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Chatbots in Ayurveda: Comparative Review with Modern Medicine and Traditional Chinese Medicine Systems

Running Title: Comparative Review of Chatbots in Ayurveda and Global Medical Systems

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Abstract: ***Artificial intelligence has transformed many sectors of healthcare such as diagnostic, treatment, surgery, research etc. Intelligent machines which can interact and respond like humans are called as chatbot. Under the Digital India movement, Ministry of AYUSH has adopted digitalization to transform education, research and services. AI and AI- based chatbots are used in different aspects of healthcare throughout the world. In Ayurveda, the development and use of chatbot is at a very initial stage whereas in modern medicine and TCM they are widely used in certain areas of health care. This comparative review on use of chatbots in Ayurveda and contemporary sciences such as Traditional Chinese medicine and modern medicine, explores the current status of chatbots in healthcare. Structured literature search was carried out among scientific databases such as PubMed, Scopus, Google scholar, IEEE Xplore, Chinese National Knowledge Infrastructure (CNKI), Ayush Research Portal etc. along with official government websites such as WHO, Ministry of AYUSH, Institutional reports and conference proceedings on digital health. This review describes state of health chatbots in modern medicine and TCM and highlights the potential, scope and limitations of chatbots in Ayurveda.***

Keywords: Artificial intelligence, Ayurveda digital health, Chatbot, Digital health, Healthcare chatbots, Ministry of Ayush initiatives

1. Introduction

Homo-sapiens' quest for tools to reduce hardship and easy working is still going on in the 21st century. Modern machines, computer technology and artificial intelligence (AI) are the means of faster and effective working. Machines and software which can simulate intelligence are named as artificial intelligence.

A chatbot is an artificial conversational system that, powered by artificial intelligence, can interact and respond similar to a human. These intelligent machines can understand many human languages by using Natural Language Processing (NLP) and machine learning (ML).[1] Chatbots are also called as smart bots, interactive agents or digital assistants. "AI chatbots are conversational agents that mimic human interaction through written, oral and visual forms of communication with a user."[2]

Chatbots are the most innovative tools used in healthcare, emerged especially after COVID-19 pandemic to optimize healthcare. Use of AI is increasing both in modern clinical practice and clinical research. AI driven systems using deep learning and pattern recognition, interpret prognosis, disease progression and can help to enhance patient outcome, robots by assisting in complicated surgeries, working with precision for improved surgical outcome.[3]

For globalization, standardization and generation of evidence-based data, traditional health systems are also integrating modern technology. AI-chatbot in health sector are increasingly used for delivering health services.

2. Objective of the Review

By utilizing modern technology, allopathic/modern medicine has evolved largely in diagnosis, treatment, rehabilitation and research as well. Similar application of technology and AI has been found effective with traditional systems of medicine as well. AI-based chatbots are the most innovative technology used in healthcare. This review aims at comparing the use of AI-based chatbots in medicinal systems namely Ayurveda, Traditional Chinese medicine and Allopathic medicine.

3. Materials and Methods

Searched databases and search strategy:
To explore and compare the use of chatbots in Ayurveda, TCM and modern medicine, focusing on scope for Ayurveda, a structured literature review was conducted. As the use of medical chatbots is fairly new, this review included all time published literature on chatbots. Databases searched included PubMed, Scopus, Google scholar, IEEE Xplore, Chinese National Knowledge Infrastructure (CNKI), Ayush Research Portal along with official government websites such as WHO, Ministry of AYUSH, Institutional reports, conference proceedings on digital health. Search items included keywords such as "chatbots", "Artificial intelligence", "Ayurveda", "TCM", "modern medicine", "AI in healthcare". Boolean operators (AND, OR) were applied to refine terms and expand coverage across various intersections.

Inclusion criteria:

- Peer reviewed journal articles, conference proceedings and official reports.
- Articles focused on technology and development of AI and chatbots in healthcare.
- Articles in English.
- Studies that compare use of technology in Ayurveda and other systems of medicine.

Exclusion criteria:

- Studies unrelated to healthcare related chatbots.
- Articles focused solely on chatbots not related to healthcare.
- Non-scientific web articles and blogs.

Philosophical background of Ayurveda:

Ayurveda is one of the most renowned systems of traditional medicine which is rooted in ancient India and its history goes back to 5000 years. Word Ayurveda means science of life. From the sages this knowledge is passed down from generations in oral and written narrations. The Ayurveda is an *Upveda* (subpart) of Atharvaveda and original scriptures of Ayurveda are in Sanskrit language. Charak Samhita which focuses mainly on Ayurvedic medicine and Sushruta Samhita which mainly focuses on Ayurvedic surgery are considered as the main scriptures of Ayurveda knowledge. There are many other compilations popular such as Ashtanga Hridaya, Nighantu, Madhav Nidana etc.[4] Ayurveda is based on philosophy, clinical experimental testing, keen observations of natural phenomenon, correlation between environment and body and traditional experimental approach.[5]

According to the five-element theory of Ayurveda the universe (including humans) is made up of five elements viz. *Prithvi, Aap, Teja, Vayu* and *Aakash.* These five elements form the base for three humors viz. *Vata dosha, Pitta dosha, Kapha dosha* which control the basic physiological functions of our body. The state of balance of these *doshas* is consider as health and imbalance in the *dosha* state is considered as a cause of a disease. Ayurveda has therapeutic as well as disease preventing approach by the use of multiple natural herbs, formulations, Panchakarma practices, diet and lifestyle correction, parasurgical procedures etc. In Ayurveda personalized approach is offered to each patient for achieving balance in the doshas and achieving health.[6]

Modern medicine:

History of allopathic medicine or modern medicine traces back to ancient Greek. During the 19th century, with the advent of science, technology and scientific enquiry, foundation of vaccination, anesthesia, germ theory, antisepsis, X-ray etc. was led, which resulted in rapid advancement of allopathic medicine.[7] It is ideal for urgent treatment as it is quick and highly effective. Allopathy focuses on signs and symptoms such as infection, bacteria, viruses etc. It utilizes modern diagnostic tools, tests, technologies like X-ray, MRI, vaccines, modern pharmaceutical products, sophisticated surgical procedures. This treatment is targeted towards a disease entity instead of treating a person. It is based on analytical, experimental and reductionist approach.[8]

Philosophical background of Traditional Chinese Medicine (TCM):

Traditional Chinese medicine dates back to 4000 to 8000 years, it includes Chinese herbal medicine, treatment procedures like acupuncture, moxibustion, manual therapy "Tuina", traditional exercise "Qigong" and "Taijiquan" etc. The Yijing (The book of changes) and Huangdi Neijing (The Yellow Emperor's Classic of Internal Medicine) are the oldest known written scriptures available about TCM.[9]

Basic concepts of TCM includes Yin-yang and five element theory (viz. wood, fire, earth, metal and water). At the core of yin-yang concept is change as a fundamental principle of universe and it relies on dialectical interaction of yin and yang. The yin represents moon and has characteristics such as yieldingness and submissiveness; whereas yang represents sun and has opposite characteristics such as unyieldingness and dominance.[10] Yin-yang model displays dynamic interaction between opposite elements such as water, darkness, softness, passivity and fire, light, hardness and activity respectively and suggests coexistence of both in the same environment.[11] TCM has great emphasis on regulating body's self-function, balance of yin-yang, Qi (energy) and blood.[12]

Ayurveda- in digital era:

The potential of digitalization has witnessed by the world in the triumph of allopathy medicine. The WHO Traditional medicine strategy for 2025-2034 highlights use of advanced technology to generate data, develop research repositories, telemedicine platform, AI based tools and mobile health applications.[13] As a part of Digital India movement, Ministry of AYUSH (MoA) has adopted digitalization to transform education, research and services. Many digital initiatives have been taken by MoA in different sectors such as health information (e.g. A-HMIS- AYUSH-Hospital Management Information System), research database (e.g. Digital helpline for Ayurveda Research Articles-DHARA, Ayush Research Portal, NAMASTE portal, etc) and academic initiatives (e.g. Ayurveda e-learning portal).[14] Under Ayush grid project Center for Development of Advanced Computing (C-DAC, Pune) has been working on filling the digital gap in AYUSH sector.[15]

The complex and vast textual information in Ayurveda is difficult to process manually, so that application of information technology is used to enhance potential of Ayurveda in modern era. With AI powered text mining new drug identification, herbal combinations and pharmacological activity detection has been accelerated.[16] Digital databases for herbs are used to identify local herbs, their properties and uses. Telemedicine, mobile health apps are effective in removing geographical barrier and facilitate online consultation, being used worldwide.[17] Ayurgenomics studies showing correlation between specific genotype and Prakriti can act as a base for Ayurvedic individualized treatment concept.[18] E-book, advanced virtual skill laboratories, virtual human atlas and anatomage, as well as virtual labs for obstetrics, critical care, surgery, and radiodiagnosis are being incorporated in modern Ayurvedic teaching.[19]

"mYoga" app, "Yoga locator mobile app" are aimed to encourage people to practice yoga. "Ayush Sanjivani mobile app" used during COVID-19 in spreading awareness, monitor health and generate data on AYUSH usage.[20] Many online questionnaire-based self-Prakriti assessment tools are available. "AyuSoft" a systematic examination tool based on

Ayurvedic principles which carries out dosha and dhatu analysis (*Prakriti* and *Dhatusarata*), diagnosis of disease and offers Ayurvedic treatment, diet and lifestyle advice.[21]

Conceptual background of chatbots:
From ELIZA (1968) to ChatGPT (2022), chatbots have come a long way. Different types of technology are used in chatbots over the years such as pattern matching, in which response is generated to stimulus/sentence entered. Primitive chatbots were made with this technology. It lacked human touch and was repetitive and predictable. Modern chatbots use Natural Language Processing. Natural Language Understanding (NLU) is at the core of Natural Language Processing (NLP) which extracts context and meaning from natural language inputs by user and responds appropriately.[22]

Different types of chatbots are used such as voice bots, social messaging chatbots, skill chatbot which perform a particular task, transactional bots, keyword based chatbot (keyword are used to act as triggers to understand how to respond), menu based chatbot which follow a fixed decision tree etc.[23]

Chatbots in modern medicine:
Technology and modern medicine are growing parallel to each other. Diagnostic, treatment and patient care have significantly improved by use of modern technology such as electronic health record, telemedicine, wearable devices, mobile health apps, robotics and automation in surgeries. AI is significantly used to support clinical diagnosis; for analysis of images which are collected during diagnostic and in treatment planning process.

There are many chatbots focused on health and fitness accessible on internet. Chatbots such as “FitCircle”, “Gymbot” focus on fitness, “SlimMe”, “Forksy” provide nutritional guidance.[24] “Woebot" and “Omaolo” are two chatbots used in Finland as mental health assistant. “Omaolo” utilizes online symptom questionnaire to carry out multiple functions such as assessment of health problem and guides to receive treatment during COVID-19 pandemic.[25] “Coronabot” used during COVID-19 pandemic to guide people regarding exposure and symptoms.[26] “MyGoV Corona Helpdesk” was a chatbot used by Government of India to provide information regarding COVID-19.[27] “Quro”, “Buoy Health”, “Babylon”, “Healthily”, “Ada” are some chatbots used for symptom screening in oncology. “Itruns” is a chatbot which does the heredity cancer assessment. “Mathew”, “Madhu”, “Divya”, “Rarhi” etc. are some chatbots which guide with cancer treatment options, provide link to suitable healthcare, connect with physicians. “Watson for Oncology” provides medication plan for physicians. “Unmind”, “Youper” are chatbots which track mental health and provide emotional support. “SMAG” and “Bella” are chatbots which help in smoking cessation.[28] “ChemoFreeBot” was found effective in improving self-care behavior and reduce chemotherapy side-effects in breast cancer patients because of its personalized approach.[29]

Chatbots are found useful especially in mental and behavioral health. These conversational agents create social connection with users and are effective because of their interactive and autonomous nature. “Tess” is a chatbot used in behavioral health conditions such as depression and anxiety specifically in children and adolescents struggling with obesity and prediabetes.[30]It provides 24/7, customized integrative support, psychoeducation, and interventions by individualized conversation promoting adherence to treatment. It also helps to improve engagement and avoid social stigma.

Chatbots are used in many other disease conditions such as Type-1 diabetes (Compass), anxiety, depression, work burnout (Vickybot, Otis), sexual and reproductive health (SnehAI), AntiTB chatbot, different types of cancer, Asthma (kBot).[31]

AI and machine learning is regulated by multiple laws to protect privacy of patients, ensure safety of patient data and safer use of medical devices and AI. (Table no.1) Apart from them, international organizations such as United nations and Organization for Economic Co-operation and Development also keep check on responsible development of AI.[32]

Chatbots in Traditional Chinese Medicine:
Traditional Chinese medicine has incredible effect in chronic, complex and infectious diseases. The advancement of Traditional Chinese Medicine (TCM) has been gradual because of the complex nature of its prescriptions and mechanisms of action. Especially after COVID-19, TCM has proved its therapeutic value and has acquired more attention from the world.[33] In last two decades 14 TCM databases have been created for various purposes such as providing information of herbs, their chemical ingredients, drugs (TCM-ID), their ADME properties (TCMSP), drug interaction and target proteins (TCMID), their toxicity data (TCM-Mesh), etc.[34]

In recent years AI is applied in different aspects such as new TCM drug discovery, data mining to identify new target proteins, screening of active compound with better activity, to predict ADMET (absorption, distribution, metabolism, elimination and toxicity) so, success rate of new drugs can improve, in drug standardization, in education and health management.[35]

Multiple chatbots are introduced in TCM medical domain such as Qibo, HuatuoGPT, BianQue, TCM-GPT, CMLM-ZhongJing. BianQue is a chatbot which simulates TCM doctor consultation by utilizing QA instructions and health suggestions, similarly CMLM-ZhongJing is also a model for medical consultation.[36] TCMChat gives diagnosis depending upon the input and accordingly recommends herb or formulation.[37] HBot is a communicative bot which provides visual display of acupoints, meridians in a 3D human body, give information and Q&A, prescription and moxibustion recommendation.[38]

China has established various regulations for controlling AI growth and development (Table no.1) and working towards being a leader in AI.

4. Chatbots in Ayurveda

Current status:
Chatbots are used for multiple purposes in Ayurvedic sector. In clinic/hospital chatbot manages the appointment bookings,

provide information, answer questions (FAQs), marketing of products etc. There are chatbots used in Ayurveda which offer personalized health management. "AyUR-bot" is an interactive chatbot which guides the user actively about Ayurvedic diet and medicine.[39] "AyurSanvaad" is a multilinguistic chatbot which can interact in over 22 Indian languages for online Ayurvedic consultation.[40] "Prakriti bot" which gives personalized health insights based on Prakriti, Vikriti and medical history. With the use of contemporary technology, it makes prakriti analysis easy and offers diagnosis, treatment, diet and lifestyle advice.[41] "AyurJanaKosh" is a chatbot which predicts prakriti and accordingly offers drug formulations.[42] "AyurChat" is a conversational bot, it does thorough health enquiry and provides personalized guidance based on Ayurveda.[43] "AyurMate" is an AI powered chatbot which offers treatment for different health conditions through personalized approach.[44]

Opportunities:

Ayurveda has tremendous opportunity to expand with the application of AI and AI-powered chatbots.

1) Integration of AI in Ayurveda can expand the research accuracy, help in generating clinical evidences and help in advancement of science.[45]
2) With changing lifestyle owing to urbanization people prioritize time, convenience and quick results. Conventional Ayurveda appears outdated to younger generation.[46] Integration of AI in the form of chatbots in Ayurvedic field can make it more accessible. 24/7 availability and prompt response are advantages of these conversational bots.
3) Currently only in limited areas chatbots are used in Ayurveda. They can be helpful in preventive medicine to incorporate Ayurvedic principles in daily life with prompts from chatbots to encourage healthy diet, follow *Dincharya, Ritucharya* etc.
4) It can also guide in early diagnosis of disease at the *Poorvarupa* stage.
5) In chronic illnesses such as obesity, diabetes, age related degenerative diseases chatbots can provide assistance in physical and mental wellbeing in context to lifestyle modification.
6) Chatbots are a great mean to spread awareness about Ayurveda among people beyond geographical borders.[47,48]

Challenges in Ayurveda for AI application:

1) Integrating AI with Ayurveda requires well-structured standardized and evidence-based data.
2) Ayurvedic diagnosis involves evaluating multiple subjective and objective parameters related to both the patient and the disease (*Rogi* and *Roga Pariksha*). However, the qualitative and subjective nature of Ayurvedic data poses challenges for AI integration.
3) Ensuring data accuracy and consistency is essential to enable the system to generate reliable and authentic recommendations.[49] AI in medicine works on datasets, in case of diagnostic data, in a certain clinical condition if limited or incomplete data is available then there is possibility of misdiagnosis by AI, so human supervision is important.[50]
4) Being the personalize treatment it is difficult to prescribe the similar Ayurveda medicine in all the case
5) There is no any dedicated regulatory body for controlling and development of AI in India.

Table 1: Comparative analysis Ayurveda vs TCM vs Modern:

Criteria	Ayurveda	TCM	Modern medicine
Philosophical background	*Tridosha*, Five element theory, Holistic approach	Yin-yang, Qi theory, holistic	Evidence based, analytical, experiment based
Current chatbot use	Limited, early stage	Advanced, widely used	Advanced and widely used in medicine and surgery
Areas used in	Consultation, Prakriti analysis, Awareness, yoga practices, diet and lifestyle modification	Consultation, Awareness, Acupuncture	Fitness, Nutrition, Mental health, Guide with treatment & connect with physician, Awareness
Regulation	No specific	Chinese Cybersecurity law, New generation AI development plan, AI strategy Advisory committtee	USFDA, HIPAA, GDPR

USFDA- United States Food and Drug Administration
HIPAA- Health Insurance Portability and Accountability Act
GDPR- General Data Protection Regulation

Ethical, legal and cultural considerations with the use of chatbots in Ayurveda:

1) Online platform carries issues such as data security and privacy; similar challenge is associated with health chatbots as personal data is included.
2) Ethically correct, unbiased approach should be checked as human subjects are involved.
3) Chatbots lack the ability to conduct proactive, doctor-like questioning, manage multi-turn dialogues efficiently, or lack the similar determination.[51]
4) Chatbots may fail to understand and respond appropriately, sound shallow and may have repetitive content.[52]
5) In complementary and alternative medicine (CAM) like Ayurveda and TCM there can be variation among expert practitioners regarding diagnosis and choice of drug formulations, in such scenario use of AI chatbot becomes challenging due to lack of standardized practices.
6) Chatbots in Ayurveda are still in early phase and need expert supervision when dealing with health-related concerns.

5. Conclusion

Digitalization took place early in modern medicine and TCM as compared to Ayurveda. AI has been proving very effective in advancing Ayurveda. Chatbots which are recent advancement in technology, been used in modern medicine and TCM, can be effectively used in Ayurveda.

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