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ARTIFICIAL INTELLIGENCE IN CLINICAL DIAGNOSTICS – AN INDIAN PERSPECTIVE

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ABSTRACT

With changes in medical technologies and healthcare delivery methods, timelines and payment options, adoption of innovative tools to manage patient information and make decisions are becoming important. The need for analysis of a huge amount of data and quick decision-making has put artificial intelligence (AI)- enabled solutions at the forefront of the current wave of healthcare revolution. The aim of AI is to enable greater accessibility, understanding, correlation, action and ability of healthcare information. Nowadays, the capacity to extract information from disparate information sources, analyze large unstructured data sets and the abilityof natural language processing allow AI systems to tackle challenges in healthcare coordination that previously had no other means of recourse. In this article we intend to trace the journey of application of artificial intelligence in medical science, discuss its current status in clinical diagnostics and throw light on the AI solutions on the anvil with a focus on India.

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INTRODUCTION

The goal of Artificial Intelligence (AI) is to emulate human cognitive functions, thus reducing human efforts in repetitive and hugely analytical tasks. It is bringing a sea change in healthcare research and services, powered by increasing availability of data and rapid evolution of analytics techniques. AI tools can be applied to various types of healthcare data (structured and unstructured). AI techniques, which are being increasingly used, include machine learning methods for structured data, like the classical support vector machine, neural network, and the modern deep learning, as well as natural language processing (NLP) for unstructured data [1]. The rapid commercialization of machine learning and big data has helped bring AI to the forefront of healthcare and life sciences and is set to change how the industry diagnoses and treats disease.

Evolution of AI

The term artificial intelligence was first coined by John McCarthy, a young Assistant Professor of Mathematics at Dartmouth College, Hanover, New Hampshire, USA in 1956 when he held the first academic conference on this subject - Dartmouth Summer Research Project on Artificial Intelligence. Research in the 1960s and 1970s produced the first problem-solving program, or expert system, known as Dendral[2]. While it was designed for applications in organic chemistry, it provided the basis for the subsequent system MYCIN, considered one of the most significant early uses of artificial intelligence in medicine [3]. Many of the early efforts to apply artificial intelligence methods to real problems, including medical reasoning, had primarily used rule-based systems, reported Duda RO and Shortliffe EHin *Science* back in 1983[4]. Such programs were typically easy to create, because their knowledge was catalogued in the form of "if/then" rules used in chains of deduction to reach a conclusion. However, MYCIN and other systems such as INTERNIST-1 and CASNET did not achieve routine use by practitioners though [4,5,6]. Nevertheless, in many relatively well-constrained domains rule-based programs have begun to show skilled behaviour. This is true in several narrow domains of medicine as well, but most serious clinical problems are so broad and complex that straightforward attempts to chain together larger sets of rules encounter major difficulties [7,8]. Essentially rule based models cannot incorporate the myriad biological variations seen both in humans and in diseases. Absence of such logical human reasoning models, which is based on the addition of new rules, leads to unanticipated interactions between rules and thus to serious degradation of program performance [9,10,11].

Given the difficulties encountered with rule-based systems, more recent efforts to use artificial intelligence in medicine have focused on programs organized around models of disease. Efforts to develop such programs have led to substantial progress in our understanding of clinical expertise, in the translation of such expertise into cognitive models, and in the conversion of various models into promising experimental programs. Of equal importance, these programs have been steadily improved through the correction of flaws shown by confronting them with various clinical problems [12].

Already, there is evidence of substantial progress being made by AI techniques in radiology and such techniques can definitely assist clinicians in making better decisions or even replace human judgement in certain functional areas of radiology practices [13]. The availability of huge healthcare data and rapid development of big data analytic methods have made the recent successful applications of AI in healthcare possible. Guided by relevant clinical questions, AI techniques can unlock clinically relevant information hidden in the massive database, which in turn can assist in clinical decision making [14,15,16].

What can AI systems do in Clinical Diagnostics currently?

- By using carefully crafted algorithms AI can 'learn' patterns from a large volume of healthcare data, and then use the obtained insights to aid clinical decision making. It can also be equipped with learning and self-correcting abilities to improve its accuracy based on human feedback.
- AI systems can help clinicians by providing up-to-date medical information from journals, textbooks, and that available from ongoing or past clinical trials for appropriate patient care [17].
- By automating the pre-analytical process for laboratory diagnostics, an AI system can help to reduce diagnostic and therefore therapeutic errors that are quite common in human clinical practice [18,19].
- An AI system extracts useful information from a large human population to assist in making health risk and health outcome predictions possible [20].

- An AI system can interpret an individual's health status based on clinical history, vital statistics and diagnostic test results.

How is an AI system developed?

Before AI systems can be deployed, they have to be 'trained' through information that are generated from clinical activities, like screening, diagnosis, treatment assignment and so on in order that they learn from, similar instances, associations between subject features and outcomes.

Once 'trained' the quality of AI system is often measured by comparing the results to those derived from human experts, a product validation process. However, since the field is ever evolving there are no clear specifications in validation techniques. One way of validating the systems is by using existing data from clinical case reports. Such clinical data often exist in the form of demographics, medical notes, electronic recordings from medical devices, physical examinations and laboratory and radiology test results [21]. Specifically, in the diagnosis stage, a substantial proportion of the AI literature analyzes data from diagnosis imaging, pathology testing, genetic testing and electrodiagnosis.

AI devices

Based on the discussion we have had above, it can be postulated that AI devices mainly fall into two major categories. The first category includes machine learning (ML) techniques that analyze structured data such as imaging, genetic and EP data. In the medical applications, the ML procedures cluster patients' traits and infer the probability of the disease outcomes [22]. On the other hand, the second category includes natural language processing (NLP) methods that extract information from unstructured data such as clinical notes to supplement structured medical data. The NLP procedures are tools for turning texts to machine-readable structured data, which can then be analyzed by ML techniques [23].

Few Examples:

Worldwide

- Tennessee-based molecular diagnostics start-upIQuity will release its IsolateMS blood test, which uses machine learning to recognize differentially expressed protein-coding genes and noncoding-genes, markers of multiple sclerosis.
- Cognoa, a Palo-Alto-based digital health startup, has developed a

machine learning platform capable of diagnosing developmental delays in children utilizing only information and videos provided remotely by parents. It has already evaluated 300,000 children and the company just completed another round of funding in preparation for FDA approvals.

- Google's DeepMind, in collaboration with England's NHS, is in the process of feeding its algorithm over one million digital eye scans. It has already demonstrated the ability to identify sight-threatening conditions with equal accuracy to human ophthalmologists.
- A research team from Beth Israel Deaconess Medical Centre and Harvard Medical School has trained a neural network to interpret pathology images for tumors. In studies, the network's diagnostic success rate was 92%, which compared to 96% for the human pathologists that participated. Yet, the result most promising: when combined, the machine and human results reached 99.5% accuracy.
- Researchers at New York University's Langone Medical Center have taught a machine learning algorithm to diagnose PTSD only by listening to a person's speech pattern. Its diagnostic success rate has reached 77%. Similar voice-only approaches have also shown promise detecting Alzheimer's.

In India

- *Health Vectors* based out of Bengaluru has developed an algorithm to conduct disease risk profiling and reduction pathways based AI system that suggests diet, physical activity and lifestyle modifications recommended as per the risk statusof an individual.
- Bengaluru based, *SigTuple* applies the latest advances in artificial intelligence towards solving the healthcare diagnosis problem. They build algorithms, which learn from medical data, and help physicians by automating disease screening and diagnosis. They are testing these algorithms through low-cost diagnostic devices and a cloud-based intelligent platform. Sigtuple's product, *Shonit* automates the procedure of medical diagnosis to reduce the time and effort. Sigtuple's core product *Manthana* is an AI driven learning platform that provides solutions for automated analysis of peripheral blood smear,

urine and semen sample, retinal scans, and chest x-rays.

- Based on an individual's demographics and clinical history another Bengaluru based startup, *Healthi*, can recommend most relevant diagnostics tests, use AI based algorithms to analyze the test results and recommend if one needs a physician consultation.
- Bengaluru based AIndra Systems is building intelligent medical devices for use in screening of Cervical Carcinoma. They have created CervAstra a combination of their compact walk away Autostainer 'Intellistain', Image Acquisition Device 'Visionex', which can digitize slides at 15 mins each and AI Algorithm 'Astra', which can analyze wholes slides and segregate cells into High grade squamous intraepithelial lesion (HSIL), Low grade squamous intraepithelial lesion (LSIL) and Squamous Cell Carcinoma types.
- Bengaluru based Niramai Health AnalytixPvt Ltd is using a high-resolution thermal sensing device and a cloud-hosted analytics solution for analyzing the thermal images for screening for breast cancer. Their device uses big data analytics and machine learning for early breast cancer diagnosis.
- Gurugram based *Chironx AI* provides AI-based computer-assisted detection for diagnostic clinical imaging. It develops artificially intelligent machine learning-based computer-assisted detection (CADx) plugins for clinical application in those clinical settings where resources are less and burden is more. They are involved in analyzing images and researching algorithms for diagnosis of respiratory infections and other critical illness and their application for the development of automated CADx tools.
- Mumbai based *Qure.ai* is applying tailored deep learning deep learning algorithms to medical images to make the most of the rich 3-dimensional information contained in medical images for producing a diagnosis. One of their key focus areas is algorithm interpretability, ensuring that the reason for a suggested diagnosis is clear to a doctor. Their deep learning algorithms precisely quantify disease and tumor volumes, so that patient response to therapy can be monitored closely.

- Bengaluru based Touchkin is a predictive healthcare startup. Its machine learning platform identifies the potential health problem through changes in the patterns of communication, activity, and sleep of a person, which are tracked by the smartphone. Touchkin platform. It collects the data from mobile phones and sensors and uses the data to identify changes in behavioural patterns.

What lies in near future?

These impressive results are only a precursor to show how machine learning can enhance the diagnostic powers of medical devices, clinical laboratories and ultimately, of healthcare systems. As researchers feed the algorithms with more data, as the tools begin to be adopted by hospitals and physicians, “teaching sets” will grow and in turn, diagnostic accuracy will improve. The data may come from a network of physical devices, embedded with electronics, software, sensors, and network connectivity, from the electronic health records and medical notes with an AI system playing a central role [24]. By 2020, 40% of IoT-related technology is expected to be health-related, more than any other category, making up a $117 billion market[25]. The convergence of medicine and information technologies, such as medical informatics, will transform healthcare as we know it, curbing costs, reducing inefficiencies, and saving lives [26].

As we have discussed in the past, AI has transformative promise across the healthcare landscape, from empowering personalized medicine to improving operational efficiency and predictive cost management. However, diagnosis appears the most-imminent application. The tech giants that dominate the machine learning as a service market—currently IBM, Google, Microsoft, and Amazon as well as start-ups—will be well-positioned as hospitals and diagnostic chains require big data analytics infrastructures.

Lingering questions

However, there remain some substantial questions about the efficacy of integrating machine learning into the diagnostic process. What would bemedicolegal ramifications if an algorithm is responsible for a misdiagnosis? Will overdependence on technologyblunt intuitive clinical decision making of physicians, compromising the overall outcome of health management and, thus increasing the cost? Should physicians trust an algorithmically-derived diagnosis if they know how a computer systemarrived at the conclusion it did? Who will bear the legal responsibility of such report generated by an AI system?

Endnote

Regardless of the still unknown, machine learning as a diagnosis tool has proven its potential to save lives and 2017 appears the tipping point [27]. Of all the sectors in India, Artificial Intelligence is poised to disrupt Healthcare the most, in the coming years. Through the application of machine learning, data mining, natural language processing (NLP), and advanced analytics, artificial intelligence will assist doctors in diagnosing diseases faster.

Conflict of Interest Statement-

There is no conflict of interest.

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