. This may hasten the creation of novel dental treatments and procedures.(Khan *et al.*, 2014).

Merits and Demerits of Big Data in Dentistry:

Merits:

Big data analysis in dentistry offers several merits:

1. Better patient care: By using big data analytics, dentists may access thorough patient profiles, pinpoint risk factors, and personalise treatment programmes to suit each patient's requirements. The results and happiness of patients are improved by this personalised approach.

2. Evidence-Based Dentistry: Big data analytics gives dentists access to extensive datasets and research findings, enabling them to make decisions that are supported by the available evidence. This guarantees that dental procedures and treatments are backed by research.
3. Public health interventions: Big data analysis reveals inequities and trends in oral health across groups. The population's total oral health may be improved by using this information to guide public health activities, allocate resources effectively, and create preventative interventions.(Khan *et al.*, 2014).

Demerits:
While big data analysis in dentistry offers significant advantages, there are potential disadvantages to consider:
1. Data Quality and Accuracy: Reliable analysis depends on the dental data's quality and accuracy. Data that is lacking, inconsistent, or inaccurate might produce false conclusions and judgements.
2. Data Privacy and Security: Maintaining data privacy and security is essential since dental data contains sensitive patient information. To ensure patient confidentiality, strict adherence to privacy laws and strong security measures are necessary.
3. Technological and Resource Challenges: Adequate infrastructure, knowledgeable staff, and resources are needed to use big data analytics in dentistry practises. For certain dental practises, the expense of purchasing and maintaining advanced analytics tools and systems might be a problem.(Khan *et al.*, 2014).

Challenges and Considerations:
While big data analysis holds great potential in dentistry, several challenges need to be addressed.
1. Protecting patient privacy and maintaining data security are of utmost importance while handling sensitive dental information. It is crucial to follow legal requirements and put in place effective data protection procedures.
2. Data Quality and Standardisation: For accurate analysis and interpretation, it is essential to guarantee data completeness, correctness, and standardisation across various sources and systems.
3. Technical know-how and infrastructure: Dental practises and institutions should spend money on the right infrastructure, data storage, and analytical tools. Additionally, needed are qualified individuals with knowledge of data interpretation and analysis.
4. Ethical Considerations: Ethical concerns are necessary for the ethical use of big data in dentistry, including patient data de-identification, informed permission, and openness in data utilisation.(Khan *et al.*, 2014).

Dental Public Health Implications:
Data mining pertaining to Public Health Dentistry involves the application of this to public oral health problem. In the context of Dental Public Health, big data analysis holds immense potential. Developing countries, like India, face significant oral health challenges with limited resources. Leveraging big data can provide crucial insights into disease burden, oral health disparities, and the effectiveness of existing interventions. This knowledge can inform the development of effective oral health policies, resource allocation, and preventive strategies tailored to the specific needs of the population.

Future implications:
The future implications of big data analysis are promising. As technology advances, the volume and variety of healthcare data will continue to grow exponentially. This presents opportunities to leverage advanced analytics, artificial intelligence, and machine learning algorithms to uncover hidden patterns and relationships in healthcare data. The combination of many data sources, including genetics, electronic medical records, and wearable technology, shows promise for precision medicine and personalised oral healthcare.

Policy implications:
Big data will undoubtedly be valuable and promising for the healthcare and welfare sectors, with consequences for policy. The aforementioned concerns should be actively addressed in research in order to get more knowledge about the healthcare and social welfare sectors so that sophisticated and useful solutions can be found (Song and Ryu, 2015).
Big data use in oral healthcare has significant policy ramifications. The importance of big data analysis must be acknowledged by policymakers, and they must promote its incorporation into healthcare systems. Strong governance structures and ethical principles are required to solve data privacy and security issues. Policies should also foster collaboration between healthcare professionals, computational statisticians, and computer scientists to ensure effective data analysis and interpretation.

Conclusion:
Big data analysis might provide crucial insights to improve oral health in developing countries like India with limited resources, but with huge disease burden paving the way for effective oral health strategies and policies.

Summary:
There is ever-increasing evidence that the events we encounter, the choices we make can impact future well-being, health, longevity & every aspect of lives and communities. Big data refers to data that is so large, diverse, and complicated that it requires novel architecture, methods, algorithms, and analytics to manage it and uncover its hidden value. Three things distinguish this data: it is large in quantity, it cannot be organised into conventional relational databases, and it is produced, collected, and processed fast. It uses a variety of data mining methods to find patterns and correlations in huge pre-existing databases, which may be described as the automatic extraction of meaningful, frequently undiscovered information from enormous databases. The objectives of data mining may be summed up as description, identifying relationships and patterns that can be understood by humans, and prediction, predicting a particular reaction of interest. Data mining pertaining to Public Health Dentistry involves the application of this to public oral health problem. Big data analysis might provide crucial insights to improve oral health in developing countries like India with limited resources, but with huge disease burden paving the way for effective oral health strategies and policies.

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