

Review article

Concurrence of big data analytics and healthcare: A systematic review

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ABSTRACT

Background: The application of Big Data analytics in healthcare has immense potential for improving the quality of care, reducing waste and error, and reducing the cost of care.

Purpose: This systematic review of literature aims to determine the scope of Big Data analytics in healthcare including its applications and challenges in its adoption in healthcare. It also intends to identify the strategies to overcome the challenges.

Data sources: A systematic search of the articles was carried out on five major scientific databases: ScienceDirect, PubMed, Emerald, IEEE Xplore and Taylor & Francis. The articles on Big Data analytics in healthcare published in English language literature from January 2013 to January 2018 were considered.

Study selection: Descriptive articles and usability studies of Big Data analytics in healthcare and medicine were selected.

Data extraction: Two reviewers independently extracted information on definitions of Big Data analytics; sources and applications of Big Data analytics in healthcare; challenges and strategies to overcome the challenges in healthcare.

Results: A total of 58 articles were selected as per the inclusion criteria and analyzed. The analyses of these articles found that: (1) researchers lack consensus about the operational definition of Big Data in healthcare; (2) Big Data in healthcare comes from the internal sources within the hospitals or clinics as well external sources including government, laboratories, pharma companies, data aggregators, medical journals etc.; (3) natural language processing (NLP) is most widely used Big Data analytical technique for healthcare and most of the processing tools used for analytics are based on Hadoop; (4) Big Data analytics finds its application for clinical decision support; optimization of clinical operations and reduction of cost of care (5) major challenge in adoption of Big Data analytics is non-availability of evidence of its practical benefits in healthcare.

Conclusion: This review study unveils that there is a paucity of information on evidence of real-world use of Big Data analytics in healthcare. This is because, the usability studies have considered only qualitative approach which describes potential benefits but does not take into account the quantitative study. Also, majority of the studies were from developed countries which brings out the need for promotion of research on Healthcare Big Data analytics in developing countries.

1. Introduction

Over the last decade, there has been a rapid digitalization across the industries. Healthcare has also undergone this digital transformation with an increase in use of Electronic Medical Records (EMRs); Healthcare Information Systems (HIS); and handheld, wearable and smart devices. As a result, a massive amount and variety of health-related data today, is in digital form, which includes – omics data, socio-demographics data and insurance claims data apart from clinical data. This high-quality healthcare data offers potential value for optimizing care delivery, but it is still “perceived as a by-product of healthcare

delivery, rather than a central asset source for competitive advantages” [1]. As the electronic health data remains largely underutilized and hence wasted [2], there is a need for converting the raw data into meaningful and actionable information [3,4].

Much of the highly valuable healthcare data is in unstructured or semi-structured form. Added to it, the complex, dynamic and heterogeneous characteristics of the data [5–7] renders it difficult to extract useful information using traditional data analytical tools & techniques [8]. In fact, there is a finite human ability to process this data without effective decision support [9]. This creates the need for integration of Big Data analytics into healthcare. Big Data analytics has the ability to

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analyze a wide variety of complex data and generate valuable insights which otherwise would not have been possible. When applied to the healthcare data, it has the potential to identify patterns and lead to improved healthcare quality & reduced costs and enable timely decision-making [6,8,10,11]. As per the report by McKinsey Global Institute [12], by utilizing Big Data effectively, US Healthcare can create a value of more than \$300 billion every year, of which two-third would be in the form of reducing healthcare expenditure by about 8%. Using Big Data technology, hidden knowledge can be uncovered using automated analysis of outcomes [13].

Advancement in cloud computing and increased deployment of EMRs enable easy access to longitudinal patient data [14]. The integration of longitudinal patient data with data from disparate, structured and unstructured Big Data sources offer the potential of comprehensive understanding of diseases at a considerably higher pace [15,16]. The ability of Big Data analytics to identify disease heterogeneity allows quick and accurate diagnosis and assessment of therapies [3,17–19]. By linking data from different sources and discerning patterns, the predictive power of Big Data analytics can also be used for transforming continuous real-time data into valuable information. This is of utmost importance in emergency medical situations as it can mean the difference between life and death [10].

The promising value of Big Data technology in healthcare has created an increasing interest of academic & industry investigators. Nevertheless, there have been only a few literature reviews and the literature remains largely fragmented. The purpose of this research therefore is to gain a comprehensive understanding of current outlook on this technology. It aims at answering the research question on: *How “Big Data analytics” fits in healthcare environment to enhance its value?* Accordingly, this review explores the conceptual aspect of applying Big Data analytics to healthcare and its significance in enhancing care delivery and business worth. It also describes the challenges posed in leveraging Big Data analytics in healthcare and the need for approaches to overcome them.

2. Review method

A systematic review was conducted for capturing relevant literature from different sources, focusing on the following objectives:

- To determine different perspectives to definition and concepts of Big Data in healthcare
- To explore the sources of Big Health Data
- To identify Big Data analytical techniques and technologies in healthcare
- To illustrate the potential benefits and applications of Big Data within healthcare
- To present strategies for tackling the challenges of Big Data application within healthcare

By investigating these objectives in detail, this review will make a significant contribution in understanding the overall context and the future application of Big Data techniques in the healthcare domain.

2.1. Information sources

A search for articles was made on following databases: ScienceDirect, PubMed, Emerald, IEEE Xplore and Taylor & Francis. The references included in these articles were also scanned for a thorough review.

2.2. Selection criteria

To select the literature for inclusion in the literature review, following inclusion criteria were used:

- IC 1: Articles that deal with Big Data analytics in healthcare

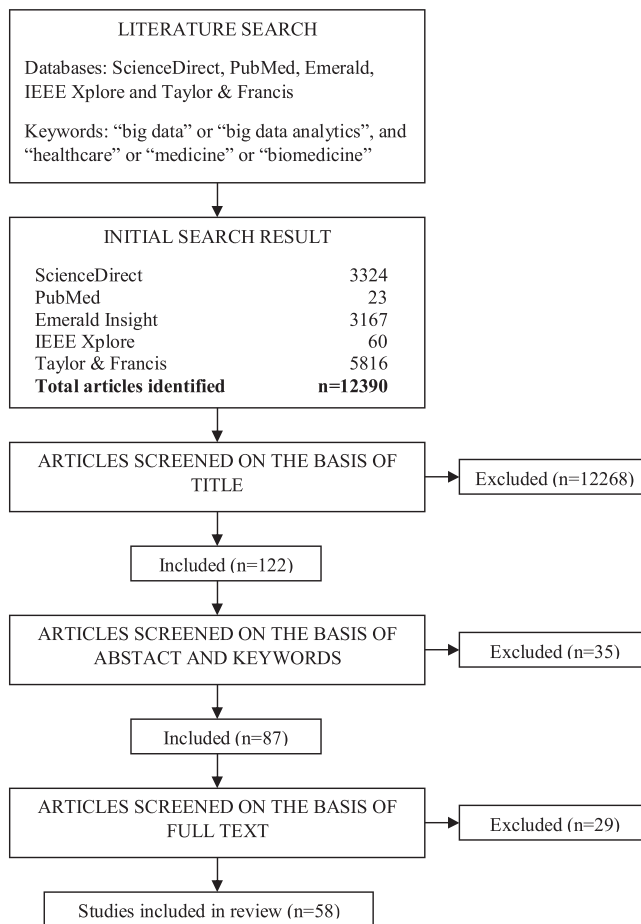


Fig. 1. Research Process.

IC 2: Articles published between 2013 and 2018

IC 3: Only articles published in English

To capture the literature relevant to the research interest, the articles with their primary emphasis on traditional analytics in healthcare were excluded.

2.3. Study selection

The procedure for search and selection of research material was carried out in the following four phases (Fig. 1):

1. The search for publications on electronic databases containing keywords “big data” or “big data analytics”, and “healthcare” or “medicine” or “biomedicine”
2. Scrutiny of the title, abstract and keywords of identified articles and selection of the significant articles on the basis of selection criteria
3. Perusal of articles that were not eliminated in the previous phase for the review
4. Scanning of cross-reference articles for detailed study

2.4. Quality assessment

During the review, activities ensuring the quality of the search process were undertaken. The web searches were made in incognito mode to avoid any influence of historical searches. From initial searches, the authors manually extracted relevant papers and articles. The analysis and evaluation of abstracts was carried out and the authors verified which articles were to be included or excluded from the study.

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