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A Bird's Eye View on the Integration of Artificial Intelligence (AI) In Ayurveda

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A B S T R A C T

The integration of Artificial Intelligence (AI) into *Ayurveda* marks a significant advancement in traditional medical practices. This review article explores AI's multifaceted uses and relevance in the conventional Healthcare industry and *Ayurveda*. It also highlights the transformative potential of AI in *Ayurveda* while acknowledging the importance of maintaining the holistic essence of traditional practices. By embracing AI, *Ayurveda* can evolve to meet contemporary healthcare demands, offering a synergistic approach that combines ancient wisdom with cutting-edge technology. The article concludes with a discussion about the future of *Ayurveda* in the era of Artificial Intelligence.

Key words: *Artificial intelligence, AI tools, AyurAI, AI in Ayurveda, Nadi Tarangini*

INTRODUCTION

Ayurveda has been promoting integrative healthcare since time unknown. As technology advances, Artificial Intelligence (AI) is making significant strides in various sectors, including healthcare. Integrating AI in *Ayurveda* can revolutionize how *Ayurveda* professionals diagnose and aid in data-based treatments, digital therapeutics, clinical trials, and also improve their evidence-based knowledge and skills to support healthcare.

This article aims to explore the potential benefits of AI in Healthcare especially in *Ayurveda* and the practical applicability of AI tools in the field of *Ayurveda* along with its future prospects.

MATERIALS AND METHODS

The literature search was done from databases like PubMed and MEDLINE focusing on the articles related to the application of AI in Healthcare systems and Ayurveda. The classical texts of *Ayurveda* were also reviewed to understand the origin and history. Original articles and e-journals regarding the latest developments in the field of Healthcare were thoroughly examined and a comprehensive compilation was carried out.

The Origin, Propagation, and Practice of *Ayurveda* in the Past:

Ayurveda is considered an *Upa-Veda* of *Atharva Veda*. The legendary version of origin is that *Lord Brahma* remembered *Ayurveda*, taught *Daksha Prajapati,* he taught *Ashwini Kumaras*, they taught *Sahasraksa* who in turn taught *Atreya Punarvasu*, he taught *Agnivesha,* and so on.[1] Later, in *Samhita Kala* (6th BC - 7th AD) a systematic development of the science occurred. Several classical treatises were written by *Acharyas* with shreds of evidence of organized medical care.[2] This way, the true wisdom of *Ayurveda* was bestowed on humans and animals to lead a healthy life. During

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the eighteenth and nineteenth centuries, India transitioned from the medieval era to the modern age marking the emergence of intellectual activities. Numerous books on *Ayurveda* were authored and published by British officials and Indian physicians. Additionally, *Ayurvedic* pharmacies were modelled after modern medical practices.[3] This tells us that *Ayurveda* has always been open to adopting new ideologies and technologies for ages. In due course of time, with advancements in technology and computers, AI has become the latest addition in various Healthcare sectors including *Ayurveda*.

AI in Healthcare

The Organization for Economic Cooperation and Development Council on AI defines it as A machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments.[4] This includes software with capabilities like perception (audio, visual, textual), decision-making (diagnosis), prediction (treatment plans), knowledge extraction from data (suggesting mode of actions), interactive communication (chatbots for consultations), and logical reasoning (theory development).

In healthcare industries, AI algorithms can analyse medical data such as patient records, imaging scans, genetic information, etc. to accurately predict diagnosis, health risks, and treatment outcomes thus enabling personalized patient care within no time.[5] The WHO's "Global Strategy on Digital Health 2020–2025" emphasizes the role of AI in improving healthcare and empowering patients.[6]

AI in *Ayurveda*

With the increase in the integration of AI in the mainstream healthcare industry, attempts are also made to include AI to revolutionize *Ayurveda*. This involves integrating machine learning algorithms, Natural Language Processing (NLP), and data analytics in various aspects of practice and teaching. The uses and relevance of AI in multiple branches of *Ayurveda* are as follows:

1) In *Roga Nidana* - Enhances Diagnostics:

Diagnostic methods of *Ayurveda* involve the *Roga Pareeksha such as Nidana Panchaka* and the *Rogi Pareeksha* such as *Dwi-Vidha, Tri-Vidha, Chatur-Vidha, Ashta-Vidha, Dasha-Vidha Pareeksha* and *Sushrutokta Dvadasha Pariksha*,[7] etc, requiring years of experience. AI algorithms can analyse patient data, clinical history, and investigations to identify patterns and associations that may not be apparent to human practitioners. This allows for precise, reliable, and early diagnoses allowing for timely intervention thus preventing *Upadravas*.

2) In *Dravya Guna* - Helps in Drug Discovery and Pharmacological R & D

a) Pharmacological Research: AI accelerates *Ayurveda* pharmacology by identifying potential medicinal herbs and their therapeutic benefits by analysing various ancient literature, research papers, and clinical data. For example, a study by Fathifar *et al*. (2021) used AI-driven natural language processing to identify herbs with anti-inflammatory properties based on information from ancient and historical *Ayurveda* texts.[8]

b) Formulation Optimization: AI predicts herb-drug interactions by analysing molecular structures and pharmacological profiles, minimizing adverse reactions. It can optimize the formulation of medicines for enhanced efficacy and reduced side effects.

3) In *Rasashastra and Bhaishajya* - Ensures Safety and Novelty

a) Quality Control: Due to a lack of standard protocols, quality control, safety, and efficacy have always been issues regarding *Bhasmas* and *Rasaushdhis.* Integration of AI can ensure the quality, safety, effectiveness, and consistency of *Rasaushadhis* by monitoring the manufacturing process and detecting anomalies.

b) New Drug Development: AI can accelerate the development of new *Ayurvedic* pharmaceuticals by predicting the efficacy of various herbo-mineral combinations.

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4) **In *Swasthavritta* - Aids in *Prakriti* Assessment and Lifestyle Modifications**

a) ***Prakriti* Assessment:** In *Ayurveda, Swastya Rakshana* is prioritized over *Vikara Prashamana*. Treatments are individualized based on the patient's *Prakriti*, which is determined by *Tri-Dosha* theory. Though assessing *Prakriti* can be tedious, it is vital to advise *Pathya* and *Aushadha*. To simplify this process, a self-assessment tool using AI algorithms like the Naive Bayes can be employed to design a chatbot based on a *Prakriti* dataset.[9] The chatbot can interact with users through predefined questions to understand their *Dosha* and *Prakriti* to provide personalized care plans.

b) **Lifestyle modification:** AI-driven health monitoring devices, smart wearables, and applications enable individuals to make informed lifestyle choices. AI chatbots can analyze and personalize *Charya*s, *Rasayana*, *Pathya-Apathya, Ahara Vihara* and recommend specific *Yoga* and *Pranayama* accordingly, promoting preventive healthcare.

c) **Public Health Analytics:** AI can analyse community health data to identify trends, predict outbreaks, and plan public health interventions.

5) **In *Kaya Chikitsa* - Personalizes Treatment Plans**

a) **Personalized Treatment:** AI-powered systems can analyze data on patients' *Prakriti, Vikriti, Dosha, Dushya, Bala, Satwa, Satmya,* etc. to develop tailor-made treatment plans including *Shamana, Shodhana Aushadis* and *Pathyas*.

b) **Telemedicine and Remote Consultations:** AI-powered virtual assistants can provide instant access to patients regarding health information, treatment options, and self-care advice. Additionally, AI-powered chatbots can be trained on extensive *Ayurvedic* texts and modern medical data to provide preliminary advice to patients and facilitate remote consultations by physicians.

6) **In *Shalya Tantra*:** AI-powered robotic systems can assist in precise surgical procedures, like *Ksharasutra, Agni Karma, Prachanna*, etc. ensuring accuracy and reducing human error. It can also monitor patients before and after surgery, predicting complications and suggesting appropriate measures.

7) **In *Stri Roga - Prasuti*:** AI-based applications can analyse or track hormonal patterns and menstrual cycles to assist in diagnosing and treating reproductive health issues. It can also provide personalized care plans for expectant and new mothers, ensuring better health outcomes for both mother and child.

8) **In *Kaumarabhritya*:** AI devices can track and analyse children's growth patterns, immunization schedules, and developmental milestones. The predictive analytics can identify early signs of Paediatric illnesses, facilitating in-time effective treatment.

9) **In *Samhitha Siddhanta*:** AI systems can analyse classical *Ayurvedic* texts to extract knowledge and correlate it with modern medical research. AI can also create interactive classrooms and virtual simulations to teach *Ayurveda*.

10) **In *Panchakarma*:** AI chatbots can assist in patient education and engagement regarding *Panchakarma* procedures. Additionally, incorporating AI robotics into *Panchakarma* treatments can greatly improve precision and consistency thereby offering numerous benefits and improved outcomes.

Examples of Platforms using AI tools in *Ayurveda*

a) ***Nadi Tarangini*:** An AI-based tool designed for *Nadi Pariksha* that records pulse data, processes it through an AI algorithm, and generates a report on the balance of the *Doshas*, potential health issues, and treatment recommendations.[8]

b) ***Niwarana*:** An AI-based system for traditional medicine developed in Sri Lanka. It allows the users to access information on the best *Ayurveda* doctors who have specialized respective branches. It uses sentiment analysis to evaluate doctor reviews and offers a chatbot for users to find relevant doctors according to their injuries or diseases.[10]

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c) **Other applications:** Applications based on AI algorithms such as 'e-Dravya' which enables the selection of medicinal herbs based on criteria,[11] 'e-Roga' which explores symptomatology in *Ayurveda*,[12] and "e-Chikitsa" which suggests the classical medicines based on the symptoms are developed by Dr. Prasanna Kulkarni, MD (Ayu), MSc (Data Science) from Bengaluru, India and these applications are available on the Google Play Store.

AI also strengthens *Ayurveda's* position in digital era through e-journals, e-books, and indexing units like the Digital Helpline for Ayurveda Research Articles (DHARA), AYUSH Research portal, Traditional Knowledge Digital Library (TKDL), Random Uninterrupted Documentation for Retrospective Analysis (RUDRA), AyuSoft, *Prakriti Vichaya,* and *Triskandha Kosha.*[8]

Ethical Considerations

Integrating AI into *Ayurveda* must prioritize patient privacy, consent, and cultural sensitivity. AI should enhance, not replace, traditional wisdom and human judgment. Transparency in AI algorithms and accountability for AI system decisions are crucial. It is necessary to ensure that the principles of *Ayurveda* are respected without compromising its values during AI deployment*.*

DISCUSSION

Merging the traditional wisdom of *Ayurveda* with modern AI technologies leads to improved healthcare outcomes. AI offers significant advancements in the field by personalizing medicine and treatment, optimizing drug development, ensuring quality control, facilitating remote consultations, and continuous health monitoring.

The practical utility of AI in *Ayurveda* can be illustrated through the following example scenarios:

1) **Patient Education:** Consider a wellness centre that aims to educate its clients about the *Virechana Karma* and its detox action:

▪ **Interactive Apps and Chatbots:** AI-driven mobile apps and chatbots can answer patient queries, and guide their users regarding *Pathya-Ahara* and *Vihara* during *Deepana Pachana, Snehapana, Vishrama Kala,* and *Samsarjana Kramas* at anytime from anywhere across the globe*.*

▪ **Content Personalization:** AI customizes educational content based on the user's health profile and interests.

2) **Preventive Healthcare:** Consider a healthcare research centre such as ICMR-AYUSH that aims to assess and reduce the incidence of *Hridroga* among Indians:

▪ **Risk Assessment:** AI analyses data from wearable devices, health records, and lifestyle surveys to identify individuals at risk of developing *Hridroga*.

▪ **Preventive Plans:** The system generates personalized preventive care plans, including *Aharaja* and *Viharaja Pathya Apatya* for *Hridroga.*

▪ **Behavioural Nudges:** AI sends timely nudges and reminders to encourage healthy behaviors, such as *Dina Charyas, Ritu-Charyas, Yoga, Pranayama, Dhyana*, etc. aimed at preventing *Hridroga*.

3) **Lifestyle Changes:** Consider a patient who has been diagnosed with *Sheetapitta* (Urticaria), a disease that aggravates due to various dietary and lifestyle trigger factors, and that he wishes to monitor and keep track of his triggers to avoid the recurrence:

▪ **Daily Monitoring and Tracking:** An AI-enabled mobile application and wearables can be designed to track his daily activities, dietary intake, and symptoms. The application can also enable him to log his meals, physical activities, stress levels, and any incidents of Urticaria flare-ups.

▪ **Intelligent Data Analysis:** The app uses AI algorithms to analyze the logged data, identifying patterns and correlations between the patient's diet, lifestyle, and the occurrence of Urticaria symptoms.

▪ It provides real-time feedback and alerts if certain foods or activities are consistently linked to flare-ups.

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4) Formulation Optimization: Consider a researcher who is looking to develop a new *Ayurvedic* formulation to treat *Amlapitta* and wants to employ AI for the same:

- **Data Mining:** AI can use various e-*Samhitas*, research papers, and clinical studies to identify effective herbal combinations.

- **Predictive Modelling:** Using machine learning models, AI predicts these compounds' efficacy and potential side effects.

5) Tele Medicine: Consider a patient from Canada who seeks consultation for chronic pain with an esteemed *Ayurveda* Physician in India:

- **Virtual Consultations:** AI-powered telemedicine platforms enable video consultations throughout the world.

- **Symptom Analysis:** AI tools analyse patient-provided data (symptoms, photos, videos) to assist the practitioner in making an accurate treatment plan.

- **Follow-up and Compliance:** AI ensures patients adhere to their treatment plans by sending reminders and tracking progress.

Furthermore, AI-driven predictive analytics can anticipate health risks, enabling early interventions and preventive strategies. Incorporating AI-driven image and pattern recognition can digitize and standardize practices, making *Ayurveda* more globally acceptable. Additionally, AI can enable smooth communication between *Ayurveda* professionals and other healthcare professionals, resulting in holistic and integrative treatment plans that combine the strengths of more than one system of medicine for the benefit of patients.

CONCLUSION

Integration of AI in *Ayurveda* holds immense potential and paves the way for a holistic and data-driven care approach. By combining the ancient science of life with cutting-edge technology, we can deliver more personalized, effective, and evidence-based care to patients. It not only enhances diagnosis, treatments and saves time but also creates a broader network of patients, promotes modernization and scalability thus globalizing and making *Ayurveda* more transparent to the scientific world. It is also important to have collaborative efforts between *Ayurveda* professionals, technology experts, and policymakers to harness the integration of AI in *Ayurveda.*

Acknowledgment

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