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REVOLUTION OF ARTIFICIAL INTELLIGENCE IN PHARMA INDUSTRY, DIGITALIZED INNOVATIONS

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ABSTRACT
Artificial intelligence (AI) is a branch of computer science, sometimes also known as machine intelligence. It mainly deals with problem-solving by making use of computer systems that perform various tasks. Artificial intelligence in Pharma refers to the use of various software and algorithms that can be operated by human intelligence for performing various tasks and functions. AI plays a vital role in the growth and development of new drugs. It helps us to improve workflow efficiency, reduces operating costs and promotes safety, accuracy, and efficiency. Pharma and the healthcare industry are much benefited by the use of AI and machine learning approaches. Many pharmaceutical companies began investing in AI and most of the companies are offering software across many applications like predicting treatment results, drug design and data preprocessing. Over the last five years, the use of artificial intelligence in the Pharmacy has led to various contributions made by scientists in developing new drugs, tackling diseases, and more. The present article briefly describes the importance of AI in the field of pharmacy and various applications of AI in the Pharma and healthcare industry. This article also contains information about the current scenario of AI in pharmacy and future perspectives of AI.

KEYWORDS: Artificial intelligence, verge genomics, Watson for oncology, TUG robots, imagen osteo-detect, AIDOC.

1. INTRODUCTION AND HISTORY
Artificial intelligence is a branch of computer science, sometimes also called machine intelligence. It mainly deals with problem-solving by making use of computer systems that perform various tasks.[1] Generally, human intelligence is required for the operation of computer systems and the development of various software and algorithms.[2] AI can be used in the analysis of data, saving human efforts and also saves our time and money. The three elements of AI are a massive amount of data, sophisticated algorithms, and high-performance parallel processors.[3] The various approaches made are cybernetics, symbolic, statistical and integrating the approaches. The use of AI in the Pharma industry helps in the development of new drugs and also contributes to the healthcare industry.[4]

It is considered that artificial intelligence was established in the year 1956. John McCarthy coined the term "Artificial intelligence" and is recognized as the father of AI. However, in the year 1955 Allen Newell and Herbert A. Simon developed the first AI system which was called Logic Theorist. Alfred N. Whitehead and Bertrand Russell have proved nearly 40 theorems of Principia Mathematica using this system. However, they could not get it published.[5,6]

Artificial intelligence in the field of pharmacy helps us to improve workflow efficiency, reduces operating costs and also promotes safety, accuracy, and efficiency. AI can give more healthcare offerings like health trackers and wearable which offer real-time capture of data that can enable us to monitor the patient's condition. AI has many potential uses in the early process of drug discovery, right from the initial screening of drugs to prediction of the success rate of the drug.[7] AI also plays a role in early diagnosis of diabetic retinopathy, early prediction of cardiovascular risks, drug target identification and validation, multi-target drug discoveries and biomarker identification. However, the challenges and problems of AI are natural language processing, perception, motion manipulation, social intelligence, reasoning, problem-solving, general intelligence, etc.[8] AI also has many great advantages in the healthcare industry like managing medical records and other data, doing repetitive jobs, treatment design,

digital consultation, drug discovery, medication management, etc.[9]

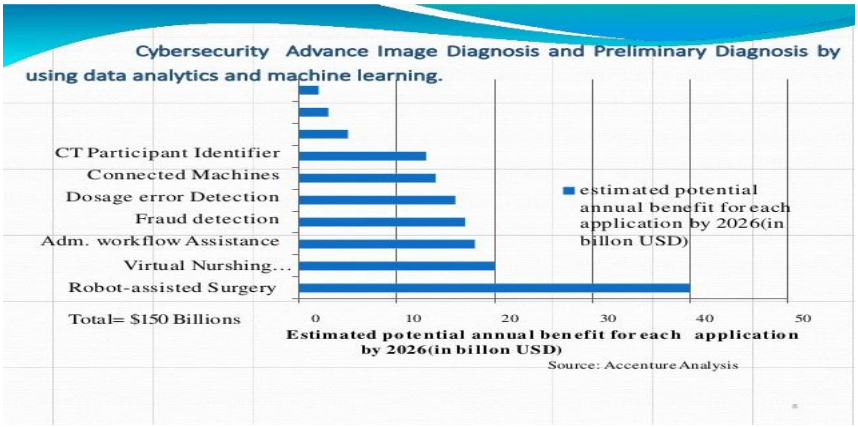

Figure 1: Cybersecurity advance image Diagnosis & Preliminary diagnosis by using data Analytics and Machine learning.

2. Importance of ai in pharmacy

Production and drug development is not an easy task and may cost a pharmaceutical industry as much as $2.6 billion along with a time frame of as long as 12-14 years for completion. This is why AI becomes a bonus for pharmaceutical companies. It reduces the time which is needed for drug development and also decreases the prices which are associated with drug development; it also enhances the returns on investments and may even cause a reduction in cost for the end-user.[10]

Table no. 1: Role of artificial intelligence in healthcare (Pros vs cons).

Pros	Cons
Better data-driven decisions	Concerns regarding privacy & security.
Increased disease diagnosis efficiency	Lack of curated healthcare data
Treatment time cut in half	High initial capital investment
Integration of information	Lack of interoperability
Reduce unnecessary hospital visits	Reluctance from staff to embrace AI
Create time-saving administrative duties	Potential for increased unemployment

The vital importance of AI is that it is much superior to humans in analyzing data and it also analyzes a large amount of data that would not fit in any of the conventional computers. AI is widely used in research areas. The processing power of AI is prominent that any other tools which are available at anyone's disposal and in research, especially on gene mutation; can go through lots of information and pick out only important and required information.[11]

Vel small molecule drug leads for unnamed cardiovascular disease targets were generated by **Merck** partnership with **Numerate** in march 2012. In December 2016 Pfizer and IBM announced their cooperation to advance drug discovery in immune-oncology.[12]

Table no. 2: Artificial intelligence in the pharma industry.

Function	Ai technology goals	Ai company
Clinical	Patient identification, screening & engagement for clinical trials. Connects researchers with funding based on their research & achievements, not based on their pedigree or contracts. Rmark bio is helping to break down the walls that many emerging scientists face when entering the industry. Improves clinical trial recruitment. Analyzes clinical trial operations.	1. Brite health. 2. Rmark bio. 3. Ibm watson. 4. Mckinsey's quantum black.
Medical	Identification, collection, & aggregation of congress data to question, objectives & strategies.	Scimar one
Business	Predictive analytics to business	Motionhall.

development	development & licensing.	
Market research.	Uses ai & data collection (patient health data, medical images & other information) to address the traditionally long cycle from research to market of pharmaceuticals.	Owkin
Regulatory	Improves patient safety & meets tough quality, compliance & data privacy standards.	Genpact's cora pharmacovigilance platform.
Commercial	Ai to determine the efficiency & side effects of drugs by comparing the individual customer's drug and medical history against the makeup of any given medication, allowing a more personalized range of treatment options. Aicure visually confirms that patients take their medication via smartphone. Patient diagnostics and treatment. Predicts dementia and neurodegenerative diseases from voice samples.	1. Better fit technologies. 2. Aicure. 3. Alibaba. 4. Winter light labs.
Cross functional	Aligns all relevant scientific data & clinical trial information to questions, objectives, & strategies; stores information over time for ongoing decision making and cross functional alignment.	Scimar one.

3. Current scenario of AI in the pharmacy[13]

1) Developing new drugs: A study published by MIT (Massachusetts Institute of Technology) has found that only 13.8% of drugs successfully passed clinical trials.

2) Novartis utilizes AI to predict untested components researchers should explore to find new cures: Novartis is embracing advancements in AI technology to create new and improved treatments and find ways to get people to access treatment quickly. It is currently using "machine learning to classify digital images of cells, each treated with different experimental compounds".

3) Verge Genomics uses AI to predict the effect of new treatments for patients suffering from Alzheimer's and ALS: The drugs in Verge Genomics are developed by automating their discovery process. They use automated data analysis and gathering to create solutions to some of the most complex diseases known today, including ALS and Alzheimer's.

4) Bayer and Merck & Co. identify pulmonary hypertension by using AI algorithms.

5) AI in pharmacology can also be used to find cures for existing diseases such as Parkinson's and Alzheimer's as well as uncommon diseases.

6) Tencent Holdings makes use of AI to remotely monitor patients with Parkinson's.

7) Mission therapeutics also uses AI to establish treatments for Alzheimer's. CURATE. AI created an AI platform to cease disease progression by optimization drug dosage at an individual level.

8) AstraZeneca and Alibaba generated AI to assist patients with automated cancer diagnostics.

Table no. 3: Artificial intelligence (AI) in pharmaceutical market.

Market segment	Market drivers	Geographic coverage	Key players
By application Drug discovery Drug development Drug commercialization. **By deployment type** Cloud On premises	Increase in processing powers of ai systems leading to enhanced ai capabilities. Death of skilled health care professionals Growing importance of precision medicine.	North america Europe Asia-pacific Rest of the world	3scan, inc. Aicure.llc. Arterys,inc. Atomwise,inc Benchsci analytics, inc.

4. Applications of ai in pharmacy

1. Early diagnosis of diabetic retinopathy

Diabetic retinopathy is an eye disease caused due to diabetes. This occurs mainly due to damage caused due to an increased level of glucose in blood vessels in the retina. Increased level of glucose in the retina either causes a swelling, leak or block of blood vessels or sometimes abnormal new blood vessels grow on the retina. All these lead to the stealing of vision.[14]

Advancement in the field of artificial intelligence helped in the early diagnosis of diabetic retinopathy with the help of quantifying properties of the nerve fiber. A study of a convolutional neural network helps to automate the quantification of corneal subbasal nerve plexus to diagnose diabetic neuropathy.[15] Different microscopy images obtained with the help of high-end graphics processor units help to identify the total nerve fiber length, tail points, branch points, number and length of nerve segment. All these algorithms together helped the doctors in the early detection of diabetic retinopathy. The trial version of these is going on India's famous eye hospital-like Arvind hospital and Shankar neutrally which has shown a positive response towards it.[16]

2. Early prediction of cardiovascular risks

The new artificial intelligence algorithm helped scientists discover a new way of assessing a person's risk of heart attacks and related cardiovascular risks with the help of the patient's eye. This is first initiated by scientists from Google and its health care subsidiary partners. With just the help of a scan of the patient's eye, the software can collect all data regarding the weight of the individual, blood pressure and whether they smoke or not.[17]

This algorithm has been very much useful as it helps to predict the cardiovascular risk very much fast and early without an actual blood test and start early treatment for the same. But the system needs to be checked and tested thoroughly before actual implementation in health care industries.[18]

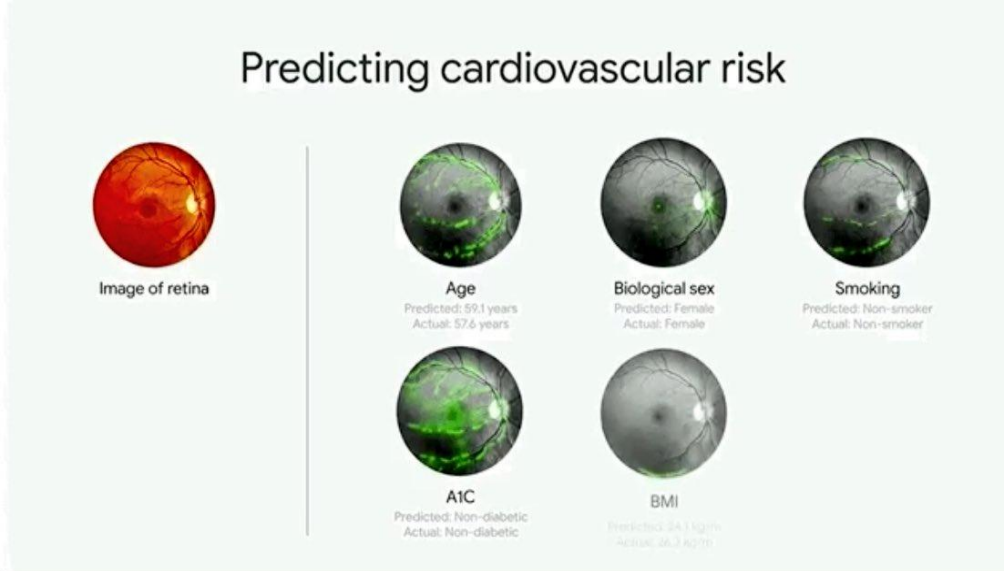

Figure 2: Predicting cardiovascular risk.

3. Ct brain bleed diagnosis[18]

A device called AIDOC first got US FDA approval in the year late 2018 to check brain bleeding. It was one of the first few AI devices which got granted.

The system was designed in such a way that it helped radiologists to check intracranial hemorrhage, bleeds in the CT scan providing high quality and accurate scan images. It helped a lot in curbing out the workload of the radiologist as more than 75% of cardiovascular disease is registered which is massive.

With the ability to provide a high work optimization and smart high-quality scan, this tool is working very smoothly. Though it doesn't involve a different hardware install and is easy to operate, it's simple resource can be maintained and set remotely.

4. Fracture detection in wrist in adult patient[18]

An AI-based software called IMAGEN OSTEO-DETECT is diagnostic software which utilizes highly intelligent algorithms involving dual x-rays.

This software is very much useful in determining common wrist fractures in adults called distal radius fractures. The software search damages in the bone and utilizes the machine learning technique to identify the problem areas and point out the particular area in the image and assist the physician for the same.

This software is multi-tasked and is used in different situations like primary care, emergency and accidental moments. Although this is only designed to assist.

5. Mri brain interpretation[18]

The advancement of artificial intelligence is seen in interpreting an MRI scan of the brain. ICOMETRIX, a company designed the machine in such a way that it helped to decrease the clinical errors, decreasing the time taken for analysis, and improving patient care for those afflicted with the issue.

The overall system is designed in such a way that changes in the brain are confidently evaluated with the help of high sensitivity and augmented processes. But still, there is plenty of work AI has to offer to improve more in the healthcare system[19]

6. Tools of ai[20,21,22,23]

1. Ibm watson for oncology

IBM has created a supercomputer and named it Watson. It is a combination of sophisticated analytical software and AI, which is designed basically to answer the questions. It helps clinicians to make better decisions for the treatment of cancer. Watson for oncology is a solution that consists of information from guidelines, best practices, medical journals, and textbooks. It analyses the information of the patient from a large network of data and skills and then provides choices for the treatment based on the evidence obtained.

At the Manipal Comprehensive Cancer Center, Bengaluru, India, treatment recommendations were provided for 638 breast cancers between 2014 and 2016. Treatment recommendations were provided by Watson for oncology for the identical cases in 2016. The center's board in 2016 carried out a blinded second review for all the cases in which there was no agreement, to account for guidelines and treatments not available before 2016. If the tumor board recommendations were designated 'recommended' or 'for consideration' by Watson for oncology then the treatment recommendations were considered concordant.

Table no. 4: Programming without & with AI.

Programming without ai	Programming with ai
A computer program without ai can answer the specific questions it is meant to solve.	A computer program with ai can answer the generic question it is meant to solve
Modification in the program leads to change in its structure.	Ai programs can absorb new modifications by putting highly independent pieces of information together. Hence you can modify even minute pieces of information of a program without affecting its structure.
Modification is not quick & easy. It may lead to affecting the program adversely.	Quick & easy program modification.

2. Robot pharmacy

UCSF medical center uses robotic technology to improve the safety of patients. Robotic technology is used for the preparation and tracking of medications. Oral and injectable medicines can be prepared by this technology which includes toxic chemotherapy drugs. This technology is advantageous to Pharma and healthcare industry and also to the pharmacists and nurses of UCSF and this has given the freedom to them so that they can utilize their expertise by focusing on direct patient care and working with the physicians. And according to UCSF medical center, robotic technology has prepared 3, 50, 000 medication doses without any error. Therefore, the robot has proved to be far better than humans as they can deliver accurate medications.

Table no. 5: Difference in robot System and Other AI programs.

Ai Programs	Robots
They usually operate in computer simulated worlds.	They operate in real physical world
The input to the AI programs is in symbols and rules	Inputs to robots is analog signal in the form of speech waveform or images
They need general purpose computers to operate on	They need special hardwares with sensors & effectors

3. Tug robot: Aethon TUG autonomous robots travel the hospital 24/7 and deliver medications, materials, clinical supplies, meals, specimens, etc; almost anywhere. It was designed with the nurses in mind. It is advantageous as it results in higher job satisfaction and more time for patient care. It consists of two configurations that are fixed and secured carts as well as exchange base platforms which are used to carry racks, bins, and carts. Fixed carts are employed for delivering medications, laboratory specimens, and sensitive materials, whereas the exchange platform is used to transport materials that can be loaded on different racks. The advantages of using TUG include patient safety, employee satisfaction, worker safety, and improved productivity.

7. Impact and Risks

Even though AI aids in speeding up drug discovery, it is on the edge of replacing human intelligence in the process just yet. Darren Green, GSK's director of computational drug design and selection says that "we

are still a long way from the machine doing it all".[24] According to Zhvoronkov `if we want the fusion of regenerative medicine with pharmacology and gene therapy" the only way possible is AI. Verscheure, head of Swiss Data Science Centre (a joint venture between Swiss universities ETH Zurich and EPFL) which is expecting to tackle some of the problems. He said how effortlessly AI algorithms could be fooled.[25] The latest image-recognition test trained an AI system to recognize pictures of socks, but when a few pixels were altered of that image, the best algorithm recognized the image as an Indian Elephant—a mistake which human beings would have never made. He says that AI should not be used in areas of cancer diagnosis, where we need to understand the basis of any decision made.[26] The other point of heedfulness with AI is the training of neural networks and types of biases that can be easily introduced, causing errors and even discrimination. The unbalanced data in AI strategies for drug discovery causes racial biases and even inaccuracies which are to be considered. Hunter says, "The prime thing here is transparency, making sure that one understands the quality of the data input".[27]

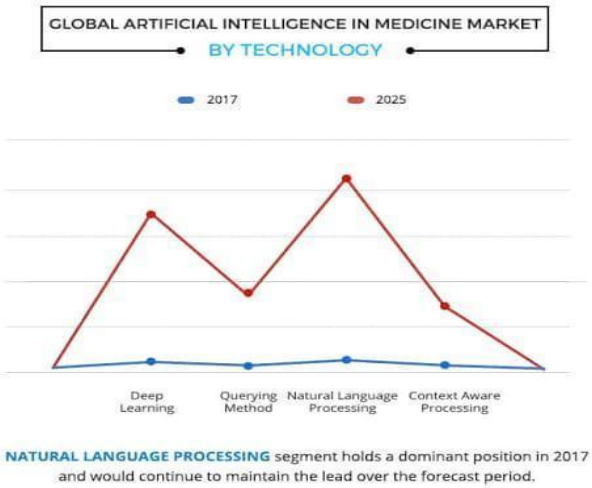

Figure 3: Global artificial intelligence in medicine market (By technology).

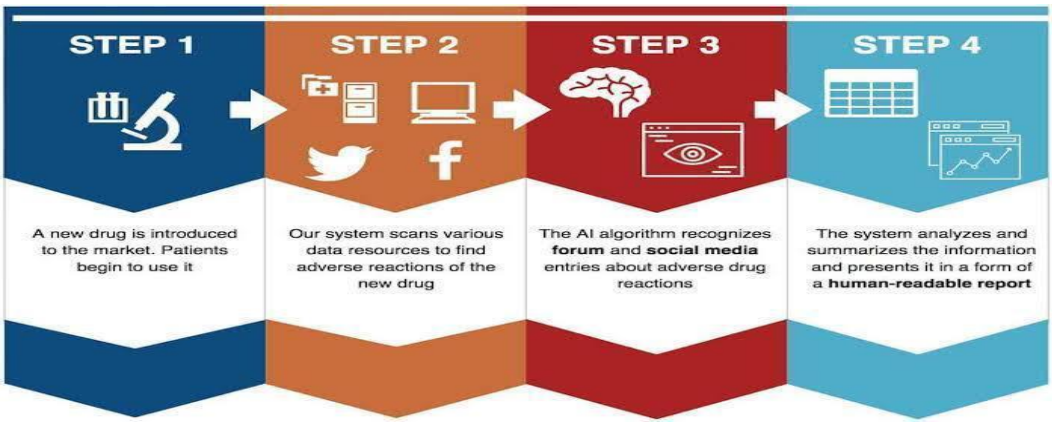

Figure 4: Steps of usage of AI.

Table no. 6: Artificial intelligence in healthcare, Applications, AI approaches & Challenges.

Ai in healthcare	Applications	Ai approaches	Problems of ai / challenges
Managing medical records & other data Doing repetitive jobs Treatment design Digital consultation Virtual nurses Medication management Drug discovery Precision medicine Healthcare monitoring Healthcare system analysis.	Healthcare & medicines Automotive Finance & economic Video games Heavy industries Robotics	Cybernetics Symbolic Statistical Integrating the approaches	Reasoning, problem solving. Knowledge representation Planning Learning Natural language processing Perception Motion manipulation Social intelligence Creativity General intelligence

8. CONCLUSION AND FUTURE PERSPECTIVES

It is said that the most sophisticated machine that can ever be created was Homo sapiens which everyone would have agreed upon a few decades ago. Though, today the scenario has changed remarkably. Human beings are no longer considered as "most sophisticated machines". The brain of human beings is considered as the most complex network of knowledge. It is working hard to generate something which is more efficient than the human brain, which is more efficient than human brains and also which can replace the human brain in performing such a task. This is the reason why AI is being used in pharmaceutical industries as well as in health care areas and also becoming an integral part of them. Endless research is being conducted throughout the world for the improvement of the efficiency of health care activities and manufacturing, researchers are trying to utilize AI in every activity they are carrying out. The different tools of AI such as Watson for oncology, Tug robot, and robotic pharmacy have completely changed the look of the profession. The above tools can be competent enough to function rapidly as well as the possibilities of error that may occur are either zero or negligible. The bigger the health care sector it requires more sophisticated and technologically advanced infrastructure which means the sector is going to depend ponderously on AI for nearly all of its future work. AI not only reduces errors but also enhances the efficiency which is persistent when humans are performing the task, which in turn means better quality of the product, decreased wastage and huge profit margin for companies. This is the main reason why AI is used in companies that are becoming technologically advanced day by day. But, this causes large scale human unemployment consequently all the activities of the human job will become a part of AI's job. This means "The end of the human race" according to Stephen Hawking. However, AI should be included in health care but in coordination with humans.

9. REFERENCES

1. John McCarthy (1927-2011): Artificial Intelligence (complete) - Thinking Allowed -Jeffrey Mishlove, retrieved August, 2021; 13.
2. Shasha, Dennis; Lazere, Cathy *Out of Their Minds: The Lives and Discoveries of 15 Great Computer Scientists*. Springer, 1998; 23. ISBN 9780387982694. Retrieved February 27, 2016.
3. "Leading academic who coined the term 'artificial intelligence'". *The Irish Times*. Retrieved January, 2016; 28.
4. "History of Computers and Computing, Birth of the modern computer, Software history, LISP of John McCarthy". *history-computer.com*. Retrieved January, 2016; 28.
5. ^ [a] [b] [c] Woo, Elaine (October). "John McCarthy dies at 84; the father of artificial intelligence". *Los Angeles Times*, 2011; 28.
6. ^ Hayes, Patrick J.; Morgenstern, Leora "On John McCarthy's 80th Birthday, in Honor of his Contributions". *AI Magazine*. Association for the Advancement of Artificial Intelligence, 2007; 28 (4): 93–102. Retrieved November 24, 2010.
7. Williams, Sam (March). *Arguing A.I.: The Battle for Twenty-first-Century Science*. AtRandom, 2002; 5: ISBN 978-0812991802.
8. Lester Earnest. "A. M. Turing award: John McCarthy, United States – 1971". ACM. Retrieved September, 2012; 5.
9. Dasta JF. Application of artificial intelligence to pharmacy and medicine. Hosp Pharm, 1992; 27: 312-5, 319-22.
10. Flasiński M. Introduction to Artificial Intelligence. 1st ed. Switzerland: Springer International Publishing, 2016; 4.
11. Cellan-Jones R. Stephen Hawking Warns Artificial Intelligence could End Mankind. Available from: http:// www.bbc.com/news/technology-30290540.
12. Statistica. Artificial Intelligence (AI). Available from: https://www.statista.com/study/38609/artificial intelligence-ai-statista-dossier/. [Last accessed on 2017 Jun 24].
13. Breitbart. Your Pharmacist will Soon be a Robot. Available from: http://www.breitbart.com/california/2016/05/02/ pharmacist-will-soon-app-robot/. [Last accessed on 2017 Jun 24].
14. NES Global Talent. How Artificial Intelligence is Beign used in the Pharmaceutical Industry. Available from: https://www.nesglobaltalent.com/media/press-releases/ how-artificial-intelligence-being-used-pharmaceutical industry. [Last accessed on 2017 Jun 24].
15. Eye for Pharma. Artificial Intelligence - A Brave New World for Pharma. Available from: http://www.social. eyeforpharma.com/clinical/artificial-intelligence-brave new-world-pharma. [Last accessed on 2017 Jun 24].
16. Klopman A. Artificial intelligence approach to structure activity studies. Computer automated structure evaluation of biological activity of organic molecules. J Am Chem Soc, 1984; 106: 7315-21.
17. Agatonovic-Kustrin S, Beresford R. Basic concepts of artificial neural network (ANN) modeling and its application in pharmaceutical research. J Pharm Biomed Anal, 2000; 22: 717-27.
18. Cherkasov A, Hilpert K, Jenssen H, Fjell CD, Waldbrook M, Mullaly SC, *et al*. Use of artificial intelligence in the design of small peptide antibiotics effective against a broad spectrum of highly antibiotic resistant superbugs. ACS Chem Biol, 2009; 4: 65-74.
19. Aliper A, Plis S, Artemov A, Ulloa A, Mamoshina P, Zhavoronkov A. Deep learning applications for predicting pharmacological properties of drugs and

drug repurposing using transcriptomic data. Mol Pharm, 2016; 13: 2524-30.
20. Margaret Rouse. IBM Watson Supercomputer. Available from: http://www.hatis.techtarget.com/definition/IBM Watson-supercomputer.
21. IBM. IBM Watson Health. Available from: https:// www.ibm.com/watson/health/oncology-and-genomics/ oncology.
22. Abrar P. IBM's Supercomputer Helps Doctors Fight Cancer. Available from: http://www.thehindu.com/business/ IBM's-Supercomputer-helps-doctors-to-fight-cancer/ article 14556945.ece.
23. University of California San Francisco. New UCSF Robotic Pharmacy Aims to Improve Patient Safety. Available from: https://www.ucsf.edu/ news/2011/03/9510/new-ucsf-robotic-pharmacy-aims improve-patient-safety.
24. McHugh R, Rascon J. Meet MEDi, the Robot Taking Pain Out of Kids' Hospital Visits. Available from: http:// www.nbcnews.com/news/us-news/meet-medi-robot taking-pain-out-kids-hospital-visits-n363191.
25. Pantozzi J. This Robot can Help Kids Through Chemo, Vaccinations and other Scary Medical Procedures. Available from: https://www.themarysue.com/medi robot-for-kids-medical-procedures.
26. Trynacity K. MEDi Robot to Comfort Patients in Stollery Children's Hospital. Available from: http://www.cbc. ca/news/canada/edmonton/medi-robot-to-comfort patients-in-stollery-children's-hospital-1.3919867].