Artificial Intelligence: Transforming Ayurveda

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Abstract

As we know technology is at its boom in 21st century and it has touched our every aspect of life including The Ayurveda: 'The science of life'. So for upgrading this ancient and 5000 yrs old system of medicine there must be full fledged inclusion of technology that allows computers and machines to function in an intelligent manner. This change with the help of technology is called as Artificial intelligence. It is the simulation of human intelligence processes by machines, especially computer systems. By adopting and adapting this digital world in the field of Ayurveda we can create a revolutionary change. The development of artificial intelligence (AI) in the medical field has been growing rapidly. The majority of the studies utilized AI models to predict certain patterns and find reliable computerized models to assist physicians. The objective of this article is to categorize and seek the current and further usage of AI in Ayurveda. A systematic scoping review has been conducted. The entire database, articles, news have been used to find studies regarding AI and Ayurveda. A broad range search strategy was applied to locate all relevant studies. Although the results from this review have shown the potential use of AI models in Ayurveda, future research ought to focus on verifying and validating the models by performing a large scale clinical trial to better promote AI in Ayurveda in the era of digital health.

Keywords: Ayurveda; Artificial intelligence; Digital health.

INTRODUCTION

Upgrading with a positive change is the only way of staying ahead. Ayurveda is a science of life with a holistic and totalistic approach to health and personalized medicine. It is one of the oldest medical systems, which comprises thousands

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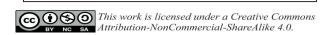
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Received on: 19.09.2022

Accepted on: 20.10.2022

of medical concepts and hypothesis. It has the capability to treat all the chronic ailments and life style disorders.

Artificial Intelligence is no longer a new concept on a global scale. Technology is growing more effectively with each passing day, empowering every business with a wide range of capabilities & opportunities, impacting our daily life in so many ways. From helping us find the Ayurveda stores in the city to suggesting the best doctor nearby, from recommending what to buy to keep ourselves healthy, AI is indeed making day-to-day life easier for us by understanding our needs better.

However, while this technology has a tremendous potential to reduce the human workload by saving time, costs, and efforts, its application in Ayurveda and the beauty space has not kept pace with the

adoption across other industries. It is primarily because Ayurveda, with its ancient roots, is considered an anti-thesis to the revolutionary and futuristic AI.

Although Ayurveda has been practiced in India for over 5,000 years, it is relevant and applicable to the modern era. The drastic changes in our lifestyles and dietary patterns have made it even more relevant even more essential in today's world.

General consideration for adopting the new technology

- Effective: It should be as effective as classical technology in the entire aspects e.g. therapeutic efficacy
- Easy to handle
- Economical
- It should be safe, having no hazardous effects.

Technology adoption in the field of Ayurveda is taking place in various form:

Learning

- Tele conference
- e-CME
- e-learning
- RDBMS-Relational Database Management Systems

Problem solution

- Instrumentation for Ayurvedic diagnosis
- Nadi (dosha-pulse) analyzer
- Search for Authentic Ayurveda Doctor

Research

- Drug pathway analysis
- Reverse pharmacology
- Absorption /Target/ Action of medicine
- Namburi spot test
- Ayur-genomics

Clinical

- Use of herbal beauty products
- Palatability and Appearance of Ayurveda Products
- Minimizing the dose of Ayurveda Formulations
- Use of modified methods and procedures for Panchkarma
- Telemedicine

TELE-CONFERENCING

Teleconferencing is a real-time and live interactive program in which one set of participants are at one or more locations and the other set of participants are at another. The teleconference allows for interaction, including audio and/or video, and possibly other modalities, between at least two sites. Various methods are available for setting up a teleconferencing unit. Teleconferencing is found to be a very useful tool in continuing medical education (CME), postgraduate medical education, undergraduate medical education, telemetering and many other situations like discussions about the specific case or problem. The use of teleconferencing in Ayurveda education has many advantages including savings in terms of travel costs and time. It gives access to the best educational resources and experience without any limitations of boundaries of distance and time. It encourages two way interactions and facilitates learning in adults. Despite having some pitfalls in its implementation it is now being seen as an important tool in facilitating learning in medicine and many medical schools and institutions are adapting this novel tool.[1]

E-CME

Now e-CME is possible through teleconferencing and it has changed the total scenario of importing education and exchanging thoughts all over the world without travelling at a very minimal cost.

E-learning

Today an Ayurveda student is not only dependent on his institutional teachers, he can listen to renowned personalities of Ayurveda all over the world through live lectures and recorded videos on YouTube and many other online platforms.

RDBMS

Technology tools have helped us to save the manuscripts by digitization of Ayurveda texts and it has also helped us to convert age-old texts in different languages so that everybody can understand and utilize them to enrich their knowledge. This has helped a lot to the Ayurveda students and researchers.[2]

Data Mining

Another application of AI in the field of Ayurveda is data mining. Data mining is a computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics and

database systems. The term data mining appeared around 1990 in the database community. Currently, data mining and knowledge discovery are used interchangeably. To achieve valuable information, in context of Data Mining, it follows three major steps i.e. data collection, data shrink and valuable data quest. There are various approaches adopted by variety of researchers. Such approach involves, association analysis, Extrapolative modeling database fragmentation and divergence detection.

The data mining tool enables precise knowledge searches using Boolean operators. Information related to diseases, causative factors, symptoms, treatment guidelines, drugs, dietary recipes, lifestyle changes and treatment procedures can be searched through complex queries employing any number of combinations of search strings.

A database also has been designed for medicinal/ herbal plants with the following objectives:[3]

- Collection of medicinal data.
- Web designing for medicinal plants using HTML/SQL/PHP.
- Screening of medicinal plants based on diseases.
- Screening based on family.
- Screening of herbs based on their vernacular names.

PRAKRITI ASSESSMENT

Prakriti (Human Body constitution) clearly defines harmony with human nature and cause for moving out of balance and experience disease. Basically, according to Ayurveda there are 3 *doshas* called *Vatta, Pitta*, and *Kapha* which decides body function on physical and emotional levels. These 3 elements are known as *Tridosha*. Few people may predominant in one or mixture of 2 or more. For the long time, Ayurveda *Dosha* have been utilized for diagnosis, treatment and *Prakriti* assessment. However, these diagnostic methods actually lingers behind in quantitative quality estimations due to lack of objective parameters. A cautious and proper examination prompts a powerful treatment.

Now with the help of artificial intelligence *Prakriti* assessment has been made easy with self-assessment performa and software. Self *Prakriti* assessment helps to decide the food regime and seasonal regimen that should be followed. It also helps one to take precautions to make life healthy and fit.[4]

NADI PARIKSHA

Nadi Pariksha/Pulse Diagnosis is a non-invasive ancient technique of Ayurveda disease diagnosis through pulse. It accurately diagnoses physical, mental and emotional imbalances as well. It is also the scientific tool that enables a person to secure their personalized wellness regimes such as therapeutic massages, personalized diet, and detoxification. The time tested and age old natural way of healing, Ayurveda, has taught that any presence of disease in our system will be indicated as an imbalance in our 'Doshas' - *Vata, Pitta* and *Kapha*. The principles of Ayurveda follow the natural way to diagnose diseases and bring back balance to the body, and one such mode of diagnosis is '*Nadi Pariksha*'.

One research has proposed model using Artificial Neural Networks and Decision Trees to create a tool that can take the ayurveda pulse readings using optical sensors so as to detect the *Prakriti* (VPK) of the patient. This covers the *sparshan pareeksha* phase of the three fold Ayurvedic Diagnosis. Questionnaires have been formulated for the two diseases considered, Anemia and Hyperacidity, respectively. These questionnaires are used as substitutes to the *Darshana* and *Prashna* phases. The paper by Begum and Divaakar proposes the use of pressure sensors to detect pulse. As the pressure of the sensor over the pulse increases, the amplitude of the pulse signal first increases, reaching a maximum, and then decreases. After a particular threshold value, the pulse dies.[5]

Various techniques for pulse sensing are discussed such as Microphone as a sensor, Pressure as a sensor, Bi-Sensing Pulse Diagnosis Instrument in the research paper by Chauhan. Romil et al.[6] He also proposed a device for *Nadi Pariksha*. It uses eighth order Butterworth filter for preprocessing of the three signals using optical pulse sensors so that the noise is eliminated. Three pulse sensors are used for the three signals to be visualized. The pulse data is then further classified into *Vata, Pitta*, and *Kapha* using artificial neural networks.

Khair and Joshi proposed a method for detecting the pre-meal and post-meal difference in a person using pulse. Results to their experiment showed that pulse signal carries useful information for classification of pre-meal and post-meal signal. Pre-meal classification had an accuracy of 88.88%, while post-meal showed an 81.48% accuracy.[7]

Kulkarni and Kumbhar developed a non-invasive diagnosis tool for detection of diabetes using two techniques, i.e tridosha analysis and application of

artificial neural networks.[8]

'*Niwarana*' an artificial intelligence based system for traditional medicine has developed in the country of Srilanka. *Niwarana* is an artificial Intelligence based system for traditional medicine.[9]

Niwarana uses a sentiment analyzer to recognize comments added by the users to evaluate doctors. Sentiment analyzer will provide a score according to the positivity or negativity of text in comments of users. Moreover it will rank doctors with the use of that score.

Drug pathway analysis

The system of Ayurveda focuses on establishing and maintaining balance of the life energies within us, rather than focusing on individual symptoms. The medicines used in this system usually contain more than one drug with a strategy to provide holistic health benefits through a multimodal therapeutic approach. Multiple bioactive compounds present in these polyherbal formulations are capable of modulating several disease targets. These complex relationships between these bioactive, target diseases and genes can be studied with the help of network pharmacology.[10]

Establishing the pharmacokinetics and pharmacodynamics of Ayurveda single and multidrug based therapeutics can be addressed through a multidisciplinary approach by involving basic sciences such as Chemistry, Molecular Biology, Pharmaco-epidemiology Biotechnology, Ethno-pharmacology, Ayurveda Drug Discovery, Reverse Pharmacology, and various other areas.

Reverse pharmacology

Reverse pharmacology is a rigorous scientific approach of integrating clinical observations, transforming experiential observation into leads by trans-disciplinary exploratory studies, and developing leads into drug candidates or formulations through robust preclinical and clinical research. Conventional approaches route the journey of drugs from laboratory to clinic. Reverse pharmacology, though not completely comparable to the traditional drug discovery process, follows an alternative pathway from clinic-to-laboratory and again back to clinic. As Ayurveda formulations have been used for thousands of years, their clinical experiences can catalyze drug discovery if recorded rigorously. The seeds of Indian reverse pharmacology sowed with the study of two physicians, Dr. Kartick Chandra Bose and

Gananath Sen (1931).[11]

Absorption /target/ action of medicine

After administration of *bhasma* to normal human volunteer, blood samples can be taken at specific intervals and assessment of the metal can be done in blood. For assessing metals like Hg, a technique viz Graphite Furnace Atomic absorption spectrometry (GF-AAS) with hydride generation technique can be used. For detection of metals like iron in blood, technique like AAS or ICP-MS can be used. For detection of phyto-constituents like *piperine* or *curcumin* in blood, technique like HPLC can be used. We have been using the mineral medicines since years; however the evidence generation about its pathway in the body is necessary. This can help in further drug development and global acceptance. The risks involved in long term use of mineral medicines, which is an unexplored area, can be avoided. *Rasashastra* medicines can emerge as globally accepted mineral supplements, catering the bodily requirements of iron, copper, calcium, gold, zinc etc. elements.[12]

Namburi Phased Spot Test (NPST)

Namburi Phased Spot Test (NPST) is the study of spot and colors at three successive phases spreading over three different time intervals. When a drop of clear solution of a substance (*Bhasma* or *Sindura*) under examination is put on Whatman paper impregnated with suitable reagent, a spot with series of changes in color and pattern will appear. This test is commonly used in chemistry. It has the advantage of measuring the sensitivity of reactions at different time intervals. This method is used to detect or study continual chemical reactions that take place gradually between two chemical substances on static media at every second. It is used to assess the *bhasma* qualitatively.[13]

Ayurgenomics

Ayurgenomics[14], an integration of the principles of Ayurveda with genomics, plays a vital role in explaining how current drugs can be used more effectively by targeting them on patients of particular *prakriti.* Prakriti based medicine can help in changing the current scenario of global health wisdom through effective integration of 'omics'. Ayurveda offers its modalities by way of *ahara* (diet), *vihara* (lifestyle) and *aushadhi* (medication), which constitute the three pillars of *prakriti* based medicine. Disease prevention and promotion of health towards longevity with a better quality of life, the base of preventive medicine, could be achieved through these attributes of Ayurveda.

Use of modified methods and procedures for Panchkarma

Panchkarma procedures are also not untouched with the effect of emerging artificial intelligence. A big transformation has been seen in the instruments used for *panchkarma* procedures.

An automated instrument for *vaman* (therapeutic emesis) was invented by a team of researchers led by Dr. B Sreenivasa Prasad, President, Board of Ayurveda, National Commission for Indian System of Medicine (NCISM). The automated system for *Vaman Karma* is equipped with monitors which show vital clinical parameters of patients during the procedure, thus helping in continuous monitoring. It also has provisions to handle vomitus of *Vaman Karma* hygienically and as per the biomedical waste management policy.[15]

Many other advances has been made in Panchkarma procedures through use of technology such as automated machines has been introduced for *shirodhara* which helps to maintain the temperature throughout the procedure and uniformity of drip flow without any human intervention. Other advances which has been done are automated *sarvang vaspa swedan yantra*, dual system steam generator, electric *nadi sweda yantra*, electric facial steamer, rectum steam chair, *awgaha* tub with circulation, automated *sarwang dhara yantra*.[16]

Ayurveda Beauty Products[17]

The beauty industry has existed since the advent of Ayurveda and has come a long way since then. Today, the concept of beauty and cosmetics has advanced. For every arc on our face, there is now a product to enhance its appeal and project it beautifully. Ayurveda cosmetic manufacturers are combining their creations with the advanced scientific know how of AI to keep up with the digital era and produce highly personalized products.

Artificial Intelligence can take all the details and variations of a customer into account that comprises personal allergies, medical condition, past treatments, previous reports, along with current medications, country, climate, skin color, ethnic background and so forth. For this, customers need to refer to the personalized card online and fill all the required details. Afterward, the custom-made products, after taking all the details into account by AI, are made available online. These products will then provide to individual beauty needs as opposed to offering standard solutions for a particular skin type.

AI can also be used to expand the Ayurveda market by significantly enhancing user experiences. Moreover, it can also be utilized to bolster economic applications that have a momentous impact on cost reduction, revenue growth, and asset consumption

As a result of this tech driven approach, Ayurveda cosmetic brands are registering positive outcomes in the form of increased sales due to heightened customer experiences and apt product recommendations delivered by the AI system.

Palatability and appearance of Ayurveda products

As the world is changing in terms of life style and food habits, everyone expects more palatable and easy to prepare Ayurveda formulations. Ayurveda pharmaceutical companies in view of globalization of Ayurveda are trying their best to move shoulder to shoulder with allopathic pharmaceutical products and standards. Ayurveda pharmaceuticals companies are changing the trend of Ayurveda drug presentation so that it is more economic and more attractive & palatable.

Ayurveda medicines and nutraceuticals are gaining popularity among physicians and patients for better therapeutic value. Lack of quality standards and problems, in preparing or testing them, are the main hurdles experienced by both the practitioners and the patients.

A study was done to improve the palatability of the Ayurveda Nutraceutical Preparation (ADS) by masking its bitter taste and to standardize the taste masking procedure. In that study Eudragit E 100 was used as an acid soluble coating material. It was found that Eudragit E 100 inhibited the contact in between the plant extracts and the taste buds due to insolubility of Eudragit E 100 in saliva. Sensory evaluation of taste indicated that the taste of coated granules was significantly masked.[18]

To make medicinal mixtures palatable and convenient to take, Ayurveda companies are going from decoctions to capsules and now to biscuits to gain acceptability among the new generation. One of the pharmacy, has set the trend by launching the popular health tonic Chyavanprash as *Chyavana* biscuits.[19]

As no new effective drug and vaccine is available yet to treat covid-19, it is important for people to have a strong immunity system so that they can fight any kind of infection easily and keep themselves safe. Keeping this in mind department of natural products, NIPER at SAS Nagar, Mohali has developed Immunity booster Herbal tea. This Herbal Tea is aimed at modulating immune response in body so that it may be used as a preventive

remedy against covid-19 viral infection.[20]

Minimizing the dose of Ayurveda formulations

As we all know the that dose mentioned in classics for certain formulations are not possible for present generations and every patient is expecting low dose medication therefore pharmaceutical companies have introduced herbal extracts of most of the herbs to reduce the cost and increase the palatability. Even *kwath/kashaya* are available in tablet form and *ghrit* is available in gelatin capsule form.

Telemedicine

Health care providers, unrelated to COVID-19 management faced some unique challenges in this scenario. There was a challenge to provide health care services to the needy people within the regulation of imposed restrictions in running outpatient clinics. Those who were connected with their patients through digital ways of communication suddenly faced a heavy influx of messages, calls and mails although at times unsolicited and untimely. At speciality care centers the challenge was faced by adopting the standard telemedicine facilities operated by a dedicated server and by designated panel.

Seeing the urgency and immediate need of such novel approaches to resume the health care services in AYUSH, Central Council of Indian Medicine has recently issued a detailed guideline about telemedicine practice for Ayurveda, Siddha and Unani Practitioners on 7th April 2020.[21]

DISCUSSION

Artificial intelligence is sometimes called machine intelligence, because it is demonstrated by machines, in contrast to natural intelligence displayed by humans and animals.

Machine Learning (ML) and deep learning (DL), the subdomains of Artificial Intelligence (AI), have undergone exceptional growth in recent years. ML is fully capable of pattern recognition and training prediction models. Additionally, DL is the most recent branch of ML capable of classification and recognition tasks using a system of artificial neural networks.[22]

Although the applications of AI in Ayurveda are expected to show various possibilities in its advancement but qualified and comprehensive reviews are lacking. For this reason, this study aimed to analyze the current utilization of AI in Ayurveda to summarize the evidence and suggest improvement directions for future studies.

Throughout the world, innumerable researches are being carried out on AI. A large amount of money is being invested to create a system that can function far more efficiently and at a much less time, than a normal human being. Be it an educational institute, a manufacturing firm, a government office, or a research organization; AI finds its application in every field.

AI is applied and not limited to screening, assessment, treatment, relapse prevention, and so on. In particular, the combination of Ayurveda and technology is expected to provide better answers to the weaknesses in the existing traditional medicines. For example, AI techniques will be able to help prescribe the most effective herbal medicines because herbal medicines have a mechanism of action of complex compounds. Moreover, AI could guide making the correct diagnoses.

Recent advances in the research of herbal medicine for the prevention of coronavirus disease 2019 (COVID-19) are note worthy, as aforementioned in the results. A number of distinctive compounds from natural products have shown the potential to inhibit SARS-COV-2 and MERS-COV, while compounds from herbal medicine have been shown to alleviate the acute respiratory infection. With the development of AI models, herbal medicine could be precisely customized per patient depending on the symptoms.[23] AI can analyze more complex portions of a patients' dataset and detect highly complex and time dependent conditions such as adverse drug reactions and sepsis.[24]

Online medical education, patient's assessment, diagnosis and telemedicine has changed the total scenario of health system in India and abroad. Telemedicine provides rapid access to medical practitioners who may not be available in person. With telemedicine there is higher likelihood of maintenance of records and documentation. Written documentation increases legal protection of doctors as well as patients. When effectively used, it reduces the burden on secondary health care system. It is also useful for regular routine checkup on continuous monitoring. Telemedicine provides patient's safety as well as doctor's & health worker's safety, especially in situations where there is a risk of contagious infections. An online consultation can be conducted without exposing staff to viruses/infections at the time of such outbreaks.

More importantly, in order to widely spread the utilization of Artificial intelligence models in Ayurveda, concrete evidence is much needed as novel technologies may fail to be adopted without sufficient evidence. That being said, for researchers

who plan to conduct research using AI methods with Ayurveda, it is significantly vital to verify the generalizability and validate the effectiveness and the reliability for the betterment of the promotion of Ayurveda globally.

Subjects for future studies in relation to Artificial Intelligence & Ayurveda

- Nutri-genomics & Food incompatibility
- Ayurveda Diagnosis and decision taking
- Understanding Ayurveda basics and physiology
- Robotic surgery
- Practice of Kutipraveshik Rasayan
- Ayurveda food and natural preservatives
- Paperless hospital
- Identification of herbs and methods to improve their cultivation
- Ethno-pharmacology

CONCLUSION

The use of AI models has been bringing efficient solutions to a vast number of real world clinical problems in Ayurveda clinical practice. The results from this review have revealed the use of AI in various Ayurveda modalities. Even though research for AI models in Ayurveda is at its initial stage, the results from the chosen studies are promising that the AI techniques could well be applied to assist practitioners in better serving the patients. Applying AI in the various fields with Ayurveda modalities, precise biomarker decision, measurement, and application may be required for future research. In order to facilitate this, well designed randomized controlled trials are needed to validate the AI models.

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