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Examining the Uses and Priorities of Big Data in Pharmaceuticals

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Abstract

A huge amount of data is generated annually in the field of medical care and drug diagnosis. With the continuous growth of data storage tools and the smart devices availability in the world, the big data influence will continue to develop. This efficacy has also been transferred to the field of medicine. The current study was conducted to identify the big data applications in the pharmaceutical field. The present study was done in two stages with a combined approach. In the first step, big data applications were determined and extracted by library examination and content analysis methods. In the second stage, the extracted applications were ranked using the expert committee consisting of experts who studied in the pharmaceutical field of Iran. The results of this research reveal that drug discovery and development and clinical trial analysis have the highest importance and after them, drug effectiveness and performance, drug safety, and drug personalization are in the next ranks. According to the results of this study, it can be stated that big data can help experts discover and develop better drugs and better identify the impact of drugs and other chemical compounds on the human body. Big data can assist improve the accuracy of the predictions about the impact of chemicals and drugs, which will lead to improved safety in drug production and help prevent the interactions of adverse drugs. Finally, the applications identified in this research are essential for the field of medicine and health, and big data may greatly affect the improvement of these fields. In general, it can be concluded from the results of this study that the use of big data will play an important role in pharmaceuticals and will seriously contribute to drug discovery and development, improving drug safety and effectiveness.

Keywords: Pharmaceuticals, Data, Big data, Medicine

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Introduction

In recent years, there have been great changes in the speed and volume of data production, which is beyond the understanding of the human mind [1-3]. In 2013, the data total volume was 4.4 zettabytes in the world. With time, the volume of data experienced a huge increase and reached 44 zettabytes by 2020 [4]. The data generated amount by scientific projects, popular companies, and small industries is growing at a tremendous rate. This high volume of generated data brings incredible storage, processing, and analytical problems that must be carefully addressed and considered [5-7]. In addition, traditional relational database systems and related data processing possibilities are inadequate in effectively dealing with massive data, where data sizes are typically measured in

terabytes or petabytes. Despite the advancement of existing technologies, currently, it is not easy to analyze such huge data, so the existing tools cannot effectively deal with large volumes of data when their size is very large [5]. This caused the demand to analyze large data sets through big data to increase dramatically in the last decade [8, 9].

Big data can be defined as a complex and huge database that stores multi-scale and heterogeneous data retrieved from multiple sources. According to the 5V model, big data mainly has high volume (storage capacity) characteristics, high production rate (speed of creation), versatility (high changes), value (applicability), and accuracy (accurate and accurate) [4]. Big data may be generated by various sources such as information systems, social networks, or the web. They may also be in text, image, audio, or video formats. Big data processing involves feeding the data into the system, maintaining the data for storage, analyzing the data, and visualizing the results [10, 11]. Organizations face challenges in big data management that can be overcome by using big data. Some big data analysis methods include predictive analysis and prescriptive analysis [12, 13]. Given that data plays a vital role in the era of data analysis and the demand for solutions related to impressive analytical tools has been constantly increasing, organizations and institutions are looking for ways to use big data power. Therefore, by providing potential solutions for public and private organizations, big data has been able to find a wide range in various industries and fields, including health sciences and related fields [14, 15].

Big data in health care and medicine has attracted many researchers' attention due to its different advantages. Data related to big data can be used for analyses such as optimization of electronic medical records, identification of disease patterns, treatment of diseases such as Alzheimer's disease, trends and preventive prediction of epidemics, and development of predictive models to identify patients at-risk, etc. to be used [16]. Also, the monitoring system together with big data models can provide an active monitoring platform to provide feedback for doctors [17]. Many types of research have been done in this field. Latha Bhaskaran *et al*. conducted a study on how big data approaches can be used in the fields of pharmaceutics, toxicology, and pharmacology. The results showed how researchers can use big data in the mentioned fields to address different challenges and create solutions [14].

In their research, Ma *et al*. described three main areas in which pharmaceutics uses big data, which are informed decision-making, improving care delivery in healthcare settings such as hospitals and community pharmacy settings, and Quality performance measurement for geriatric medical and geriatric health services and medication management activities such as medication adherence tracking and medication matching [18]. Motulsky also examined the challenges of big data in the pharmaceutical field in his research and examined the challenges, limitations, and applications of big data [4]. Another study attempted to create a concept proof showing that big data approaches have the potential to enhance drug monitoring safety in hospitals and thus can greatly assist pharmacists and vigilance professionals to identify adverse drug reactions [19].

Considering that the amount and variety of data available in the field of pharmaceuticals are constantly increasing and specialists in this field need to analyze data in the shortest time with the highest speed and accuracy, and on the other hand, the purchase of special hardware and software for this technology It is expensive and it is necessary to plan and prioritize the deployment steps to launch this technology, so the upcoming research has identified and prioritized the applications of big data in the pharmaceutical field. Due to the many applications of big data in the field of pharmaceuticals and allocating financial resources to launch this technology in each field, by identifying each case and prioritizing their importance, managers can use the results of this research for planning, application, and budget allocation for this important technology.

Materials and Methods

The following study is done from the perspective of practical purpose and with a combined method. In the first part of the research, a review of related studies and articles in the field of big data and its applications in the field of medicine and pharmaceuticals was discussed.

Studies in the period from 2010 to 2024 were reviewed in PubMed, Web of Science, Google Scholar, and Scopus databases. Using the keywords Pharmacy, Pharmacology, Drug Discovery, Big Data, and Data Science, sources were searched and identified. In the second part of the research, Swara's method was used to rank big data applications. Swara's method is one of the multi-criteria decision-making methods that has advantages such as accuracy in calculating index weight and interaction of participants.

Results and Discussion

Based on the review and analysis of previous studies, five of the most important big data applications in the field of pharmaceuticals were identified and extracted according to **Table 1**.

Table 1. Applications of big data in the pharmaceutical field

Big data applications	Application definition
Drug discovery and development [14, 20-23]	The process through which new drugs against diseases are discovered or the use of existing drugs is changed
Medicine Personalization [14, 15, 24]	Drug selection (drug combination/specific dose) according to the characteristics of each patient to improve effectiveness and reduce the number and severity of drug side effects
Drug efficacy and performance [14, 25-28]	The ability of a drug to promote a measurable biological response
Analysis of clinical research [14]	Clinical research studies health and disease in people. There are two principal types of clinical research: clinical trials and observational studies
Drug safety [25, 29]	Drug safety is usually determined using pharmacokinetics, the study of drug movement in the body, including the processes of drug absorption, distribution, metabolism, and excretion. Drugs with a strong safety profile have fewer side effects

The weighting results based on Swara's method are shown in **Table 2**. Drug discovery and development and clinical trial analysis have the most weight and importance, followed by drug performance and efficacy, drug personalization, and drug safety.

Table 2. Weighting results of big data applications using the Swara method.

Applications	Relative importance	K_j coefficient	q_j coefficient	Standard weight W_j
Drug discovery and development	-	1	1	0.263
Clinical trial analysis	0.176	1.176	0.850	0.224
Drug efficacy and performance	0.137	1.137	0.748	0.197
Drug safety	0.159	1.159	0.645	0.170
Personalization of medicine	0.161	1.161	0.556	0.146

In recent years, the large amount of data generated in the surrounding environment has attracted the attention of business professionals and various industries. Accordingly, technologies and capabilities related to data analysis play an important role in various fields. Big data refers to a huge amount of data that cannot be processed by ordinary software. In the field of health and medicine, due to the amount of available data, big data technology is used. This study was conducted to identify and prioritize the big data applications in the field of pharmaceuticals. The analysis of previous studies showed that the expected future of big data applications in the pharmaceutical field, the potential of big data to be used in drug discovery and development to speed up drug production, improve drug safety, drug performance, clinical trial analysis, and drug personalization in effect some of the medicine will increase.

Production and delivery of a new drug to the market requires a very high cost and a long time of several years. Big data allows pharmaceutical experts to simulate the reaction of a drug with body proteins and cell types in different conditions [14]. In the study by Ma *et al*. the results revealed that the use of big data in the industry of pharmaceutical can lead to better patient care and appropriate drug prescription [18]. In this sense, the findings of the current study are in line with the findings of this study. Also, Motulsky believed that big data promises a revolution in pharmaceuticals, and by using this technology, we move from individual reports and matching with limited resources to predicting drug behaviors and using multiple sources of performance analysis [4]. Big data can assist in improving the predicting accuracy of the effects of chemicals and drugs, and this also improves safety in drug production, and data analysis outputs lead to the prevention of potential adverse drug interactions [14]. Patient data analysis provides the possibility for the medical staff to be able to predict the patient's condition and possible changes in the coming days based on the registered electronic medical record of the patient, the type of prescription drugs, as well as the economic and social conditions of the patient [25].

Due to the high cost of using big data software and hardware, there is a need to plan for the provision of data analysis infrastructure, therefore it is important to prioritize these applications according to the available capabilities. The weighting results using Swara's technique revealed that drug discovery and development and clinical trial analysis are the most important. Next, big data applications in the fields of drug effectiveness and performance, drug safety, and drug personalization were prioritized respectively. As shown in **Table 3**, the benefits of using big data in each of the fields of drug science can

help to make informed and timely decisions in the process of drug production and development [18].

Table 3. Advantages of using big data.

Applications	Benefits of using big data
Drug discovery and development	• Identifying new drug targets • Identifying adverse drug reactions (side effects) • Identifying potential drug interactions • Improving the accuracy of drug discovery predictions • Improving the efficiency of drug discovery processes • Identifying new drug options
Clinical trial analysis	• Increasing data accuracy, due to the variety and volume of data sources • Effective safety monitoring • Safety concerns identification • More effective and efficient clinical trial design and implementation • Drug safety profile
Drug efficacy and performance	• Recognizing patterns in large data sets • Improving the prediction accuracy about how drugs behave in the body • Identifying new drug targets • Better understanding of how drugs work and how to improve them • Informed decisions about drugs and how to use them • Faster development of new drugs
Drug safety	• Increased accuracy in identifying potential drug safety concerns • More effective and efficient drug safety monitoring • Early detection of potential drug safety concerns • Understanding the drug profile
Personalization of medicine	• Understanding human and drug interactions • Identifying patient response to medication • Equivalent/similar risk of side effects

Conclusion

Based on the results obtained from the study, it was determined that the most important big data applications in the pharmaceutical field are drug discovery and development, clinical trial analysis, drug performance, drug safety, and drug personalization. Big data can assist experts to better discover and develop drugs and better identify the impact of drugs and other chemical compounds on the human body. This can assist improve the efficacy and safety of drugs and other chemicals. Big data can also assist improve the accuracy of the predictions about the impact of chemicals and drugs, which can improve safety in drug production and help prevent adverse drug interactions. According to the research results, managers of pharmaceutical companies and active experiments in the field of pharmaceuticals should provide special infrastructure and software for big data analysis to analyze data related to the manufacture of new drugs. To use the capabilities of this technology in evaluating drug performance, laboratories, and medical centers must also provide the necessary infrastructure to store and analyze related data. On the other hand, data science and big data are completely specialized fields that require interaction between experts in this field with pharmaceutical schools and drug manufacturing companies. It is also suggested to hold educational workshops or courses and specialized courses for pharmacy students to familiarize themselves with the capabilities of this technology.

According to the results of this study, it can be stated that big data can help experts discover and develop better drugs and better identify the impact of drugs and other chemical compounds on the human body. Big data can assist improve the accuracy of the predictions about the impact of chemicals and drugs, which will lead to improved safety in drug production and help prevent the interactions of adverse drugs. Finally, the applications identified in this research are essential for the field of medicine and health, and big data may greatly affect the improvement of these fields. In general, it can be concluded from the results of this study that the use of big data will play an important role in pharmaceuticals and will seriously contribute to drug discovery and development, improving drug safety and effectiveness.

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