

Revolutionizing Ayurveda through Artificial Intelligence

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ABSTRACT

The origin of Ayurveda is derived from four Veda: Rigveda, Samveda, Yjurveda, and Atharveda (4500 to 1600 B.C.). Ayurveda has been boon for mankind since 5000 years. The information on health care was subsequently developed by many Ayurveda is replicated from the Darshana shastra, mainly based on Sankhya darshana and Nyaya-Vaishesika darshana. Ayurveda is the ancient science of life. Ayurveda has been science which has been preaching about the longevity of human life. It is necessary to upgrade Ayurveda with new technology so that most of the population would get benefit. Artificial intelligence is a system that replicates human intelligence and problem solving abilities. Artificial intelligence undergoes a number of processes it takes countless data, and then it processes it and helps to streamline it. Artificial intelligence is a branch of science that creates machines that can learn, make decisions according to data it has, and perform tasks. There are many challenges in healthcare that are to improve population health, to improve the patient's experience of care, to enhance caregiver experience and to reduce the rising cost of care.¹⁻³ There is need of application of technology and artificial intelligence (AI) in healthcare address some of these supply and demand challenges in the growing population of world.

INTRODUCTION

Ayurveda emphasizes a holistic approach to health and individualized treatment. Acharya Charaka and Acharya Sushruta have described about various diseases in detail which are applicable even today, for e.g. Acharya Sushruta has described about Sandhana karma which is applicable even today.⁴ In Ayurvedic text there is no record of pharmacological testing, 50 distinct pharmacological categories of medicinal plants were described. The categories include anti-inflammatory, analgesic, anti-histaminic, anti-allergic, diuretic, anti-diuretic, emetic, anti-emetic, purgative, astringent, anti-pyretic, anti-asthmatic, and others.⁵ Information on health care was subsequently developed by many Ayurvedic practitioners and collected into three important books known in Ayurveda as the triad (Bruhdtrayi): Charak Samhita, Sushrut Samhita, and Ashtang Hridaya Samhita. The subsequent three books that are commentaries on the senior triads are known as the junior triad (laghu trayi): Madhavanidana, Sarangdhar Samhita, and Bhavaprakash Nighantu. These books contain basic concepts of health and disease, disease management, anatomy and physiology, hygiene, materia-medica, pharmacology and therapeutics, herbal formulations, pharmacy, and synthesis of herbo-mineral formulations. Diseases are classified according to organ systems and functions. It is commonly recognized that Ayurveda has a lot of potential for treating chronic illnesses

that contemporary medicine is unable to heal. Despite the enormous potential of Ayurvedic medications, the science is still not favoured to be accepted as conventional wisdom. Thus there is need for advancement and use of new technology to robust its development. There is indeed need for technical developments and the development of methods to be incorporated into Ayurveda. World Health Organization estimates that 70-80% of the world's population uses alternative treatments, mainly herbal remedies directly or indirectly. Similar to conventional medicine, Ayurvedic medicine has also benefited from advances in science and technology. Thus advancement will facilitate the understanding of diseases, the development of improved pharmaceutical products, and the application of diagnostic techniques. Scientific studies in laboratory animals have now confirmed the pharmacological properties of many Ayurvedic herbs. The Atpa-upadesha (concept of accepting the last word of an Ayurvedic teacher without questioning) now needs a support of evidence in science. Since last decade large number of medical college and medical research institutions, various research institutes, are currently involved in Ayurvedic research. So it is necessary to develop a strong evidence based practice. In this process of developing research based practice various innovative methods artificial intelligence should be used.

Machine learning models can spot trends in Ayurvedic diagnoses and therapies, forecasting age related changes and

suggesting countermeasures. Combining complementary and modern medicines can improve patient issues and treatment strategies. This article explores the presentation of machine learning to Ayurveda. Ayurveda is currently not exposed in terms of various concepts and ideologies. To decrease the lacunae in the current availability, the agglomeration of Ayurvedic sciences with modern technologies such as artificial intelligence and machine learning is essential. However, one of the issues with Ayurvedic medicine is the lack of standardization in diagnosis, which can lead to inconsistent and erroneous treatment. Machine learning can identify medical problems objectively and consistently.

Aim

To study the possible usage of Artificial intelligence in enhancing practice of Ayurveda. Objectives

To study of application of Artificial intelligence in new innovation and augmentation of Ayurveda.

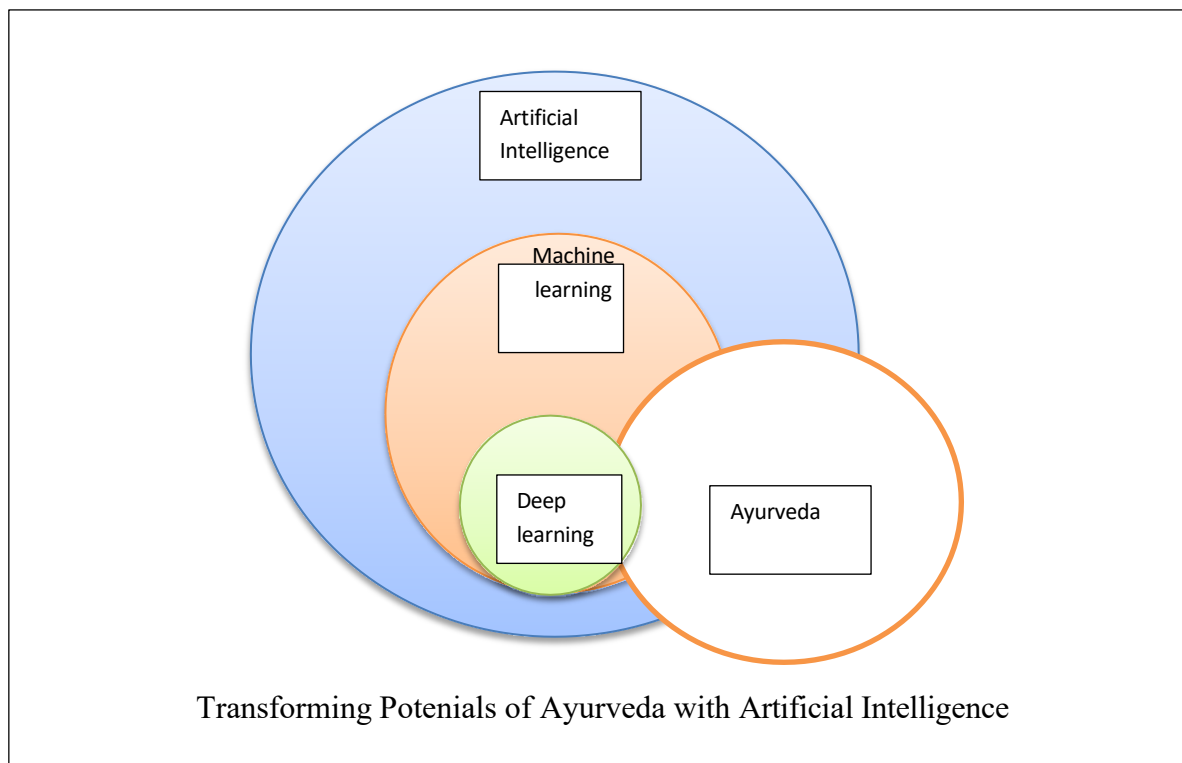
To analyse artificial intelligence probable use in Ayurveda. Materials and

Methods

This research is a conceptual study. The source materials used are the classical Ayurveda texts, along with the commentaries are referred. Research articles published have also been studied during study. Compilation and analysis of all the relevant information was done to explore potential benefits of Ayurveda.

What is Artificial Intelligence?

AI refers to the science and engineering of making intelligent machines, through algorithms or a set of rules, which the machine follows to mimic human cognitive functions, such as learning and problem solving.⁶ AI systems have the potential to anticipate problems or deal with issues as they come up and, as such, operate in an intentional, intelligent and adaptive manner.⁷ Artificial Intelligence's strength is in its ability to learn and recognise patterns and relationships from large multidimensional and multimodal datasets; for example, AI systems could translate a patient's entire medical record into a single number that represents a likely diagnosis.⁸



How to build effective and trusted AI-augmented Ayurvedic healthcare systems?

Human-aligned AI

A human-aligned AI approach combines an ethnographic understanding of Ayurveda, with AI. Through user-designed research, first recognize the key problems including the fundamentals, uses and limitations in Ayurveda. Organising, and facilitating the barriers to the amalgamation of AI within the clinical context of Ayurveda. After chief key problems, the next phase is to recognize which problems are suitable for AI to solve, whether there is availability of related datasets to build and later assess AI. In an existing workflow arranging algorithms is necessary. AI systems would operate within existing norms and practices to safeguard adoption, providing appropriate solutions to existing problems for the end user.

Research- The emphasis should be on directing of new step wise research experiments to build AI tools, for Ayurveda.⁹

Research experiments would give brief idea what way the AI should be used what are the loopholes in its use.¹⁰

Experimentation and feedback will help to light up the purpose and planned uses for the AI system: the likely end users and the potential harm and ethical implications of AI

system to them.

Assess and authenticate- Assess and authenticate the predictions made by the AI tool to test how well it is functioning. Three dimensional critical evaluations are done based on statistical validity, clinical utility and economic utility. Statistical validity will help to understand the performance of AI on metrics of precision, consistency, robustness, steadiness and calibration.

Monitor and sustain- Even after an AI system has been deployed clinically, it must be continually monitored and maintained to monitor for risks and adverse events using effective post-market surveillance. Coordination of Healthcare organisations, regulatory bodies and AI developers to analyse the relevant datasets for AI performance

What is future of AI?

AI can enable Ayurveda healthcare systems to achieve AI augmented care, precision diagnostics, precision therapy and, precision medicine.¹¹ Research in the application of AI healthcare will increase by specificity of drug in disease, clinical consultation by virtual means, diagnosis of disease, prognosis, medical management and health monitoring. There will be significant progress in the development of powerful algorithms that are efficient, able to use unlabelled

data and can combine disparate structured and unstructured data including imaging, electronic health data, multi-omic, behavioural and pharmacological data.

In future AI systems will become more intelligent, enabling AI healthcare systems achieve a state of precision medicine through AI-augmented healthcare and connected care. Healthcare will shift from the traditional one-size-fits-all form of medicine to a preventive, personalised, data-driven disease management model that achieves improved patient outcomes (improved patient and clinical experiences of care) in a more cost-effective delivery system.

Application of AI in Ayurveda

Use of AI in Nadi Pariksha

Nadi Pariksha is mainly pulse wave analysis. According to Yoga Ratnakara all the diseases can be diagnosed from Nadi and it was compared with strings of veena playing all the Ragas which signifies the importance of Nadi Pariksha.¹² Nadi Pariksha is qualities or properties of pulse such as pulse movement (gati), speed of the pulse (vega), stability of the pulse (sthiratva). AI can play major role in Nadi Pariksha and these properties can be analysed and compared with the modern pulse parameters namely pulse wave velocity, pulse rate variability and arterial stiffness with Data and interpret its findings. Nadi Pariksha helps in determining various diseases, thus with help of AI it would be easy for diagnosis.

Prakruti parikshan (Geneomic Constitution)-

Prakriti is constitution of body which is made of vata, pitta, and kapha in a body. Prakruti Parikshan is Ayurveda's unique way of determining a body type for an individual. Prakruti Parikshan is one of the major and basic principles of Ayurveda. Prakruti parikshan can be used for determining disease in a patient.¹³ Prakriti is an inherent nature of an individual determined at the time of your birth, which cannot be changed during your lifetime.

Use of AI in Dhatu Sarita Examination-

Human body comprises Doshaa, dhatu, and mala.¹⁴ They serve as the body's foundation; dhatu gives strength to our body.¹⁵ There are 7 dhatu in our body. Dhatusarata characterizes the structural, functional, and immunological health status of dhatu. Physical and psychological strengths and abilities can be assessed through understanding Dhatu sarata.

Person's bala pramana can be expected with the help of examination of dhatusarata. There are eight types of sara. 1] Rasasara 2] Raktasara 3] Mamsasara 4] Medasara 5] Asthisara 6] Majjasara 7] Shukrasara 8] Sattva Sara.¹⁶ Each dhatu sarita has its own properties. Dhatu sarita assessment plays important role diagnosis and treatment part, thus it is essential part in treatment of patient. There is need for use of AI in its assessment. AI assisted dhatu sarita assessment will be a boon. Data inputs of the patient and interpretation according to dhatu assessment points.

Nidan Panchak-

Nidan panchak comprises of Nidan (etiology), Purvaroop(symptoms), Roop (signs), Upshaya(examination methods), Samprapti (pathogenesis) helps in diagnosis of disease.

Nidan (etiology)- It is necessary to know the etiology of diseases. AI with help of previous data of various etiological factors can help in identifying the causes of the disease. AI with help of Algorithms can provide clue towards the chronicity of the disorder. With help of Nidana a provisional diagnosis of disease can be made. Nidana (etiology) with AI calculation help in planning specific treatment.

Purvaroop (prodromal features)

Purvaroop of disease helps to know the dosha responsible for that disease. There are two types of puravarupa, samanya(general) purvarupa and vishishta (specific) purvarupa. These indicate the forthcoming disease of the patient. Purvarupa is helpful in making correct diagnosis if two diseases are having alike Nidana. The hetu of Hikka (Hiccup) and Swasa (Dyspnoea) are similar with help of Purvarupa avastha (Stage) disease will be diagnosed. A set of data input would help to analyse. A Data interpretation on basis of data input and Algorithms can help in diagnosis of

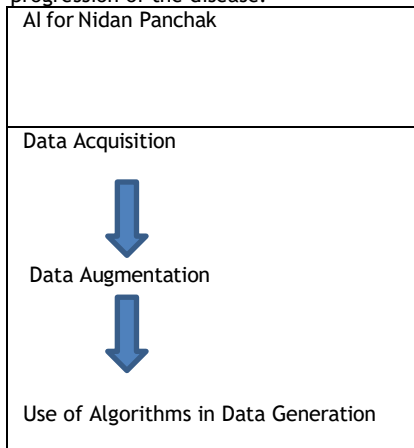
diseases.

Roopa- It indicates onset of the manifestation process of disease. The samprapti (pathogenesis) gives rise to various symptoms of the disease. Thus Samprapti pathogenesis (Dosha dushya sammurcchhana) occurring inside the body is expressed externally as the symptoms of that disease. Roopa indicates the specific disease by expressing specific symptoms of that disease.

D) Upashaya (Relieving and Aggravating factors):

Relieving from disease is known as upashaya. Not relieving from disease is known as Anupashaya. Thus treatment protocol can be generated for specific diseases with AI tools.

Upshaya (examination method): After the use of diet, daily regimen and medicine patient has got relieved from disease or by symptoms of disease this is known as upashaya. The relief should not be temporary. The symptoms should be reduced permanently. 5. Samprapti- From etiological factors to the manifestation of symptoms various changes take place which are collectively known as Samprapti (Pathogenesis). Due to samprapti we can decide the appropriate cause of disease. Thus samprapti will help in direction of dosha dusha sammurchana. Use of AI will help to analyse the pathogenesis according to disease and help to discontinue further progression of the disease.



AI in Aushadi (Medicine)- Artificial Intelligence can be used to combat the issues of quality control, safety and efficacy of drug. AI can be used to formulate standard study protocols and help us to understand the complex processes. AI can be used in Quality Control and standardization. AI can be used for characterization, toxicity studies, clinical studies, physico-chemical evaluation, development of standard operating procedures for validation, free radical scavenging activities, other antioxidant activities, disease-specific pharmacological activities, and a few comparative studies with modern medicines. AI can also help in formulation of new drug therapy for specific disease based on previous data and results of patients. Thus AI will help in precision medicine.

Recent innovations with advance technology

AYUSH Research portal

Central Council for Research in Ayurveda and Siddha (CCRAS) has established AYUSH Research portal content is provided by AYUSH Research councils, National Institutes, and Drug standardization laboratories. Collection consists of 10751 articles out of 5605 are of Ayurveda. It helps in dissemination of Research findings in the domain of AYUSH researchers and allied faculties.¹⁷

RASEX

Government Ayurveda College, Trivandrum in collaboration with CIRA (Center for Information Research and Action), and CDAC (Center for Development of Advanced Computing), Thiruvananthapuram has designed and developed a software RASEX. This software helps in this matching the pharmacological features with medicinal properties. RASEX collects and displays a medicine list which help physicians in treatment.¹⁸

Aushadha Kosha

The classified information in an easily accessible manner which is based on the original classical texts is available in Aushadha Kosha mainly, Charaka samhita, Sushruta samhita, Ashtanga sangraha & Ashtanga hridaya. Collection of all references from foundational writings related to the Hetu (causes), Lakshana (signs and symptoms), and Aushadha (medicine or therapy) of health and disorders are provided here. Thus an easy access to researcher and practitioner in receiving classified information on all disorders is available.¹⁹

AyuSoft

In collaboration with CDAC, Pune; Interdisciplinary School of Health Sciences and Department of Ayurveda, University of Pune; Jnana Prabodhini, NGO, Pune, this interactive software has been developed. It provides end-to-end medical solutions based on traditional medicine which helps in making health decisions. This software can be useful in Case analysis, investigations, diagnoses, and treatment, guidance on nutrition and lifestyle, personal management information system, multimedia-based encyclopaedia, and textual and analytical report tool.²⁰

Traditional Knowledge Digital Library is known as TKDL.

In collaboration with the Council of Scientific and Industrial Research (CSIR), Ministry of Science and Technology, and the Ministry of Health and Family Welfare's Department of AYUSH TKDL is developed. The ancient texts on Indian Systems of Medicines, such as Ayurveda, Siddha, Unani, and Sowa Rigpa, Yoga have language problem which has been overcome by TKDL using information technology tools and an innovative classification systematically and scientifically converting and structuring the available contents five international languages, namely English, Japanese, French, German, and Spanish.²¹

Ayurvedic Formulary of India (AFI)

To develop pharmacopoeia standards and also to meet the requirements of Drugs and Cosmetics Act AFI was made with compilation of various formulations in classical Ayurvedic books to develop pharmacopoeia standards and also to meet the requirements of drugs and cosmetics Act. Therapeutic indications of various formulations have also been listed, as per the original reference book. In AFI the original Shloka of reference form from which the formulations were derived have been included with the formulations. AFI is informational, user-friendly, and of international quality which is now being used widely.²²

DHP-

At present various applications have been used such as "Digital Health Platform (DHP)" to serve as "a common digital health information infrastructure (*info structure*)" on which digital health applications can be built to support consistent and efficient healthcare delivery.²³ Such DHP in India is working the Ayushman Bharat Digital Mission (ABDM).²⁴

External digital health applications such as Electronic Health Records (EHRs), supply chain systems, insurance systems, and patient-engagement apps are used. Thus helps by facilitating interoperability.²⁵ For traditional medicine 'NIWARANA' an artificial intelligence based system has developed in the country of Sri Lanka. NIWARANA AI allows users to access information of Ayurveda doctors who have specialized in specific field of medicine.

Evaluation of doctors is done by sentiment analyser by recognizing the comments added by the users. This gives a score which is positive or negative which ranks a doctor.²⁶

Result-

In traditional machine learning is precision medicine - predicting treatment protocols that would be beneficial in patient based on various patient attributes and the treatment context.²⁵ AI can be used as powerful tool in Ayurveda. AI can be boon to healthcare provider and to the patients. AI would be helpful in enhancing capability of Ayurveda as a parallel treatment module in this era. Thus this article aims at exploring use of AI in Ayurveda, so as the world views Ayurveda with larger perspective. More and more research should be done in collaboration with Ayurveda practitioners, scientist, researchers, and academicians to grow and nurture Ayurveda with new technology.

DISCUSSION

In the current phase of globalization, the world tremendous change in the technology has seen. There is need to use advanced technology in Ayurveda to match the frequency of globalization. Thus there is need to do more research on applicability of AI in Ayurveda. AI helps to make decision based on its It is necessary to enhance the Ayurveda science with AI to make treatment of Ayurveda more precise and increase accuracy in treatment of patients.

This information refines treatment plans and optimizes the health issues of the patient. AI- powered natural language processing (NLP) can decrypt and assay ancient Ayurvedic textbooks, making this knowledge more accessible to experimenters, interpreters, and the population. This renewed science can lead to a better understanding of Ayurveda's principles and their operations in promoting life and graceful aging.

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