

Artificial Intelligence & Health Care : A Revolutionary Combo

Ms. Jissa Donel

Nursing Tutor – All India Institute of Medical Sciences, AIIMS Raipur
Corresponding Author: Ms. Jissa Donel

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I. Introduction

AI is advancing dramatically. It is already transforming our world, socially, economically and politically. The “AI for Good Global Summit” took place at ITU in Geneva, Switzerland, on 7-9 June 2017, organized by ITU and the XPRIZE Foundation, in partnership with twenty UN agencies stated that Artificial Intelligence (AI) will be central to the achievement of the Sustainable Development Goals (SDGs) and could help solve humanity’s grand challenges by capitalizing on the unprecedented quantities of data now generated on sentient behavior, human health, commerce, communications, migration and more. ⁽¹⁾ The future of healthcare holds great promise for applying AI to improve many aspects of the care process. This paper gives an overview about artificial intelligence and potential benefits of application of these technologies in health care sector.

II. What Is Artificial Intelligence??

According to Eric Horvitz (Microsoft Research), “AI is not really any single thing – it is a set of rich sub-disciplines and methods, vision, perception, speech and dialogue, decisions and planning, robotics etc seeking true solutions in delivering value to human beings and organizations”. ⁽¹⁾ AI was viewed as a set of associated technologies and techniques that can be used to complement traditional approaches, human intelligence and analytics and/or other techniques. Combining the experience, knowledge and human touch of clinicians with the power of AI, holds great promise in improving many aspects of health care. Artificial intelligence (AI) aims to mimic human cognitive functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytics techniques. ⁽²⁾

III. Growth of Artificial Intelligence in Health Care Industry

With immense power to unleash improvements in cost, quality and access, AI is exploding in popularity. According to a 2016 report from CB Insights about 86% of healthcare provider organizations are currently using AI in some way. ^(3,4) Growth in the AI health market is expected to reach \$6.6 billion by 2021 that’s a compound annual growth rate of 40 percent .In just the next five years, the health AI market will grow more than 10x. ⁽⁵⁾ Healthcare market in India is growing at a fast rate and poised to grow from \$100 billion in 2016 to \$280 billion in 2020, creating a huge opportunity for healthcare and health tech companies and startups. Growth is already accelerating, as the number of healthcare-focused AI deals went up from less than 20 in 2012, to nearly 70 by mid-2016. ⁽³⁾ The government aims to increase the healthcare spending to 2.5 percent of the GDP by the end of its 12th five year plan, and to 3 percent by 2022. ⁽⁶⁾ Much of this will be done through public private partnerships and using tech to increase the reach and multitude of healthcare services.

Acquisitions of AI start ups are rapidly increasing while the health AI market is set to register an explosive CAGR of 40% through 2021. ⁽⁷⁾ Major technology companies – including Google, Microsoft, and IBM - are investing in the development of AI for healthcare and research. Several health startups were newly started in the last 10 years, which really redesigned and revolutioned the health care.

‘Niramai’ is among the leading start-ups using technology to fight cancer. This Bengaluru-based start-up started in 2016 uses AI for a pain-free breast cancer screening. ‘MUrgency’ is another healthcare mobile app that connects people who need emergency responses with qualified medical, safety, rescue, and assistance professionals. ‘MUrgency’ acts as an aggregator bringing together varied emergency services, including doctors, nurses, paramedics, ambulances, and first-aid assistants, all on one platform. Users can call for emergency medical response and assistance with just one tap on the mobile app. ‘Advancells’ startup started in 2013 makes stem cell therapy affordable. The technology has been found capable of treating various diseases such as diabetes, Parkinson's, Alzheimer's, arthritis, stroke and heart diseases. Portea is another example of health start bringing doctors and medical professionals to the patient's doorstep. It offers home visits from doctors, nurses, physiotherapists, and technicians for patients. Using remote diagnostics, point-of-care devices, and remote monitoring equipment; doctors and medical professionals can monitor patients who can't travel to hospitals.

Address health, Live health, Lybrate, Practo and many other useful health startups based on AI technologies can be added to this. ⁽⁸⁾

IV. Significant Benefits Of Artificial Intelligence In Health Care Industry

Of all the industries where artificial intelligence is picking up the pace, healthcare is one major sector where the impact will be massive. AI is a self running engine for growth in healthcare. It is considered as health care's new nervous system. Computer scientist Andrew Ng had called AI as the new electricity, with the potential to change how the world operates. Future of healthcare holds great promise for applying AI to improve many aspects in the care delivery system. The use of AI in healthcare will go far forward turning data into useful and actionable information that benefits the health and care of patients. All the new health startups, applications, softwares etc that are formed and functions using AI technologies contributes enormously in many dimensions in health sector. The potential benefits of these technologies are numerous. Few are listed below:

- **Aid in clinical judgement & diagnosis**

AI technologies can serve as a useful modality in diagnosing and treating the disease in the most appropriate way. Artificial intelligence plays a crucial role in timely and correct detection of serious illnesses whose treatment and prevention depends to a large extent on timely detection of the symptoms. Humans often tend to make mistakes when analyzing images and samples and making effective decisions but artificial intelligence algorithms can quickly study and scrutinize millions of samples in quick succession and reveal useful patterns. Major improvements in medical imaging, radiology, interpretation of diagnostic tests using newer AI technologies lead to a more precise and accurate diagnosis of disease. AI can diagnose diseases based on a complex algorithm using hundreds of biomarkers, imaging results from millions of patients, aggregated published clinical results from pubmed and other electronic resource. Image recognition technology-a newer advancement of AI analyse data from studies such as EKG, EEG, XRAY, MRI, CT scans etc and compiling interpretations of results by expert physicians and guides in creating an accurate diagnosis leading to the most needed treatment. ⁽⁹⁾ Basil Harris (Basil Leaf Technologies) designed a tricorder that can diagnose 13 diseases (pneumonia, urinary tract infection, diabetes, acute diseases, chronic conditions, etc), with AI built into the device in the decision-making control. Artificial neural networks, such as GoogLeNet and AlexNet were used effectively as diagnostic tools to accurately distinguish between tuberculosis chest X-ray images and normal images. ⁽¹⁰⁾ Similarly, neural network algorithms have been able to accurately grade gliomas, cervical and breast cancers as well as identify cancer stages. Google's parent company, Alphabet, is working on an AI program to detect metastasis using high-level image recognition.

Several trial studies have been conducted in different parts of the world using AI technologies in diagnosing diseases. A Stanford University study tested an AI algorithm to detect skin cancers against dermatologists, and it performed at the level of the humans. ⁽¹¹⁾ A Danish AI software company tested its deep-learning program by having a computer eavesdrop while human dispatchers took emergency calls. The algorithm analyzed what a person says, the tone of voice and background noise and detected cardiac arrests with a 93% success rate compared to 73% for humans. ⁽¹²⁾ Baidu Research recently announced that the results of early tests on its deep learning algorithm indicate that it can outperform humans when identifying breast cancer metastasis. ⁽¹³⁾ Many hospitals are currently using AI technologies for a faster and accurate diagnosis of diseases. At Shanghai Changzheng Hospital in China, radiologists have been utilizing AI technology from InferVision to improve medical diagnosis in reading CT scans and x-rays and identify suspicious lesions and nodules in lung cancer patients. The company, which partners GE Healthcare, Cisco, and Nvidia and works with 20 tertiary grade A hospitals in China, pairs a computerized tomography (CT) scan with AI that learns the core characteristics of lung cancer and then detects the suspected cancer features through different CT image sequences. Earlier diagnosis allows doctors to prescribe treatments earlier. ⁽¹⁴⁾

- **Better treatment with AI technologies**

Another interesting example of deep learning can help machines make better decisions than their human counterparts is the proliferation of clinical decision support (CDS) tools. These tools are usually built into the EMR system to assist clinicians in their work by suggesting the best treatment course, warn of potential dangers such as pharmacological interactions or previous conditions, and analyze even the slightest detail in a patient's health record. Sedasys System by Johnson & Johnson has been approved by FDA to deliver anesthesia to patients automatically in standard procedures. Apart from this, IBM has introduced Watson which is an artificial intelligent application. It has been designed to suggest different kinds of treatments based on the patients medical history and has been proved to be very effective. AI technologies revolutionize and redesign the treatment sector with day to day innovations. 3D printing to create human body parts, reproduce blood vessels and printing skin cells for rapid wound healing, an artificial eye that enables patients to attain a level of vision, small implanted remote controlled device that sends electrical pulses to help reduce the impact of headaches,

eye drops that dissolve cataracts eliminating the need for surgery, an artificial pancreas that measures blood glucose using a sensor and delivers insulin and adjusting the dosage according to readings ,an implant for opioid dependent patients that automatically administers doses of buprenorphine, a narcotic that can treat pain as well as addiction to narcotic pain relievers etc are few examples were AI technologies that revolutionized health treatment sector.

- **Solution for manpower issues in health care & expanding access to underserved areas**

“India needs to leverage technology because India faces huge shortage of doctors and nurses. Skill development and technology will be the two mantras in order to deliver health care to the last mile “-Dr.Trehan

The World Health Organization estimates 400 million people have no access to the most basic healthcare. At present there is a shortage of over 7 million medical and healthcare professionals all over the world and the problem is getting worse. There will be an estimated shortage, globally, of 12.9 million healthcare professionals by 2035. ⁽¹⁵⁾ There is an uneven ratio of skilled doctors to patients in our country. According to the Indian Journal of Public Health (2017 edition), India had 4.8 practicing doctors per 10,000 population. It is expected to grow to 6.9 per 10,000 people by the year 2030, but the minimum doctor to patient ratio recommended by the World Health Organisation (WHO) is 1:1000. ⁽¹⁶⁾ To worsen the problem, close to 75% of the doctors practice at urban agglomerate servicing only 28% of the population. This leaves to almost near zero cover for 76% of Indian population, which is largely rural. ⁽¹⁷⁾ The few doctors who practice in rural India have limited capabilities for managing diverse range of symptoms. Healthcare professionals are finding it especially difficult to serve the increasing needs of the population in areas which do not have access to proper healthcare facilities. AI is an effective measure to tackle challenges like the uneven ratio, making doctors more skilled at their jobs, catering to rural areas for a high-quality healthcare, training doctors and nurses to tackle complex procedures. Virtual Presence also known as Telemedicine a branch of AI allows specialists to assist their patients who live in remote locations. Using a remote presence robot, doctors can engage with their staff & patients in hospitals/clinics & assist or clear their queries. AI can also provide feedback to physicians who interact with patients by indicating overlooked concerns or cues in conversations to improve diagnosis and management.

- **Reducing human errors in practice**

AI has the potential to drastically reduce medical errors. Regarding human errors in medicine, one in ten medical diagnoses is wrong according to Institute of Medicine. According to a 2016 study by Frost and Sullivan , artificial intelligence has the potential reduce medical errors by 30-40% .According to WHO medical errors and faulty medical diagnosis are among the top 10 causes of fatalities worldwide and 1 in every 10 hospital admissions leads to a medical error and 1 in 300 admissions result in death as a result of these medical errors. ⁽¹⁸⁾ Studies on diagnostic errors in the U.S. report overall misdiagnosis rates range from 5 percent to 15 percent and, for certain diseases, are as high as 97 percent. ^(19,20) In the UK critical care units, the incidence of prescription errors was found to be 15% and the five most common incorrect prescriptions were for potassium chloride, heparin, magnesium sulphate, paracetamol and propofol. Most of the errors were minor, but 19.6% were considered significant, serious or potentially life-threatening . So in this current scenario, artificial intelligence is undoubtedly the best way forward for hospitals and medical institutions to eliminate these medical errors and make healthcare much more safer and efficient. With the advent of AI assistants, a major portion of the doctor’s clinical and outpatient services can be performed by and delegated to these AI assistants, thus giving the doctors more time to attend to serious cases more efficiently and thereby reducing the probability of medical errors. Also, AI assistants have lesser chances of making mistakes than human professionals who can sometimes provide a wrong diagnosis due to excessive work pressure and lack of AI assistance. Apps like Babylon in the UK use AI to give digital medical consultation based on personal medical history and common medical knowledge. Users report their symptoms into the app, which uses speech recognition to compare against a database of illnesses. Babylon then offers a recommended action, taking into account the user’s medical history. ⁽²¹⁾ AI powered mobile apps such as Your.MD provide basic healthcare services much more efficiently than human professionals. Their chatbots enquire patients about their symptoms and give them medical information about their health conditions that is simple and easy-to-understand. This AI platform has a huge repertoire of information that finds the connections and links between the symptoms of the illnesses and the causes, thus hugely reducing the chances of wrong diagnosis and unwanted medical errors that could have serious consequences otherwise. ⁽²²⁾ The authenticity and reliability of the information and guidelines provided by these apps have been approved by internationally certified organizations and thus patients can receive proper guidance from them which will eliminate the possibilities of errors which might have occurred as a result of wrong self-diagnosis by the patients.

- **Drug Discovery & Administration**

In the prolonged expensive process of drug discovery, AI can be a time-saving tool. The DeepVS neural network was able to accurately identify a target receptor that was the correct fit for a study compound. Developing pharmaceuticals through clinical trials can take more than a decade and cost billions of dollars. Making this process faster and cheaper could change the world. Amidst the recent Ebola virus scare, a program powered by AI was used to scan existing medicines that could be redesigned to fight the disease. The program found two medications that may reduce Ebola infectivity in one day, when analysis of this type generally takes months or years – a difference that could mean saving thousands of lives. ⁽²³⁾ The pharmaceutical company Pfizer, announced in 2016 a collaboration that will utilize IBM Watson for Drug Discovery. Pfizer is using IBM's AI technology on its immuno-oncology research system to help fight cancer by discovering new drugs for oncology. ⁽²⁴⁾ In 2016, a ground breaking trial in California found that a mathematical formula developed with the help of AI had correctly determined the correct dose of immunosuppressant drugs to administer to organ patients. ⁽²⁵⁾ Virtual Health Assistants (VHA's) can help dementia patients stay on track with their prescribed medications by sending reminders. The app answers asked questions about medications and whether symptoms require a doctor visit. 'Molly' is a virtual nurse that monitor patient's condition and follow up with treatments, between doctor visits. The program uses machine learning to support patients, specializing in chronic illnesses. In 2016, Boston Children's Hospital developed an app for Amazon Alexa that gives basic health information and advice for parents of ill children. ⁽²³⁾ Healthcare bots-a newer application of AI which are found in mobile messaging apps, can help patients quickly and in real time simply by sending a message. Health chatbots can answer health-related questions and even help patients manage medications by providing information on types of medications and recommended doses. Targeted nanorobots are novel systems for drug delivery too. ⁽²⁶⁾ The National Institutes of Health have created the AiCure app to monitor the use of medication by a patient. A smartphone's webcam is partnered with AI to autonomously confirm that patients are taking their prescriptions and helps them manage their condition. Most common users could be people with serious medical conditions, patients who tend to go against doctor advice, and participants in clinical trials.

- **Health monitoring through wearables , personal devices & smart phones**

Almost all consumers now have access to devices with sensors that can collect valuable data about their health. From smart phones with step trackers to wearables that can track a heartbeat around the clock, a growing proportion of health-related data is generated on the go. Collecting and analyzing this data and supplementing it with patient-provided information through apps and other home monitoring devices can offer a unique perspective into individual and population health. Wearable health trackers like those from FitBit, Apple, Garmin and others – monitors heart rate and activity levels. They can send alerts to the user to get more exercise and can share this information to doctors (and AI systems) for additional data points on the needs and habits of patients. ⁽²³⁾ The quality of cell phone cameras is increasing every year, and can produce images that are viable for analysis by artificial intelligence algorithms. Dermatology and ophthalmology are early beneficiaries of this trend. Using smartphones to collect images of eyes, skin lesions, wounds, infections, medications, or other subjects may be able to help underserved areas cope with a shortage of specialists while reducing the time-to-diagnosis for certain complaints.

- **Cost effective care**

In a 2016 study by Frost & Sullivan, it was reported that that AI has the potential to reduce the costs of treatment by as much as 50%. ⁽³⁾ Potential of AI through machine learning and big data is rewiring the existing healthcare landscape by economising healthcare costs. Integrating big data with wellness could potentially save the healthcare industry up to \$100 billion per year. According to Accenture analysis, when combined, key clinical health AI applications can potentially create \$150 billion in annual savings for the United States healthcare economy by 2026. ⁽⁷⁾ With the emerging technologies including artificial intelligence, the patient can get doctor assistance without visiting hospitals/clinics which results in cost-cutting. Interesting AI start ups like Sig Tuple (Digitalized blood analysis), Niramai (Thermal scans for breast cancer), Ten 3T (portable,easy to use electrocardiograms)are currently developing disruptive diagnostic solutions that will bring down the cost of diagnostic measures and treatment.

AI also holds promise for helping the health care industry manage costly back-office problems and inefficiencies. Activities that have nothing to do with patient care consume over half (51%) of a nurse's workload and nearly a fifth (16%) of physician activities. AI-based technologies, such as voice-to-text transcription, can improve administrative workflows and eliminate time-consuming non-patient-care activities, such as writing chart notes, filling prescriptions, and ordering tests. We estimate that these applications could save the industry \$18 billion. ⁽²⁵⁾

- **Personalizing treatments**

Large scale analysis of health care data can lead to personalized patient diagnosis and treatment. Contrary to the “one-size-fits-all” approach, personalized medicine attempts to enhance the efficiency and quality of cure in healthcare. More importantly, in the domain of personalized medicine, machine learning helps in assessing diseases and prescribes more effective treatments for patients that are in accordance with the biomarkers of the patients. A cloud based system involving sensor technology provided facility for tailor made physiotherapy at home for patients recovering from stroke and trauma. ⁽²⁷⁾ Exploration and analysis o data from increasing number of new mobile applications will further lead to the expansion of personalized care. For example, health and fitness apps in mobiles can propose the best diet,exercise schedule etc to clients based on the individualized data provided. These applications even acknowledge the regimen the clients had undertaken and can provide feedback to encourage compliance.

- **Enhancing patient safety**

Patient safety is a crucial element in the delivery of health care. To improve patient safety, algorithms are used as an early warning system that surveils for patient deterioration and triggers notification of real time patient alerts. Forey an application of AI that demanded clinicians to sent bed exit notifications in the University of Arkansas for Medical Sciences reduces the fall rate by 11 % and fall in the related injuries by 60% in the first year of its implementation itself. ⁽²⁸⁾

- **Prediction of diseases & hospital acquired infections**

Researches from Boston University effectively predicted heart disease and diabetes by utilizing a form of AI technology called as machine learning. They predicted hospitalization due to each disease roughly a year with an accuracy of 82%. ⁽²⁹⁾ Analysis of omics data and medical profiles by AI accurately predicted a genetic predisposition to oral cancer in a large population. Even apple watches can detect a variety of heart diseases including diabetic prediction with an 85% match in known cases. Jenna Wiens and her colleagues estimated patients risk of hospital acquired illness and risk of infection by clostridium difficile by extracting more than 10,000 variables for each day hospital admission using a Support Vector Machine –an application of AI. AI algorithms can provide continuous tracking of clinicians’ movements in hospital, without revealing who they are. Sensors in hallways close to handhygiene dispensers with a deep learning recognition system monitor clinicians’ hygiene practices, with a performance better than many of the state-of-the-art systems, reducing hospital-acquired infection rates as reported by Prof. Fei-Fei Li (Google & Stanford University). With the utilization of the powerful tools of AI, health care sector is able to deliver better care in a faster and safer pace. ⁽³⁰⁾ Precision Medicine, Genetics and genomics look for mutations and links to disease from the information in DNA. With the help of AI, body scans can spot cancer and vascular diseases early and predict the health issues people might face based on their genetics.

- **Health risk alert , morbidity & length of hospital stay**

Artificial intelligence algorithms were found to be superior to conventional statistical analyses in identifying the recurrence risk in breast cancer, morbidity following head and neck squamous cell carcinoma surgery or post-surgical complications in non-small cell lung cancer. Clinical Decision Support (CDS) is a tool commonly used in Electronic Health Record systems, which is an application of AI which is capable of providing health risk alerts during order entry of allergies or contraindications to medications or treatments. Alerts can also be calibrated to clearly distinguish life threatening problems from minor abnormalities. Even the length of hospital stay can be predicted with the help of certain AI models. Scott and Levin and colleagues used a logistic regression model using data from hospitals computerized order entry system and predicted the average length of stay and demonstrated prediction accuracy.

- **Patient triage**

For instance, AI voice-enabled symptom checkers triage patients to lower-cost retail or urgent care settings and direct patients to the emergency department only when emergency care is necessary. AI can address an estimated 20 percent of unmet clinical demand. A digital health firm developed “Dr. A.I extracted data from patient’s past medical history and knowledge from expert physicians and automatically triaged the patients and guided to appropriate department for care.

- **Fostering medical education**

Incorporation of AI in medical learning can dramatically improvise the ways students perceive knowledge.AI contribute in designing meaningfully differentiated curriculum to error free evaluation pattern.AI based medical education can significantly reduce the cost of education and burden on educators.

V. Conclusion

AI technologies are being used or trialled for a range of purposes in the field of healthcare and research, including detection of disease, management of chronic conditions, delivery of health services, and drug discovery as seen above. In the future, it is likely that AI systems will become more advanced and attain the ability to carry out a wider range of tasks without human control or input. A key challenge for future governance of AI technologies will be ensuring that AI is developed and used in a way that is transparent and compatible with the public interest, whilst stimulating and driving innovation in the sector.

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