A SCIENTIFIC OUTLOOK ON TECH INNOVATION IN AYURVEDA: A FUTURISTIC APPROACH

Abstract

Ayurveda, the world's oldest medical science, is now slowly rising to the forefront globally. There is a large void in the proper communication of *Ayurveda's* core messages to common people and standardized output of product and services. Creative thinking and Tech Innovation is needed to communicate the health benefits of *Ayurveda* to general public. Metaverse platforms like Augmented Reality, Virtual Reality and Artificial Intelligence with Robotics can be incorporated for filling the gap in Public Relations, Drug Manufacturing and Drug Research in *Ayurveda*.

Objectives: a)Discuss the future possibilities of Augmented Reality , Virtual Reality, Artificial Intelligence and Machine Learning which can transform Practice, Education Communication Drug discovery Cultivation and Smart Drug Research in Ayurveda Medical System b) Discuss the possibility of metaverse platform in which some one can experience the benefits of Ethnic health practices of Ayurveda (Eg: *Dinacharya* (Daily Regimens) ,*Rithu Charya* (Seasonal Regimens) and *Rithu Sodhana* (Seasonal Detoxification Procedures)**.**

Methodology: Scientific outlook and detailed evaluation of advanced technologies like Augmented Reality , Virtual Reality and Artificial Intelligence and Robotics in Public Relations ,Data Mining, Drug Manufacturing and Smart Drug Research in *Ayurveda*

Conclusion: By making use of new-age technologies like Artificial Intelligence and virtual immersive platforms like Metaverse, can bring innovative visual ideas into *Ayurveda* sector and thus promote awareness about the scientific basis of *Ayurveda* and can

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make the ancient medical science *Ayurveda* ready for future.

Keywords: Technology Innovation in Ayurveda, Artificial Intelligence and *Ayurveda* , Augmented and Virtual Reality in *Ayurveda*

I. INTRODUCTION

Ayurveda, the traditional medical science of Indian subcontinent, is now getting recognized globally as a system of medicine and health stabilizer. *Ayurveda* as an Industry achieved noticeable growth in last three decades. As per the statistical data published by Research and Information System for Developing Countries (RIS), on 'Ayush Sector in India: Prospects & Challenges', the global market size of the herbal medicines was estimated at US$ 657.5 billion in 2020. In the case of overall exports, the total AYUSH export of India has leaped from US$ 1.09 billion (INR 9,000 Crore as per current INR-Dollar rate) in 2014 to US$ 1.54 billion in 2020[1].Two basic factors should be in focus to increase the global market, one is improved public relations for creating awareness of *Ayurveda* in general Public and the other one is Standardized output of Services and Products. To sustain the market Large Scale Production, Quality Control , Technology Interventions are needed in *Ayurveda* Industry. There is a large void in the proper communication of Ayurveda's core messages to common people. Creative thinking and Tech Innovation is needed to communicate the health benefits of *Ayurveda* to general public. Metaverse platforms like Augmented Reality ,Virtual Reality ,Artificial Intelligence and Robotics can be incorporated for filling the gap in Public relations, Data Mining , Drug Manufacturing and Smart Drug Research .With the latest advancement in technology innovation, the field of medicine and healthcare is progressing forward and as a result, many different areas such as human health diagnostics, treatment and patient care are getting modernized . Wireless technology is advancing very fast and 5G mobile technology will enable the Internet of Medical Things (IoMT) to upgrade patient care and helps in preventing development of diseases[2].

II. OBJECTIVES

1. Discuss the future possibilities of Augmented Reality , Virtual Reality, Artificial Intelligence and Machine Learning which can transform Practice, Education, Communication, Drug discovery, Medicinal plant cultivation and Smart Drug Research in *Ayurveda* Medical System.
2. Discuss the possibility of Metaverse Platform in which some one can experience the benefits of Ethnic health practices of Ayurveda (Eg*: Dinacharya (Daily Regimens), Rithu Charya (Seasonal Regimens), Rithu Sodhana (Seasonal Detoxification Procedures)*)

III. MATERIALS AND METHODS

Technology have a major role in healthcare delivery since last century. It is useful for people to get updated about health conditions, gain medical support, it will enable doctors in monitor patient more professionally and efficiently . While technologies are helpful in uplifting the quality and outreach of both healthcare information and communication, which technology to be used for which specific condition is still an open research area as it have ethical and legal concerns. With Digital Innovations in healthcare and education through new age technologies like Augmented Reality, Virtual Reality , Artificial Intelligence and Robotics , which can only succeed if design is deeply supported by clinical practice and timely tested through healthcare interventions[3].

Historically major crisis create immense creativity, usually comes to the fore front, contributing major changes. This was what happened exactly in case of Corona Virus Disease 2019 (COVID-19) era. During this period of 3 years from 2020 to 2022, healthcare technology has moved forward to age of two decades. Technology interventions have helped healthcare service providers in managing their patients by reducing the dangers inherent in direct personal contact, reducing crowding in waiting rooms for consultations, pathological investigation areas and even hospitality management in all Medical systems including *Ayurveda*.

IV. ARTIFICIAL INTELLIGENCE AND CHAT GPT IN HEALTH CARE[5]

Simulation or action of pretending human intelligence processes by machines, especially computer systems is known as Artificial Intelligence . Specific areas of development in Artificial Intelligence include expert systems, natural language processing (NLP) , Chat GPT, speech recognition and machine learning[6].Artificial Intelligence (AI) technology can be effectively used to diagnose diseases, treatment plan as per protocol and post treatment analysis on success rates. Human will depend more on Chat GPT for initial diagnosis based on precipitated symptoms and will depend doctor for its confirmation and treatments. Possible and effective proven treatments will also be suggested by AI assisted Chat GPT. In medical systems it will spare physical investigators, lab assistants and physicians to attend patients, besides providing advanced - precise supplementary information in medical care of all conventional and alternative medical systems.

V. AUGMENTED AND VIRTUAL REALITY IN HEALTH CARE[5]

Augmented reality and virtual reality are new age technologies that upgrade or replace a real-life environment with a simulated one which comes under the spectrum of Metaverse.

1. **Augmented Reality (AR)** is a technology which amalgamates the digital world with real elements and help us to visualized digitally created models resembling the original field. It helps in visualizing digital components in the real world through a smart phone or specialized goggles. [12]

2. **Virtual Reality (VR)** provides a complete immersive experience that will reoccupy a real-life environment with a simulated one experienced through specially designed sensory devices. The core difference between Augmented Reality(AR) and Virtual Reality(VR) is that virtual reality is a completely a virtual experience through computer generated simulation where as in augmented reality ,the alternative world is generated graphically in a real space.

Augmented and virtual reality will be useful in upgrading medical education. Medical students can be trained outside the hospital/laboratories in subjects like human anatomy, human physiology, human pathology with digital models, and spare harming of cadavers or actual humans . A hands-free mode of operation will also be enabled, allowing providers to have look into patient records without leaving the patient or pausing the treatment procedure being progressed. It can be used to distract nervous patients from surgical procedures keeping them involved in digital experience of calm down from fear and stress of procedure.

VI. TELEMEDICINE AND ONLINE CONSULTATIONS[5]

Telemedicine which comprises tele-communication and online consultations, is an important tech assisted innovation, now practiced worldwide mostly after pandemic restrictions in all medical systems. With this technology, doctors can consult patients virtually, avoiding personal contact, while still being able to diagnose disease conditions and treat patients through virtual communications. This will help in saving time and money has made this technology advancement as an attractive option for both patient and practitioner. *Ayurveda* Health care system have also adopted possibilities of Tele medicines with critical thinking on lack of *Drashana* (Direct Inspection) and *Sparshana* (Real time Touch) examinations which are key factors in patient examination.

VII. THE INTERNET OF MEDICAL THINGS[5]

The Internet of Medical Things (IoMT) includes a network of devices and applications that can track patients, prevent episodes of illness in chronic cases, linking patients and doctors for better monitoring and management in critical illness. For example wearable electrocardiography (ECG) monitors are now available in market from all leading gadget companies, through which patients with fatal clinical signs can be tracked and avoid casualties. Wearable which helps in monitoring fever, oxygen saturation level and pulse rate are already been launched. With the increasing demand of health monitoring devices across the globe, it is estimated that Internet Of Medical Things (IoMT) will contribute almost one third of the IoT (Internet of Things) market value. In case of *Ayurveda* medical system there is possibility of same wearables with bio sensors that can access the qualities in body and give conclusion on Pathological *Dosha (*Humours*)* state/ *Dhathu (*Tissue*)* State in body and be indicator in possible short term and long term diseases outcomes through *Ayurvedic* principles.

VIII. ARTIFICIAL INTELLIGENCE AND ROBOTICS IN AYURVEDA HEALTHCARE

Artificial Intelligence is based on computer programming which can process large data and reach to precise conclusions. It can be used in assessment of constitution (*prakruthi*) and humours (*doshas*) of individual based on qualities (*gunas*) .Health Robots can be incorporated which will take the roll of home physician where all health data of family members will be stored. It will act as a health data board which includes all medical history and constitutional data of subscribed members of each family. It can give customized health advice for each individual according to their constitution. Remind *Dina Charyas(Day Regimens)* and *Rithu Charyas(Seasonal Regimens)* based on Weather forecast sensors. Health robots will get connected with your *Ayurveda* family physician who can monitor the health status of family members.

IX. ARTIFICIAL INTELLIGENCE IN DATA MINING[6]

Data mining is an analytical process which finds useful patterns and systematic relationship between variables from large amount of data. It is a practice of analyzing large database in order to generate new information. It have three steps like Data Exploration,

Pattern Identification and Deployment of Data . *Ayurved*a Literary /Manuscript Research, Pharmaceutical Research and Drug Research use Data Mining for scientific outcomes. Currently data mining software like TARANGA, EDM(Enterprise Data Mining) , Statistic Data Miner , IBM SPSS Modeler are used. Artificial Intelligence will help in Large Data processing and reach more precise data for scientific research in *Ayurveda*.

X. ARTIFICIAL INTELLIGENCE IN MEDICINAL PLANT CULTIVATION AND DRUG RECOGNITION[13]

Herbal medicines including *Ayurveda* is gaining acceptance in general public and through which in pharmaceutical industry across the world due to having less side effects and its wholesomeness to human system. There is a big space in the research of automated precise medicinal plants recognition considering the demand of herbal medicines in global market. There is a big challenge in *Ayurveda* Pharma industry to recognize exact drug mentioned in references of medicines due to variation in species and geographical diversification. There is a need for a simulated system that work as a robust segregator and has the ability to categorize and classify medicinal plants accurately in lesser time. Option of effective and reliable machine learning algorithms for plant categorization using leaf images and taxonomical database have been used in recent times. These machine learning plant segregators can classify plants from leaf images and phyto-morphological characters namely shape, vein, texture, leaf borders and a combination of multiple features. This will enable pharmacognosy documentators in classification and creating data base of drugs in each geographical areas with same pharmaceutical action and prepare medicinal preparation with plants domestic in origin .The medicinal plant taxonomy database and programmes that are publicly available for automatic plants recognition will be useful for *Ayurveda* Pharma Industry in Drug Standardization and helpful in Updating *Ayurveda* Pharmacopeia of India(API).

XI. ARTIFICIAL INTELLIGENCE(AI) AND ROBOTICS IN AYURVEDA PHARMACY[10]

In *Ayurveda* pharmacy major technology requirements are in automated production, packing quality control in large scale production, quality control labs for drug testing and standardization of end product. Automation technologies can robust the speed of the manufacturing process and make it safer and efficient, and also helps in reducing manpower cost. The output of automation and robotics can be analyzed in multiple production aspects related to health, safety in manufacturing, quality and production efficiency. When an AI assisted robot is assigned for given operation, it can execute the given instructions without errors or faults in every cycle irrelevant of septic- aseptic manufacturing environment. Artificial Intelligence based software with robotic assistance is the perfect solution for having the certainty of having a prescribed standard operating procedure repeated in every step, with fully automatic tracking of operations performed and directly stored in the batch records.

1. **Health, Safety and Environment:** Operational safety is one of the major concern in pharmaceutical industry due to exposure continuous exposure to raw drugs, processing drugs and heat .The robot can reduce the impact risky operations while manufacturing. In *Ayurveda* pharmacy for medicine preparation high temperature boilers, grinders and

crushers are used, which always have high chances of casualties. Robotics and automation can reduce the work hazards with more efficiency including in working hours.

2. **Quality:** The prime source of contamination in any pharmaceutical industry is being contributed by the presence of the operators (even with safety measures and proper protection gowns) . When large number of operations are assigned to a robot instead of a human operator which will reduce the risk of contamination, with safer process and increasing the quality of production. Grade A environments of production with aseptic environment where the operator performs operations at a safe distance from the product can be achieved when operations being handled by robots.

3. **Production Efficiency:** Smart-data management and quality of the batch record is part of standardized production in *Ayurveda* Pharmacy. Production operations performed by the robot can be recorded in detail with the with parameters and standardized output regulations .It is known that an operation that is performed by a human operator, would be extremely time-consuming and less robust. In addition to this by increasing the number of sensors with Machine Learning, process parameters and Artificial Intelligence (AI) tools , equip robots in-depth analysis of operations . This will help in early identification of variation from SOPs and manufacturing nonconformities, with efficient tools with proper root cause analysis. Corrective action and preventive action can be implemented early with priority, limiting the risk of losing control of production quality.

XII. ARTIFICIAL INTELLEGENCE IN AYURVEDA SMART DRUG RESEARCH[8]

Charaka samhita and *Susruta samhita* are the well known major *Ayurvedic* classic books where in more than 700 plants along with their classification, pharmacological and therapeutic properties (*Rasa, Guna, Virya, Vipaka, Karma, Pratbhava*) have been described. Drug used in *Ayurveda* are mostly herbs (Crude processed), mineral products, metals (in different oxidized forms by special manufacturing techniques) and animal products, these drugs were used as singly, in combinations (different yoga) and herbo-mineral combinations and were developed gradually.

The processing steps were mentioned in the classics to assure the quality of the products and to reduce the potential toxicity. A Separate branch "*Rasa shastra & Bhaishajya kalpana*" were designed- which mainly deals with collection, classification, purification, preparation, preservation ,mode of administration and dosages of medicines namely *Kasta* (Herbal) *Aushadhis* and *Rasa Aushadis*(metallic preparations).

Dravyaguna vigyana is a branch which deals with identification (Pharmacognosy - *Naamarupavigyana*), preparation (Pharmacy-*kalpa vigyana*) , Pharmacodynamics (*Guna-karma vigyana*) and their application in different diseases (Therapeutic- *prayoga vigyana*). The guidelines if followed properly the Pharmacodynamics and Pharmacokinetic standards of these preparations are maintained to reverse the pathological steps involved in the disease.

Concept of Drug Rediscovery[8]: Most of the *Ayurvedic* drugs/herbs are clinically used since times immemorial with proven safety and efficacy from practice . Thus conventional drug discovery process needs to be modified in such a way that benefits from *Ayurvedic* science are to be used in scientific world .The most accepted method for this intend is Reverse Pharmacology . These approach start with clinical studies and goes up to the mechanistic

preclinical studies. Drug Rediscovery is a better term to define research in *Ayurvedic* herbs and drugs. As *Ayurvedic* drugs are already in use as part of the medicinal system, and further research on these drugs would aid only in understanding their mechanism and help in optimizing their doses either in single dose or as combination doses . Thus the term Drug rediscovery will differentiate the process of discovering a drug from totally new entity from the process of understanding a drug which is existing in practice.

Stage 1: Drug Rediscovery on *Ayurvedic* drugs

- Proven *Ayurvedic* drugs to be studied for Phyto-constituents
- Activity guided fractionation of Biomarkers
- Severe Adverse Reactions (SAR) studies of active constituents
- Mechanistic studies (Preclinical and Clinical)

All these lead to optimized therapy based on new evidences to be clubbed with traditional
knowledge

Stage 2: Drug Discovery- Outputs of Severe Adverse Reactions (SAR) - Studies (Stage I) from *Ayurvedic* Rediscovery program

- Unique mechanism with multiple targets
- New target identification and validation
- System biology approach potentiating
- Single drug or molecule working on multiple targets or even multiple systems
- Multi-herb, multi target

Conventionally drugs were discovered through identifying the active ingredients from traditional remedies by accidental /intentional discovery. The Traditional drug discovery process is an educated guesswork in the beginning. It is a long (may up to 10- 15 years), complex (requires effort of several experts), and expensive process to complete.

1. **Target Identification[11]:** The main process happens in stage is the identification of a biological target that is involved in the disease pathology. This process involves a combination of biochemical assays, cell-based assays, and animal studies.

2. **Lead Discovery[11]:** This step involves identifying a molecule that has the potency to interact with the target and modify its activity. Classical approach in this phase involves screening large compound libraries to identify active molecules, which is time-consuming.

3. **Lead Optimization[11]:** It is the process of optimizing the pharmacological properties of a lead molecule, such as its potency, selectivity, and bioavailability. It comprises medicinal chemistry, computational modeling, and in vitro testing.

The sequencing of human genomes permits rapid cloning and synthesis of large quantity of purified proteins, it became a common practice to use **High through Put Screening (HTS)** screening of large compounds libraries against isolated biological targets which are hypnotized to be disease modifying in a process known as **Reverse Pharmacology[8].** With the

advancement in of Artificial Intelligence, the *target identification* process can be streamlined by using machine learning algorithms by analyzing large data souses. Advanced machine learning algorithms can be used in analyzing the large genomic data of a disease, screening potential drug targets, and predict the drug's effectiveness.

Ayurveda Drug Research methods like *Rasa* (Taste) *Guna* (Quality*) Veerya* (Potency) *Vipaka* (Metabolic Property) *Prabhava*(Non Specified Actions) and *Krama* (Pharmacological Action) of individual drugs can be coded and stored. It can be used in combination of medicines to get potency and action of complex medicine mixtures (Yogams). Pharmacodynamics and Pharmacokinetics of each drug , varieties, substituents , adultrants etc can be stored and used on need. Modern Techniques like Pharmacognosy Analysis (Macroscopic and Microscopic), Physical Examinations, Qualitative and Quantitative evaluation like **TLC, HPTLC, Gas Chromatography, Bio Assays, Screening and Biological Assays** can be fully mechanized and automated. This will help in saving time and effort for basic drug research in *Ayurveda*. Pharmaceutical Drug Standards (PRS) and Botanical Reference Standards(BRS) of various drug available in different region of world can be stored and processed to develop Drugs from regionally available sources.

XIII. AUGMENTED AND VIRTUAL REALITY FOR PUBLIC RELATIONS

The metaverse is the next generation of the internet: a single, shared, immersive, persistent, 3D virtual space which enables humans to experience life in ways they could not in the physical world. It is facilitated by the use of specially designed Virtual reality (VR) and Augmented reality (AR) Headsets. Ayurveda Health Education will be transformed to real time experience in which Anatomy, Physiology and Pathology can be experienced and learned **.**Conventional health websites will change to experience portals in which people can have virtual experience of services and decide for subscriptions **.**Brands in Ayurveda can demonstrate/market their products and services with real time experience facility**.** Realtime experience of Treatment modalities/ Daily practices like *Dinacharya (Daily Regimens) ,Rithu Charya (Seasonal Regimens), Rithu Sodhana* (Seasonal Detoxification Procedures) and *Yoga Practices* can be given to people for creating awareness **.** A comprehensive health platform/ecosystem that will disrupt the dissemination of conventional health knowledge and healthcare experience should be its futuristic outcome. This will be made possible by reaching out to the target public through podcasts and creative digital contents by creating more patient-friendly Life Experience Centers.

XIV. DISCUSSION

Artificial Intelligence and machine learning is already being used in the pharmaceutical industry for identifying new drug candidates sparing cost and time consuming traditional drug discovery process by using drug model libraries while also replacing actual trials with simulations, varying multiple parameters and to do drug research which will be helpful in reverse pharmacology . The whole process is not only much less expensive but also robust than the current process .*Ayurveda* Pharmaceutical Industry can also use the possibilities of Artificial Intelligence in Drug Identification, Big Data Base Creation on Pharmacognosy, Drug Standardization, Product Standardization and New Drug Research. Data security and privacy will be a major concern in digitalization and automation in any medical system. Even as Artificial Intelligence is being used to upgrade healthcare infrastructure and services, it can be misused to steal patient and provider data including

identities, research data, divert funds and steal information by hacking data storages and medical softwares . Stealing of patient data is possible by hacking of private systems linked to hospital software, wireless networks at health facilities, medical gadgets in Internet of Medical Things (IoMT). Considering the risks in data privacy, protection of such systems from AI-driven malware and personalized attacks would perhaps have will create more damage than that can be saved by the application of such systems. Cyber Security and data privacy in Internet of Medical Things (IoMT) will be a major concern for the medical word in coming decades.

XV. CONCLUSION

By making use of new-age technologies like Artificial Intelligence and real time immersive platforms like Augmented Reality, Virtual Reality can bring creative and innovative changes into *Ayurveda Health* sector. Artificial Intelligence and Robotics will revolutionaries conventional Health care system, Medicine manufacturing, Data Mining, Drug Identification, Drug Standardization and Drug Research with critical thinking on data safety and privacy. Metaverse platforms like Augmented Reality and Virtual Reality will promote awareness about the scientific basis of *Ayurveda* in general public and can make the ancient system of medicine - *Ayurveda* ready for future generations.

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