Applications of Artificial Intelligence (AI) in Healthcare: Research Paper

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Abstract: ***Artificial intelligence is revolutionizing and strengthening — modern healthcare through technologies that can predict, grasp, learn, and act, whether it's employed to identify new relationships between genetic codes or to control surgery - assisting robots. It can detect minor patterns that humans would completely overlook. This study explores and discusses the various modern applications of AI in the health sector. Particularly, the study focuses on three most emerging areas of Al - powered healthcare: Al - led drug discovery, clinical trials. and patient care. The findings suggest that pharmaceutical firms have benefited from AI in healthcare by speeding up their drug discovery process and automating target identification. Artificial Intelligence (AI) can help also to eliminate time - consuming data monitoring methods. The findings also indicate that Al - assisted clinical trials are capable of handling massive volumes of data and producing highly accurate results. Medical AI companies develop systems that assist patients at every level. Patients' medical data is also analyzed by clinical intelligence, which provides insights to assist them improve their quality of life.***

Keywords: Artificial Intelligence, Healthcare, Drug Discovery, Clinical Trials, Patient Care

1. Introduction

The healthcare industry is in the midst of a transformation. The causes of this revolution are rising total health - care cost and a growing lack of health - care experts. As a result, the healthcare industry is looking to implement new information technology - based solutions and processes that can cut costs and give solutions to these rising difficulties.

As we focus on these issues, we should keep in mind that they are interconnected, providing the impression that healthcare is difficult when, in fact, it is given through complex systems. That isn't to suggest that providing outstanding healthcare is not difficult; nevertheless, we can create systems with less complication, resulting in better care and a system that works for everyone. AI should be a critical enabler of healthcare simplification and the development of intelligent care systems. The COVID - 19 problem demonstrates how AI may be used for a variety of purposes, including diagnoses and treatment decision assistance, as well as contact tracing and the deployment of AI - driven technologies (van der Schaar et al., 2021) (Habermann, 2021) (Vaishya et al., 2020).

Each doctor's accomplishments and failures must be learned via experience before becoming part of the standard of care and best practices. Doctors gain knowledge from other doctors, research studies, medication and device businesses that promote goods, and their own triumphs and mistakes with their own patients. Each doctor's error can be identified and corrected, often at the expense of their patients (McNeill & Walton, 2002). This form of learning represents human nature, and physicians are not immune to our brains' and learning systems' hard - wiring. The issue is that the provider's prejudice and limits are a result of this anecdotal experience (Ross et al., 2009). In reality, based on their own personal observation, some physicians may mistakenly deceive themselves into believing that a diagnosis is correct or that a therapy is effective, despite the fact that it is counter to evidence backed by studies or the results of thousands of patients (McNeill & Walton, 2002) (Shaheen, 2021a). Sometimes a clinician is just uninformed of new therapeutic care paths or better diagnostic modalities as a result of studies and data. To optimize reimbursement, clinicians must see as many patients as possible in the present medical environment. This leaves clinicians with little time to focus on secondary patient care chores, let alone stay current on medical breakthroughs. Doctors, on the other hand, now have immediate access to the insights and best practices of hundreds of cohorts, and they don't have to wait for best practices to be formalized into national standards of care (Ting et al., 2018). We can modify this calculus even more and act at a faster scale using AI than a particular physician or institution could (Holzinger et al., 2017)

Health professionals use the expertise of large numbers of clinical studies, the lessons of large numbers of patient treatment routes, and the cumulative experience of thousands of clinicians because they didn't have it at their fingertips (Shaheen, 2021a). This necessitates the use of technology, specifically artificial intelligence (AI) (Mayorga - Ruiz et al., 2019). Clinicians are vulnerable to cognitive and cultural biases as humans, but by offering a technological balancer in the knowledge base of providers, we can reduce, if not eradicate, the effects of such biases in AI (Woo, 2019).

2. Discussions

Big data and machine learning are having an impact on most aspects of modern life, from entertainment, commerce, and healthcare. Netflix knows which films and series people prefer to watch, Amazon knows which items people like to buy when and where, and Google knows which symptoms and conditions people are searching for. All this data can be used for very detailed personal profiling, which may be of great value for behavioral understanding and targeting but also has potential for predicting healthcare trends. There is great optimism that the application of artificial intelligence (AI) can provide substantial improvements in all areas of healthcare from diagnostics to treatment. There is already a large amount of evidence that AI algorithms are performing on par or better than humans in various tasks, for instance, in analyzing medical images or correlating symptoms and biomarkers from electronic medical records (EMRs) with the characterization and prognosis of the disease

The demand for healthcare services is ever increasing and many countries are experiencing a shortage of healthcare practitioners, especially physicians. Healthcare institutions are also fighting to keep up with all the new technological developments and the high expectations of patients with respect to levels of service and outcomes as they know it from consumer products including those of Amazon and Apple. The advances in wireless technology and smartphones have provided opportunities for on - demand healthcare services using health tracking apps and search platforms and have also enabled a new form of healthcare delivery, via remote interactions, available anywhere and anytime. Such services are relevant for underserved regions and places lacking specialists and help reduce costs and prevent unnecessary exposure to contagious illnesses at the clinic. Telehealth technology is also relevant in developing countries where the healthcare system is expanding and where healthcare infrastructure can be designed to meet the current needs. While the concept is clear, these solutions still need substantial independent validation to prove patient safety and efficacy.

The healthcare ecosystem is realizing the importance of AI - powered tools in the next - generation healthcare technology. It is believed that AI can bring improvements to any process within healthcare operation and delivery. For instance, the cost savings that AI can bring to the healthcare system is an important driver for implementation of AI applications. It is estimated that AI applications can cut annual US healthcare costs by USD 150 billion in 2026. A large part of these cost reductions stem from changing the healthcare model from a reactive to a proactive approach, focusing on health management rather than disease treatment. This is expected to result in fewer hospitalizations, less doctor visits, and less treatments. AI - based technology will have an important role in helping people stay healthy via continuous monitoring and coaching and will ensure earlier diagnosis, tailored treatments, and more efficient follow - ups.

a) Genetics - based solutions

It is believed that within the next decade a large part of the global population will be offered full genome sequencing either at birth or in adult life. Such genome sequencing is estimated to take up 100–150 GB of data and will allow a great tool for precision medicine. Interfacing the genomic and phenotype information is still ongoing. The current clinical system would need a redesign to be able to use such genomics data and the benefits hereof.

Many inherited diseases result in symptoms without a specific diagnosis and while interpreting whole genome data is still challenging due to the many genetic profiles. Precision medicine can allow methods to improve identification of genetic mutations based on full genome sequencing and the use of AI.

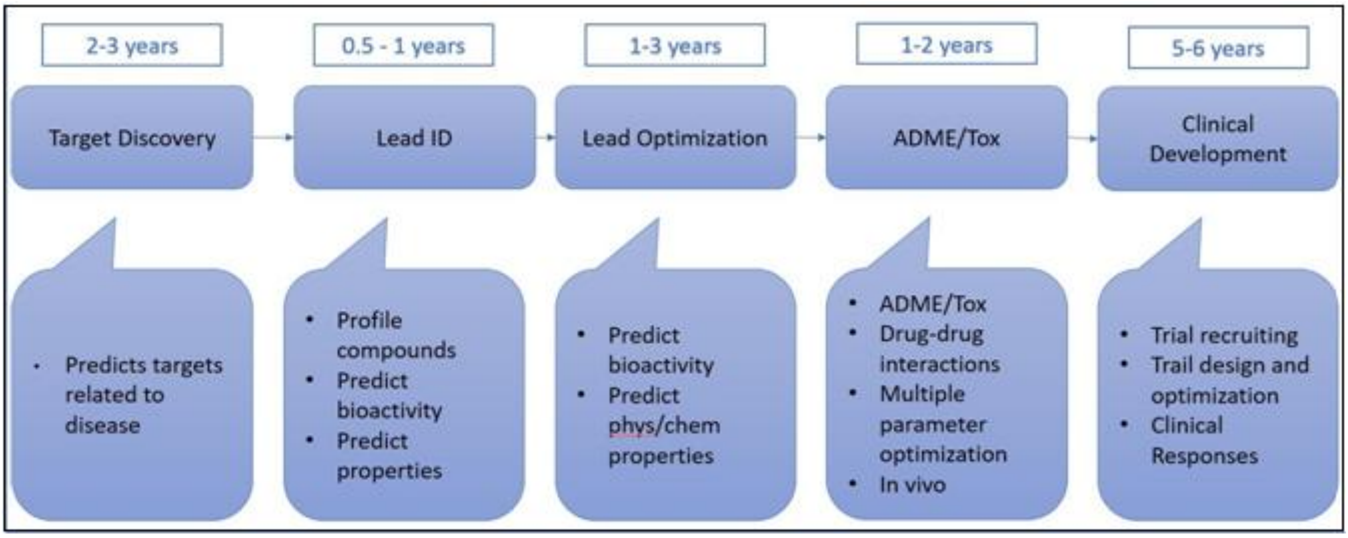
b) Drug discovery and development

Drug discovery and development is an immensely long, costly, and complex process that can often take more than 10 years from identification of molecular targets until a drug product is approved and marketed. Any failure during this process has a large financial impact, and in fact most drug candidates fail sometime during development and never make it onto the market. On top of that are the ever - increasing regulatory obstacles and the difficulties in continuously discovering drug molecules that are substantially better than what is currently marketed. This makes the drug innovation process both challenging and inefficient with a high price tag on any new drug products that make it onto the market

The drug molecules and the associated features used in the in - silico models are transformed into vector format so they can be read by the learning systems. Generally, the data used here include molecular descriptors (e. g., physicochemical properties) and molecular fingerprints (molecular structure) as well as simplified molecular input line entry system (SMILES) strings and grids for convolutional neural networks (CNNs)

c) Drug property and activity prediction

The properties and activity on a drug molecule are important to know in order to assess its behavior in the human body. Machine learning - based techniques have been used to assess the biological activity, absorption, distribution, metabolism, and excretion (ADME) characteristics, and physicochemical properties of drug molecules. In recent years, several libraries of chemical and biological data including ChEMBL and PubChem have become available for storing information on millions of molecules for various disease targets. These libraries are machine - readable and are used to build machine learning models for drug discovery. For instance, CNNs have been used to generate molecular fingerprints from a large set of molecular graphs with information about each atom in the molecule. Neural fingerprints are then used to predict new characteristics based on a given molecule. In this way, molecular properties including octanol, solubility melting point, and biological activity can be evaluated as demonstrated by Coley et al. and others and be used to predict new features of the drug molecules. They can then also be combined with a scoring function of the drug molecules to select for molecules with desirable biological activity and physiochemical properties. Currently, most new drugs discovered have a complex structure and/or undesirable properties including poor solubility, low stability, or poor absorption.



3. Applications of AI in Healthcare

The following are some applications of medical artificial intelligence applications utilized in the healthcare industry:

AI and medical visualization:
Interpretation of data that appears in the form of either an image or a video can be a challenging task. Experts in the field have to train for many years to attain the ability to discern medical phenomena and on top of that have to actively learn new content as more research and information presents itself. However, the demand is ever increasing and there is a significant shortage of experts in the field. There is therefore a need for a fresh approach and AI promises to be the tool to be used to fill this demand gap.

Machine vision for diagnosis and surgery
Computer vision involves the interpretation of images and videos by machines at or above human - level capabilities including object and scene recognition. Areas where computer vision is making an important impact include image - based diagnosis and image - guided surgery.

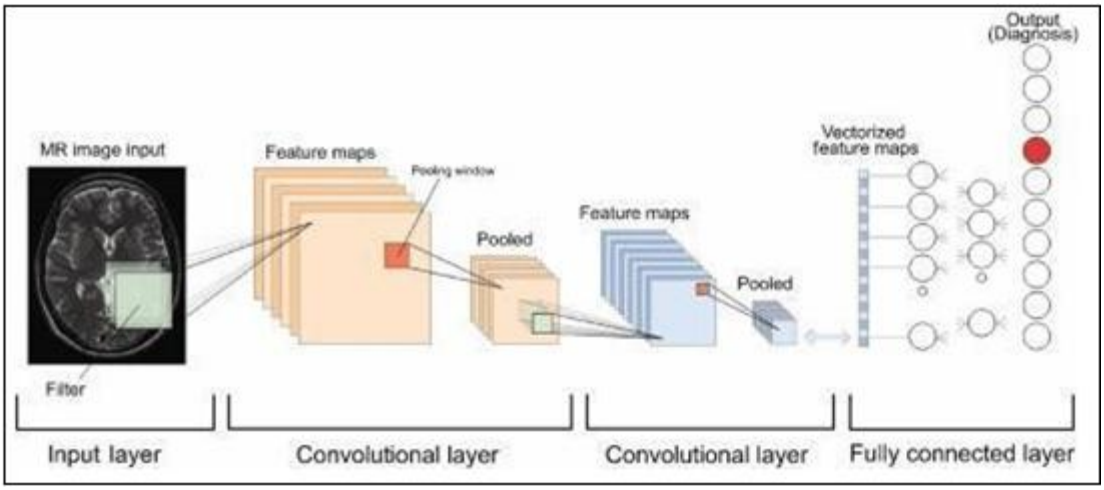
Computer vision for diagnosis and surgery:
Computer vision has mainly been based on statistical signal processing but is now shifting more toward application of artificial neural networks as the choice for learning method. Here, DL is used to engineer computer vision algorithms for classifying images of lesions in skin and other tissues. Video data is estimated to contain 25 times the amount of data from high - resolution diagnostic images such as CT and could thus provide a higher data value based on resolution over time. Video analysis is still premature but has great potential for clinical decision support. As an example, a video analysis of a laparoscopic procedure in real time has resulted in 92.8% accuracy in identification of all the steps of the procedure and surprisingly, the detection of missing or unexpected steps.

A notable application of AI and computer vision within surgery technology is to augment certain features and skills within surgery such as suturing and knot - tying. The smart tissue autonomous robot (STAR) from the Johns Hopkins University has demonstrated that it can outperform human surgeons in some surgical procedures such as bowel anastomosis in animals. A fully autonomous robotic surgeon remains a concept for the not so near future but augmenting different aspects of surgery using AI is of interest to researchers. An example of this is a group at the Institute of Information Technology at the Alpen - Adria Universität Klagenfurt that uses surgery videos as training material in order to identify a specific intervention made by the surgeon. For example, when an act of dissection or cutting is performed on the patient's tissues or organs, the algorithm recognizes the likelihood of the intervention as well as the specific region in the body [27]. Such algorithms are naturally based on the training on many videos and could be proven very useful for complicated surgical procedures or for situations where an inexperienced surgeon is required to perform an emergency surgery. It is important that surgeons are actively engaged in the development of such tools ensuring clinical relevance and quality and facilitating the translation from the lab to the clinical sector

Deep learning and medical image recognition:
The word "Deep" refers to the multilayered nature of machine learning and among all DL techniques, the most promising in the field of image recognition has been the CNNs. Yann LeCun, a prominent French computer scientist introduced the theoretical background to this system by creating LeNET in the 1980s, an automated handwriting recognition algorithm designed to read cheques for financial systems. Since then, these networks have shown significant promise in the field of pattern recognition.

Similar to radiologists that during the medical training period have to learn by constantly correlating and relating their interpretations of radiological images to the ground truth, CNNs are influenced by the human visual cortex, where image recognition is initiated by the identification of the many features of the image. Furthermore, CNNs require a significant amount of training data that comes in the form of medical images along with labels for what the image is supposed to be. At each hidden layer of training, CNNs can adjust the applied weights and filters (characteristics of regions in an image) to improve the performance on the given training data.

Briefly and very simply (Fig.2.3), the act of convolving an image with various weights and creating a stack of filtered images is referred to as a convolutional layer, where an image essentially becomes a stack of filtered images. Pooling is then applied to all these filtered images, where the original stack of images becomes a smaller representation of themselves and all negative values are removed by a rectified linear unit (ReLU). All these operations are then stacked on top of one another to create layers, sometimes referred to as Deep stacking. This process can be repeated multiple times and each time the image gets filtered more and relatively smaller. The last layer is referred to as a fully connected layer where every value assigned to all layers will contribute to what the results will be. If the system produces an error in this final answer, the gradient descent can be applied by adjusting the values up and down to see how the error changes relative to the right answer of interest. This can be achieved by an algorithm called back propagation that signifies "learning from mistakes. " After learning a new capability from the existing data, this can be applied to new images and the system can classify the images in the right category (Inference), similar to how a radiologist operates.



4. AI for Clinical Trials

A clinical trial is a procedure in which freshly manufactured treatments are given to people to test how well they work. This has taken a significant amount of time and money. The success rate however is quite low. As a result, the clinical trial automation has been proven to be a benefit for AI and the healthcare business. Furthermore, Artificial Intelligence and healthcare assist in the elimination of all time - consuming data monitoring procedures. Additionally, AI assisted clinical trials, handle large amounts of data and produce very accurate outcomes. The following are some of the most popular Artificial Intelligence in healthcare application for clinical trials:

Intelligent Clinical Trials:
Traditional linear and sequential' clinical trials are still the gold standard for ensuring the efficacy and safety of new drugs. The lengthy, tried - and - true method of distinct and defined stages of randomized controlled trials (RCTs) was developed primarily for evaluating mass - market pharmaceuticals and has remained mostly unchanged in recent decades. Artificial intelligence has the potential to shorten clinical trial cycle durations while also enhancing productivity and clinical development outcomes. This is the third in a series of reports on Al's impact on the biopharma value chain (Lee, 2021) (Angus, 2020).

Biopharma businesses have been able to obtain increasing volumes of scientific and research information from a multitude of sources in recent years, which is referred to as real - world data (RWD). They have, however, frequently lacked the expertise and tools needed to successfully use this data. Applying predictive AI models and advanced analytics to unlock RWD can help researchers better understand diseases, find relevant patients and important investigators, and enable revolutionary clinical study designs (Woo, 2019).

In combination with an efficient digital infrastructure, clinical trial data might be cleansed, aggregated, coded, preserved, and maintained using AI algorithms. Furthermore, improved electronic data capture (EDC) may reduce the impact of human error in data collection while also allowing for smooth system integration (Mayorga - Ruiz et al., 2019).

Clinical Trial Cooperation and model sharing
Researchers from several domains are racing to support the reaction to COVID - 19 in an exceptional effort of scientific collaboration. Making a worldwide effect with AI tools would necessitate scalable data, model, and code sharing strategies, as well as application adaptation to local settings and cross - border collaboration (Luengo - Oroz et al., 2020).

Data is required for AI applications. At the three application sizes, there are presently dozens of data - sharing efforts centered on COVID - 19, spanning the worldwide, national, and local levels. Genetic sequences, genomic analyses, protein structures, patients' clinical information, medical imagery, event data, epidemiological information, movement data, social media comments, news stories, and scientific literature are just a few of the resources available. Hyper - fragmentation of data - sharing activities is a problem since it could lead to advancements that are limited to specific projects and communities. The creation and diffusion of new applications could be accelerated by establishing scalable techniques for data, model, and code sharing. Global, open, comprehensive, comparable, and verifiable data - sharing activities will be useful at this stage in connecting and promoting cooperation between various communities and geographies (Lip et al., 2020) (Luengo - Oroz et al., 2020).

Open science, aided by multi - stakeholder AI collaborations that operate across international borders, can speed up information distribution and capacity building in national health systems (Shaheen, 2021b). The Epidemic Intelligence from Open Sources (EIOS) network, for example, uses open - source data to enable early detection, verification, and assessment of public health hazards and threats (Sucharitha & Chary, 2021). The network of practice for health care intelligence comprises governments, international organizations, and research institutes that collaborate to assess and share information concerning outbreak occurrences in real time under the principle of collaboration rather than competition in early detection. Global standards and database interoperability may facilitate unified reaction and decision - making at the global, national, and local levels, according to epidemiologists. Understanding the epidemiologic characteristics and risk features of various demographics as the pandemic progresses will necessitate taking into account health system resource capacity, public health measures, environmental factors, and COVID - 19's societal consequences (Sucharitha & Chary, 2021).

Aside from data sharing, there are currently few projects that exchange trained AI models for any of the suggested uses. Constraints imposed by unique computational, design, and infrastructural needs; a shortage of documenting; verification and interpretability issues; and legal concerns about confidentiality and intellectual property are among the obstacles to be overcome. Sharing pre - trained and approved AI models could help solutions adapt faster to different situations. Models used to diagnose illness from pictures, forecast patient results, filter misinformation and misinformation depending on propagating patterns through social media, and distill knowledge graphs from massive collections of scholarly papers are instances of algorithms that could be broadly useful (Luengo - Oroz et al., 2020) (Shaheen, 2021a) (Harrer et al., 2019).

5. Patient Care

Patient outcomes are influenced by artificial intelligence in healthcare. Medical AI firms create a system that aids the patient at every level. Clinical intelligence also analyzes patients' medical data and delivers insights to help them enhance their quality of life. The following are a few significant clinical intelligence systems that improve patient care:

Maternal Care
The following is a potential technique for identifying high - risk moms and reducing maternal mortality and problems after childbirth:

a) Predicting whether expectant mothers are at significant risk of difficulties during delivery using electronic health data and artificial intelligence (AI).
b) Using digital technology to increase patient entry to both regular and high - acuity care (i. e., more sophisticated and frequent care) throughout their pregnancy.

When compared to delivering in higher - acuity clinics with more strong resources and clinical experience, high - risk obstetric women who deliver their infants at low - acuity clinics have a higher risk of developing serious maternal morbidity.

Healthcare Robotics:
In addition to medical personnel, certain medical robots assist patients. Exoskeleton robots, for example, can assist paralyzed patients in walking again and becoming self - sufficient (Shi et al., 2019). A smart prosthesis is another example of technology in action. These bionic limbs attach sensors that render them more responsive and accurate than natural body parts, with the option of covering them in bionic skin and connecting them to the user's muscles. Robots can help with rehabilitation and surgery. Cyberdyne's Hybrid Assistive Limb (HAL) exoskeleton, for example, is designed to help patients rehabilitate from conditions that lead to lower limb disorders, such as spinal cord injuries and strokes, by using sensors placed on the skin to efficiently detect electrical signals in the patient's body and responding with movement at the joint (Cruciger et al., 2016).

Genetics AI Data - Driven Medicine
From genome sequencing to creating a tailored health status from the data in our fitness/activity trackers, today's healthcare consumer has grown increasingly involved in their personal medical treatment. All of this big data is being compiled and linked to produce a more predictive picture of our health or medical status. Data - driven medicine has the potential to improve not just the precision and agility of genetic disease detection, but also to open the door to individualized medical treatments (Hummel & Braun, 2020).

AI - powered Stethoscope
One notable advantage is that, unlike traditional stethoscopes, the readings may be taken even in noisy environments, allowing for more accurate diagnosis. The records can be obtained by anybody and telemetered to the doctor because there is no need for training to use the digital instrument (Prabu, 2021). This also lowers their chance of contracting COVID - 19 and makes it easier to provide better medical care in inaccessible areas and for chronically ill patients. Artificial intelligence (AI) and machine learning have made it possible for computers to discover illness patterns and abnormalities from massive amounts of clinical data. Blood flowing through regular arteries is different from blood that flows around a blood clot in the blood vessels, thus the same idea applies here (J. Agrawal, 2018).

6. Conclusion

Artificial intelligence (AI) is progressively being used to healthcare, as it becomes more prevalent in modern enterprise and everyday life. Artificial intelligence has the potential to help healthcare providers in a variety of ways, including patient treatment and administrative tasks. The majority of AI and healthcare innovations are useful in the healthcare industry, but the strategies they assist can be rather different. While some publications on artificial intelligence in health claim that AI can perform just as well as or better than humans at specific processes, such as diagnosing sickness, it will be a long time before AI in healthcare replaces people for a wide range of medical jobs.

Despite such significant improvements, AI usage in healthcare remains very much in early stages. Continuous research continues to add additional capabilities to the technology, resulting in larger advancements in the coming years across a variety of industries. AI and machine learning have a lot to contribute in the critical healthcare sector, which is undergoing one of the swiftest digital transformations at the moment, and amenities have the possibility to substantially improve quality of life for patients.

References

[1] Miller D. D., Brown E. W. Artificial intelligence in medical practice: the question to the answer? Am J Med.2018; 131 (2): 129–133. [PubMed] [Google Scholar]
[2] Kirch D. G., Petelle K. Addressing the physician shortage: the peril of ignoring demography. JAMA.2017; 317 (19): 1947–1948. [PubMed] [Google Scholar]
[3] Combi C., Pozzani G., Pozzi G. Telemedicine for developing countries. Appl Clin Inform.2016; 07 (04): 1025–1050. [PMC free article] [PubMed] [Google Scholar]
[4] Bresnick J. Artificial intelligence in healthcare market to see 40% CAGR surge; 2017.
[5] Lee K. - F. AI superpowers: China, Silicon Valley, and the new world order.1st ed. Houghton Mifflin Harcourt; 2019. [Google Scholar]
[6] King D, DeepMind’s health team joins Google Health.
[7] Hoyt R. E., Snider D., Thompson C., Mantravadi S. IBM Watson Analytics: automating visualization, descriptive, and predictive statistics. JMIR Public Health Surveill.2016; 2 (2): e157. [PMC free article] [PubMed] [Google Scholar]
[8] Marr B. How is AI used in healthcare—5 powerful real - world examples that show the latest advances. Forbes; 2018.
[9] Kalis B, Collier M, Fu R.10 promising AI applications in health care. Harvard Business Review; 2018.
[10] Singhal S, Carlton S. The era of exponential improvement in healthcare? McKinsey Co Rev.; 2019.
[11] Konieczny L, Roterman I. Personalized precision medicine. Bio - Algorithms Med - Syst 2019; 15.
[12] Love - Koh J. The future of precision medicine: potential impacts for health technology assessment. Pharmacoeconomics.2018; 36 (12): 1439–1451. [PMC free article] [PubMed] [Google Scholar]
[13] Kulski JK. Next - generation sequencing—an overview of the history, tools, and ‘omic’ applications; 2020.
[14] Hughes J. P., Rees S., Kalindjian S. B., Philpott K. L. Principles of early drug discovery. Br J Pharmacol.2011; 162 (6): 1239–1249. [PMC free article] [PubMed] [Google Scholar]