Artificial Intelligence in Healthcare - A Revolution to Social Healthcare System

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ABSTRACT

BACKGROUND

Artificial intelligence (AI) aims to mimic human functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytic techniques. In developing countries, the inequality between urban and rural health services is a serious problem, of which the shortage of qualified healthcare providers is the major cause of the unavailability and low quality of healthcare in rural areas. Medical AI technology could improve physicians' efficiency and quality of medical services, especially in rural set up. The promotion of medical AI technology in rural areas of developing countries might be one means of alleviating the inequality between urban and rural health services.

KEYWORDS

Artificial Intelligence, Health for all, Social Healthcare.

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BACKGROUND

Artificial intelligence is defined as 'a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour, and with the creation of artefacts that exhibit such behaviour'.¹ Artificial intelligence makes it possible to learn from experiences and simulate it into machines. It further adjusts to new inputs and performs human alike functions and thus mimics actions or predict next course of action. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving. The British mathematician Alan Turing (1950) was one of the founders of modern computer science and AI.²

Artificial intelligence in healthcare is the use of algorithms and software to emulate human cognition in the analysis, interpretation, and comprehension of complicated medical and healthcare data. AI can assist physicians to make better clinical decisions or even replace human judgement in certain functional areas of healthcare (e.g., radiology and pathology). Application of AI in healthcare is not new and was first used in the year 1976. Recent times has experienced significant progress in digitized data acquisition, computational power and computing infrastructure.

This has enabled access of infrastructure to larger audience. AI applications are expanding into areas that were previously thought to be only the province of human experts.

Most of these technologies have immediate relevance to the healthcare field, but the specific processes and tasks they support vary widely.

The application in the field of surgery was first successively investigated by Gunn in 1976, when he explored the possibility of diagnosing acute abdominal pain with computer analysis.³ From the era of MYCIN, a backward chaining expert system developed in early 70's, which first used AI to identify bacteria causing infections to the Apple's machine algorithm which has been proved way better than humans in predicting heart attack, AI has come a long way in healthcare in a span of 45 years.^{4,5}

AI in medicine can be used from both virtual and physical perspective. The virtual includes informatics approaches from deep learning information management to control of health management systems, including electronic health records, and active guidance of physicians in their treatment decisions.⁶ The physical is best represented by robots used to assist the attending surgeon. Also embodied in this branch are targeted nanorobots, a unique new drug delivery system.⁷

In this article, we survey the current and prospective AI applications in healthcare, the advantages and challenges with a special focus on its uses in rural healthcare and realising the World Health Organisation's (WHO) dream of "health for all".

CURRENT APPLICATION OF AI IN HEALTHCARE

Healthcare is a complex adoptive system characterised by constant change and uncertainty due to the complex nature of human body. The emergence of AI based technologies have

helped us to augment our cognitive capacities, so that the healthcare delivery becomes more efficient.

Considering hospital as one of the case sample, representing part of healthcare systems, we intend to demonstrate prospective areas in which AI can be used. For ease of understanding, we categorise hospital systems into OPD, IPD and others sections, which are well known by the common man and health fraternity.

1. In Case of OPD

- a) Patient enrolment – First step to treatment starts at patient reception; how a healthcare system prepares for and receives its patients. Patient enrolment and allocation of right physician is one of the critical tasks but at the same time handled by limitedly abled staff. We recognise the significance of right experience at this stage. However, the health care systems are struggling to align it to end user expectations. AI has power to streamline this into contactless, end user driven experience and thus result into saving of resources and time for all the stakeholders of healthcare system.⁵ This has added benefit during pandemic or epidemics like Covid -19, where most of the hospitals are manually screening patients and attendees.^{8,9}
 - b) Symptoms identification, trend assessment and prognosis– Symptom's identification in the industry is mostly visual, oral or senses driven. There are set of objective or subjective questions that are asked and assessed, based on which symptoms are identified.¹⁰ AI has power to transform this completely & thus enable doctors with additional/ prescriptive information that can help doctors with targeted next step. Doctors will be at ease to conduct the prognosis and identify the on-going trends or upcoming trends.^{7,11}
 - c) Clinical & radiological recommendations –Based on the symptoms, trends and prognosis, healthcare professionals suggest for clinical affirmation either by lab tests or radiological exams. This is mostly based on the healthcare professional's experience. Healthcare professionals utilize all the available information in their hand to suggest rights clinical tests, which are further assessed based on objective and subjective standards. These protocols/ standards are sometimes prescribed by healthcare authorities or by own experiences of the professionals.¹²
- AI has power to leverage on the larger data set across the globe, learn from doctors and other healthcare professionals' experiences and help relatively newer healthcare professionals in accurate prognosis and test recommendations. It can also help experienced healthcare professional with validation of the diagnosis and with confidence level information of success of given type of medications.^{12,13}
- d) Telemedicine –This is now commonly practised approach for delivering remote health related recommendations to minor issues. It refers to a practise of diagnosis and treating patients when the doctor and patient are not physically close to each other. It is especially useful for patients in remote location. AI has huge opportunity in this space and has power to improve the access to healthcare beyond the boundaries of distance and time.¹⁴ This also enables for low cost,

effective primary health service delivery to beneficiary at remote locations.

2. In Case of IPD Patients

- a) Health stats monitoring & warnings – The monitoring of health stats is an important task in patients admitted in hospitals. These stats often give a warning and tell us about the progression of disease or effects of treatment. This is a frequent activity and consumes significant resources. Due to the high frequency of the activity, there is high probability of errors. Errors at this stage can have dire impact on patients. With the power of AI and digital, this activity, considered routine and mundane, can be digitised for optimised use of resources and reduce errors.⁶ This provides opportunities to save lives and raise alarms on the right time with complete objectivity without dependency on people.¹⁵
- b) Inbound patient care–Care of bedridden patient is an activity requiring patience and lots of care. Hygiene plays a very important role in preventing further complications and speedy recovery of the patient. Prevention of bedsores is the key in treating an inbound patient, which is usually done by repositioning the patient and being very proactive in checking for bed sores. The monitoring and alarming capabilities of AI can enable treating centre in early detection, fall risk and emergency signals. AI can further provide microclimate control and visitor's control.^{5,16}
- c) Surgical treatment – For many diseases or condition of the patients, surgery (invasive or non-invasive) is the ultimate treatment. Sometimes the position of the organ or tumour or any other factor may obstruct the surgeon from visualising the clear anatomy of the surgical field. The use of 3D tools powered by AI is being increasingly used by the surgeons to anatomically visualise the patient's interior and make a better surgical plan. Robot-assisted surgeries have led to fewer invasive surgeries, lesser surgery-related complications, less pain and a quicker recovery time.¹⁷

However, due to high cognitive requirements in this area the health care professionals and authorities are still watchful of this space. Independent critical surgeries are still very cautious and are performed under strict and capable supervision.¹⁸

3. Other Uses in Healthcare

- a) Physiotherapy support & diet – Physiotherapy plays an important role in complete recovery of the patient. Though the main role of physiotherapy is seen in improving patient's mobility, it also helps in recovery of functions of other organs. Again, the compliance of patient is important in this aspect which is observed to be lacking. AI is widely used in this space for monitoring and timely recommendations.¹⁹ This can also be used to maintain compliance in patient diet, which is very important in cure and treatment. AI can help in providing an individualised diet to patient especially discharge.²⁰ This is an emerging space and there are lot of health service providers that are utilizing these opportunities.
- b) Patient record maintenance -Ideally records of adult patient are maintained for 1 year for an OPD patient and

3 years for IPD patients.²¹ These records are of great importance for the healthcare system. There are many problems faced by institution/hospital for the proper maintenance of the records. Even though electronic health records (EHR) are being used in many developed and developing countries, the problem still exists. AI can help in making EHR more flexible, intelligent and precise.²² It can also help in identifying risk and response to a treatment protocol, which while integrated to EHR can provide decision support.

- c) Healthcare management - Current healthcare systems focus on treatment-based care, which cannot provide appropriate, timely low-cost interventions for healthy high-risk subjects. The epidemic has caused a huge economic burden worldwide. Introduction of AI enabled personal health monitoring platforms into healthcare management systems have reduced rising healthcare costs and improve healthcare.²³

Overuse of healthcare is a growing problem due to over diagnosis caused by improvements in the sensitivity of medical detection methods. There are many instances where screening actually overdiagnoses the disease, and the patient may not actually have it. Introduction of medical AI technology into healthcare management systems might help to identify unnecessary diagnoses and treatments.^{24,25} Therefore, medical AI technology not only focuses on the classical interactions between patients and healthcare providers, but also the systems can monitor health expenditures, cost recovery, and responses to treatment, thereby increasing population wellness and quality of care while decreasing costs.

FEW EXAMPLES OF AREAS WHEREIN AI IS BEING EXTENSIVELY USED

- a) Early diagnosis and prevention of complications – The importance of early detection is very high. It usually leads to more cure, reduced complications and lesser duration of treatment. It can reduce the burden on the healthcare system. This has led to launch of various screening programme for various diseases. Early detection is the key for deciding the treatment as well in certain cases like cancer and stroke, where the initial symptoms may be scarce. Non communicable diseases like hypertension, diabetes, cancer, stroke etc are like an iceberg where only the tip is visible. These diseases are not diagnosed till there is a complication or the patient undergoes regular screening.

AI can offer a great help in this field. AI uses mathematical algorithms and data-science from the human body to make diagnosis, better than doctors can do.^{16,26,27} This gives the ability to common man to take immediate actions or consult physician for diseases that may otherwise become severe.²⁸ One of the most effective forms of AI gaining interest is the diagnosis of cancer and cardiac related area.⁵ Villar et al. developed a movement-detecting device for early stroke prediction. Two ML algorithms - genetic fuzzy finite state machine and PCA - were implemented into the device for the model building solution. The detection process included

a human activity recognition stage and a stroke-onset detection stage. Once the movement of the patient is significantly different from the normal pattern, an alert of stroke would be activated and evaluated for treatment as soon as possible.²⁹

- b) Disease management – Certain disease like epilepsy, vertigo, tremors etc are uncertain in nature. Even with the treatment, patients are advised not to do certain day to day activities like driving. AI can offer assistance in these cases, as there are sensors and ambulatory monitors which warn the patient of an impending seizure.²² Wearable sensors have proven useful to quantitatively assess gait, posture, and tremor in patients with multiple sclerosis, Parkinson disease, Huntington disease and also been used to diagnose the cause of vertigo.²²
- c) Prevention of misdiagnosis and medical errors – Though no healthcare provider or a doctor wants to misdiagnose, it is quite common in the field. Many at times it occurs without fault from anyone. The constraint of time, adequate facility for testing or lack of test in the area, reporting issues etc can lead to a misdiagnosis. This can even be fatal sometimes, and the doctor may have to face legal complications, without fully being responsible.²⁵ AI can help prevent such mis-happening.¹³ This can be leveraged to an extent to change lifestyle for better and healthy world.

CHALLENGES AND CAUTIONS IN USING AI IN HEALTHCARE

The important consideration in any kind of medical procedure, of course, is patient safety. There are increasing concerns surrounding the ethical and medico-legal impact of the use of AI in healthcare.³⁰ Some important clinical safety questions should be considered to ensure success when using these technologies.

- a) Identification of new disease or symptom -Over time, disease patterns can change, leading to a disparity between training and operational data. In such cases new disease or a newer symptom of the disease will not be identified by AI. This is mainly because most of the uses of AI are based on the retrospective models on which the algorithm was built.²² Only through prospective studies will we begin to understand the true utility of AI systems, as performance is likely to be worse when encountering real-world data that differ from that encountered in algorithm training.
- b) Reinforcement of outmoded practice- Change in medical policy and any other structural changes requires recalibration of the models. Sometimes it would also need completely new/supplementary models. The introduction of a new predictive algorithm may cause changes in practice, resulting in a new distribution compared to that used to train the algorithm.^{15,31} Therefore, methods to identify drift and update models in response to deteriorating performance are critical.
- c) Insensitivity to impact - AI driven models/ processes may still need some manual support, especially in case of false positives or sensitive matters. AI makes the

diagnosis based on the information, though inadequate. It is driven by the confidence in the model driving the process.¹⁵ So in case of some models, which might suggest higher confidence, it is important to develop and set trigger-based monitors.³²

RURAL HEALTHCARE AND AI

The doctor patient ratio is improving in India and is 1.34 doctors per 1000, in rural India it is still 0.4 per 1000.³³ Lack of trained and skilled health care service providers has resulted into unskilled or semiskilled healthcare workers working in rural India, which is a reason for poor healthcare. Even if physicians working in rural areas have sufficient knowledge and skills, they lack the support of other skilled health providers and generally have to provide a wider range of services. This professional isolation and varying scope of practice reduces the quality of medical services. Factors like the poor general economic conditions, inconvenient transportation also leads to poor healthcare in a rural setup.³⁴

The revolution in communication technology has increased the use of smartphone in India including the rural places.⁵ This is a blessing for delivery of technology like AI. Most of the smartphones are user friendly, can be used not only to improvise the expertise of rural physicians, but also can be used for communicating and providing medical advice to patients. AI driven portable devices can run few tests, including blood pressure, electrocardiographs, and routine urine/blood analyses.³⁵ Smartphones can also act as platform for the use of AI driven healthcare applications supported by some additional specialized machines. Prognosis, initial diagnosis suggestions and lifestyle management are some key areas where AI driven systems can help to set up effective, low-cost rural health care systems.³⁴

CONCLUSIONS

There are many different AI techniques available which are capable of solving a variety of clinical problems and being used currently. It must be remembered that AI does not intend to replace the physicians; it only assists. AI is a boon in realizing the WHO's goal of "health for all" as it provides improvised accessibility, especially in rural India. There is compelling evidence that medical AI can play a vital role in assisting the clinician to deliver health care efficiently in the 21st century. There is little doubt that these techniques will serve to enhance and complement the 'medical intelligence' of the future clinician and revolutionise healthcare with time.

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