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Review Article

Health technology assessment in Ayurvedic insights

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ABSTRACT

Health Technology Assessment (HTA) is a multidisciplinary approach in evaluating the clinical, cost-efficacy, ethical and the social attributes of health interventions in order to facilitate the process of evidence-based decision-making. With the current transformation of health systems in the world towards integrative and Adeo type of care, the traditional medical systems like Ayurveda must be assessed systematically to prove their relevance and applicability in the modern health care systems. The holistic, preventive and personal approach to healthcare, Ayurveda, represents an immensely rich store of therapeutic, diagnostic and prophylactic healthcare, or health, technologies, which can be used to play a significant role in sustainable and equitable healthcare models. Purpose: The purpose of this review is to understand the conceptual incorporation of HTA principles in Ayurvedic healthcare. It attempts to establish the obstacles, prospects and methodological modifications that are required to evaluate Ayurvedic interventions in accordance with the contemporary evidence-based paradigms and yet maintain the philosophical and holistic integrity of the system. Methods: Narrative and conceptual review method was followed based on the WHO documents on HTA, national policy models as HTAIn (India) and peer-reviewed articles on Ayurveda, integrative health, and evidence generation.

Keywords: Health technology, Assessment, Ayurveda, Evidence-based medicine, Integrative health, Cost-effectiveness, Traditional medicine

INTRODUCTION

Health Technology Assessment (HTA) has become an important tool in health care policy and clinical governance in the contemporary times. It has been defined as a multidisciplinary systematized process, which assesses the health technology development, diffusion, and usage in terms of medical, social, ethical, and economic consequences. The end objective of HTA is to achieve that health interventions produce the best results in regards to safety, efficacy, cost effectiveness and social acceptability. HTA helps to distribute resources in healthcare systems with rationality by combining scientific facts with information in policy decisions, which helps to improve equity, efficiency, and quality of care.[1] The worldwide growth of healthcare technologies, including pharmaceuticals, diagnostics, surgery, and digital develops has established the necessity of frameworks of evaluation. To this effect, nations have come up with national HTA agencies/units globally to inform policy choices on technology adoption, reimbursement, and clinical practice. Nevertheless, even with the increasing focus on evidence-based health policy, conventional medical systems such as Ayurveda are still underrepresented in HTA systems. Such exclusion is mostly based on methodology and epistemology of the traditional and the modern biomedical sciences.[2] The ancient Indian system of life

science and medicine Ayurveda has had a distinct lineage that spans thousands of years and has a distinct philosophical underpinning of the balance between Dosaha, Dhatu, Mala, and Agni. It is holistic in nature, covering the physical, mental and spiritual health aspects. Ayurvedic treatment extends a wide range of technologies - to herbal and mineral preparations (Aushadhi), external and internal treatment (Karma such as Panchakarma), diagnostic and preventive measures (Nidana Parivarjana, Dinacharya, Ritucharya). They are not therapeutic techniques but complete health technologies, which are located within the backdrop of socio-cultural and ecological surroundings.[3]

Integrative and sustainable healthcare methods have increased popularity in the present global healthcare environment. The non-communicable diseases (NCDs), lifestyle disorders and mental health challenges have demonstrated the weakness of reductionist biomedical interventions. Ayurveda provides preventive, promotive and individual approach which is in line with the modern emphasis on precision medicine and personal well-being. Thus, it is not only pertinent, but mandatory that a well-developed HTA framework be designed to be used in Ayurvedic interventions to introduce such traditional technologies into mainstream health policy and practice.[4]

The purpose of this review is to win a deeper understanding of the conceptual underpinning, challenges, and opportunities of implementing health technology assessment to Ayurvedic systems. It describes the re-structuring HTA to be able to support the Ayurvedic philosophies and a proposal of an integrative evaluation model that will balance tradition and scientific methods. In the given way, it aims to make contributions to developing a sustainable, evidence-based, and globally relevant model of integrative healthcare.

AYURVEDA AS A HEALTH TECHNOLOGY

The modern-day use of the term health technology in the healthcare industry deals with a broad spectrum of interventions which has included pharmaceuticals, medical devices, diagnostic services, surgical procedures as well as innovations inside the health system. World Health Organization (WHO) explains that a health technology can be realistic application of coordinated knowledge and skills that can be understood as devices, medicines, vaccines, procedures, and systems created by solving a health problem and enhancing quality of life. In this sense, Ayurveda with its vast arsenal of treatment, diagnostic and preventive methods can be thought of as a whole system of health technologies which have developed and improved over a millennia.[5]

Multi-dimensional health system ayurveda

Ayurveda is not just a source of curative therapy of any disease, it is a system of health in totality where promotion, prevention, and curative therapy are involved. It has its own principles, which include Tridosha Siddhanta (Vata, Pitta, Kapha), Agni, Dhatu, Mala, and Ojas, and they provide a physiological basis of health and disease. These are operationalized by the range of interventions that span a wide spectrum and can systematically be categorised as Ayurvedic health technologies, each associated with the levels of healthcare delivery to the various levels.[6]

The threefold objectives of Ayurveda including Swasthasya Swasthya Rakshanam (preservation of health), Aturasya Vikara Prashamanam (management of disease), and Roganutpadanam (prevention of disease) has much in common with the preventive, promotive, and curative spheres that are prioritized in present-day models of public health. Therefore, Ayurveda offers a technology platform of population health interventions, lifestyle management, and chronic disease control.[7]

Classification of ayurvedic health technologies[8]

The Ayurvedic interventions will be categorized into three broad groupings under the HTA scenario:

The pharmacological technologies (Aushadha Chikitsa) are referred to A).

These are classical preparations like Kashayam (decoctions), Arishta-Asava (fermented preparations), Guggulu Kalpa, Ghrita (medicated ghee), Vati (tablets) and Churna (powders). Both formulations are multi-component, synergistic treatment entities, which are frequently prepared via complex operations and designed to improve bioavailability (Yogavahi property).

Examples include Punarnavadi Guggulu for nephroprotection and the management of oedema, Triphala Churna for supporting digestive health and detoxification, and Chyavanprasha Avaleha for rejuvenation and enhancement of immunity.

These formulations qualify as pharmacological health technologies that can be evaluated for clinical efficacy, pharmacoeconomic impact, and safety profile using adapted HTA frameworks.

Procedural technologies (Karma Chikitsa)

Ayurveda uses special therapeutic interventions that transcend the pharmacological therapeutic interventions. The procedural health technologies used to ensure detoxification, rejuvenation, and the restoration of physiological balance attribute their quality to Panchakarma, Raktamokshana, Marma Chikitsa, Abhyanga, and Basti.[9]

Vamana and Virechana act as detoxification therapies used in the management of metabolic disorders, while Basti (medicated enema) serves as a systemic treatment approach for neurological and reproductive disorders.

Similarly, Shirodhara and Nasya provide neuro-endocrine modulation and contribute to stress reduction. Under the HTA, these therapies may be evaluated with respect to clinical outcome, and cost-benefit analysis, and the multidimensional, personalised character of these treatments requires looser evaluative standards.

Diagnostic and prognostic technologies (Nidana and Prakriti -based assessment)

The methodologies of diagnosis used in Ayurveda, including Nadi Pariksha (pulse diagnosis), Prakriti Parikshan (diagnosis of the constitution), Dosha Vikriti Pariksha, and Roga-Rogi Pareeksha are cognitive technologies based on the experience. Such diagnostic technologies fall into the category of personalized and predictive diagnostics, which correspond to the concept of precision medicine and systems biology.[10] These can be improved with the help of AI and biosensor-based instruments in the digital age to produce quantifiable parameters used in the studies of HTA. An example of this is the Prakriti-based health profiling that is joined with genomics (Ayurgenomics) to offer a platform where individual prevention technology can be assessed.[11]

Ayurveda and preventive health technologies

The contemporary HTA systems usually focus on curative technologies, although the main contribution of Ayurveda is preventive and promotive technologies. Behavioural and lifestyle technologies that are used to achieve homeostasis and avoid disease are the regimens of Dinacharya (daily routines), Ritucharya (seasonal regimens), Ahara Vidhi (dietary guidelines), and Sadvritta (ethical conduct).[12] Introducing these regimens as part of HTA would imply the consideration of the long-term societal health outcomes, reduction of the costs in the chronic disease's treatment, and positive changes in the quality of life and productivity, the aspects that are mostly not considered in the traditional biomedical evaluations.[13]

The ayurveda as a green and environmentally-friendly technology system[14]

Sustainability of Ayurveda is another characteristic of this health technology. Ayurvedic pharmacology focuses on Desha-Kala-Patra (place, time and particular adaption), and also uses medicinal resources available in the area. This will automatically decrease environmental load, promote recycling of resources. Assessment of Ayurveda via HTA is also therefore in line with Sustainable Development Goals (SDGs) since it would encourage environment-friendly, culturally based healthcare services.

Socio-cultural and ethical aspects[15]

Ayurvedic health technologies are integrated in the Indian culture and social behaviour. They are also community based, cheap, and culturally acceptable and are characterized by high compliance and patient satisfaction levels. Hence, they should be evaluated using social-cultural acceptability, an ethical aspect and community engagement outcome, which are epitome of contemporary HTA. This incisive analysis will make sure that the strengths of Ayurveda are taken into consideration in the health policy procedures, i.e. accessibility, safety, and cultural appeal.

Ayurveda and digital revolution in health technologies

The merger between Ayurveda and digital technologies has become a new horizon of HTA. The objective monitoring of Ayurvedic therapies is made possible with the help of mobile health apps, teleconsultations, and digital Prakriti assessments, wearable sensors, and data analytics. The (new) Ayur-tech platforms tend to bridge the gap between conventional wisdom and quantifiable results, allow real-world data collection and evidence synthesis in HTA. This kind of integration enables the policy makers and the researcher to measure the effects of Ayurvedic interventions at the level of the population.[16]

Difficulties in the implementation of conventional HTA on ayurveda.

Epistemological difference

Ayurveda relies on the theories of Dravya, Guna, Karma, and Dosha-Dhatu-Mala which are completely different to the reductionist biomedical theory. Holanic or preventive results such as balance of Ojas and Agni might be out of range of standard HTA tools.[17]

Multi-component interventions that are complex

Ayurvedic formulations usually have several ingredients which act synergistically. Conventional HTA which emphasizes the individual-molecule analysis might ignore the interactive effect.[18]

Outcome measurement

Traditional HTA is based on measurable results, like Quality-Adjusted Life Years (QALYs), whereas Ayurvedic results can be qualitative, including better vitality, sleep, digestion, or Manasika balance.[19]

Cost and resource analysis

Ayurvedic practices are not expensive and do not have organized economic discussions or cost-effectiveness assessments in the healthcare sector.[20]

Integrative framework for ayurvedic HTA[21]

In order to use HTA in Ayurveda, some methodological changes are required:

Table 1: HTA domain with Ayurvedic adaptation.

HTA domain	Ayurvedic adaptation
Clinical effectiveness	Combine RCTs with pragmatic trials and Anubandha Chatushtaya (physician, patient, drug, disease) based observational studies.
Economic evaluation	Include direct and indirect cost analysis—e.g., reduction in chronic medication use or hospital stay.
Social and ethical analysis	Respect cultural values and traditional knowledge systems.
Patient-centered outcomes	Incorporate Swasthya Pariksha and wellness indices beyond disease remission.
Technology appraisal	Assess quality assurance, standardization of raw materials, and sustainability of resources.

It is the Ayurvedic interventions that can be appraised using such integrative HTA frameworks to achieve the biomedical outcomes and, at the same time, the traditional parameters of Swasthya (health).

Digital health and artificial intelligence role

Data-driven Ayurveda HTA can be supported by digital health technologies e.g. telemedicine, Prakriti analysis powered by Artificial Intelligence, and wearables. The real-world evidence can be created using technologies such as biosensors to measure Agni and metabolic parameters or machine learning algorithms to evaluate patterns of patient response. These digital technologies combined with Ayurveda bring Ayurveda up to date with the digital health revolution that is taking place throughout the world, making assessments scaleable and reproducible.

Policy and global health perspective[22]

The Ministry of AYUSH and the Department of Health Research (DHR) of India have taken some steps to come up with HTA frameworks of the traditional medicine. The WHO Traditional Medicine Strategy (20252034 Chapter 3) highlights optimized alternative intake of traditional systems in universal health cover all around the world. Ayurvedic Therapy Ayurvedic HTA is therefore capable of informing policy makers on how to incorporate approved interventions in insurance coverage schemes, as well as within national health programs, so as to provide fair access and reasonable use of alternative medicine.

DISCUSSION

The incorporation of the Health Technology Assessment (HTA) system into the Ayurveda sphere is an important milestone of the creation of the scientifically approved, financially feasible, and socially agreeable traditional health system. Although Ayurveda is known to be preventative, promotive and individual towards health, it has not been critically assessed using contemporary systems of assessment. Historical HTA discussion within Ayurvedic knowledge therefore creates an argument between ancient knowledge and new health care policies in forming a transdisciplinary methodology, which may rebrand future integrative care.[23]

The mediator between two knowledge systems

The source of Ayurveda and HTA is in two distinctly different epistemological foundations. The Ayurveda is founded on the doctrine of Pratyaksha (direct perception), Anumana (inference), Aptopadesha (authoritative testimony) and Yukti (logical reasoning) which stresses the experiential and holistic comprehension. Conversely, HTA is based on evidence hierarchies based on biomedical paradigms such as systematic reviews, randomized controlled trials (RCTs), meta-analyses, and cost-effectiveness models.[24] Nevertheless, they both have one thing in common and that is, they are all aimed at enhancing the health outcomes with rational decision-making. The difficulty is to transfer the Ayurvedic wisdom into some measurable results without sacrificing the philosophical meaning of the wisdom. This involves methodological pluralism, an inclusive assessment framework that has the ability to incorporate different types of evidence, including case studies, longitudinal observations, real-world evidence, and pragmatic trials together with RCTs. This type of pluralism guarantees the elements of Ayurvedic interventions which tend to be multi-modal and patient-selection are meaningfully reflected in HTA assessments.[25]

The multidimensional ayurvedic technologies

Ayurvedic technologies are not usually one-variable. Therapy plan can consist of the use of herbs, dietary changes, detoxifications therapies (Panchakarma), lifestyle changes and psychological counselling all based on an individual Prakriti (constitution) and the stage of disease. The traditional HTA constructs that concentrate on solitary interventions can therefore under-report the systemic and synergistic outcomes of such multi-component treatments.[26]

To overcome this there is need to introduce systems thinking within HTA models of Ayurveda which treats health interventions as the interacting components of a complex adaptive system. As an example, evaluating Panchakarma needs not just to be evaluated based on symptomatic outcome, but also metabolic control, immune control, emotional outcomes, and quality of life.

Such multi-dimensional results are more characteristic of the holistic purpose of Ayurveda and can be measured by the composite scoring model or multi-criteria decision analysis (MCDA) model modified to HTA27.

Economic- efficiency and optimization of resources

Ayurvedic medicine, especially in the chronic lifestyle diseases and ailments, commonly show considerable cost-efficiency in terms of dependency on long-term pharmacotherapy, reduction in adverse effects, and self-care. By introducing Ayurvedic modalities into HTA, it will be possible to measure their economic value, especially in low-resource environments in which healthcare costs remain a significant obstacle.[28]

Indicatively, Ayurvedic care interventions in osteoarthritis, Type 2 diabetes and chronic kidney disease have been found to result in significant medication cost as well as hospitalization rates. These data can enhance the argument to incorporate Ayurveda into the national health insurance plans, the state health programs and primary care models. HTA therefore becomes a key tool to see how Ayurveda can respond to universal health coverage (UHC) and sustainable health economics.[29]

Ethical, cultural and social factors

HTA has long been used to measure the technologies based on the biomedical, economical, and ethical. Nonetheless, the Ayurvedic experience particularly gives importance to cultural and ethical aspects. The Ayurvedic approach to patients focuses on the respect towards personal constitution, community spirit, and nature. This means its evaluation has to incorporate cultural acceptability, patient preference, ethical utilisation of natural resources, and ecological sustainability as the major assessment's dimensions.[30]

In addition, Ayurveda as a concept employs non-harm (Ahimsa), which is considered an ethical principle, and which can be compared with contemporary ethical standards of safety and ecotourism. HTA is thus not only supposed to evaluate the therapeutic efficacy, but also to evaluate sustainability measures, including sourcing medicinal plants ethically, conservation and carbon footprint mitigation measures.[3]

Generation of evidence and methodological innovation

One of the crucial issues of HTA implementation in Ayurveda is that data and validated outcome measures remain not standardized. A lot of Ayurvedic effects Agni Bala, Ojas, or Manasika Prasannata are, by definition, qualitative and subjective. In order to solve this gap, new methods of assessment should be designed that will be able to measure traditional parameters without simplifying them.

Potential strategies include the development of Ayurvedic-specific patient-reported outcome measures (PROMs) and quality-of-life instruments, as well as the application of biomarkers and omics technologies such as metabolomics and proteomics to correlate Ayurvedic diagnostic concepts with quantifiable physiological data. In addition, real-world evidence (RWE) databases can be developed through digital platforms and tele-Ayurveda systems. Furthermore, the use of machine learning and artificial intelligence can help in understanding patterns of Prakriti and disease progression. Is this akin to resulting in sound, replicable information to justify HTA procedures and allow validation of Ayurvedic practices at the policy level.

Integration of policies and institutions

Policies and institutional structures are necessary to be applied in Ayurveda by using HTA. The Health Technology Assessment in India (HTAIn) of the department of health research of India has started probing into integrative models, although effective incorporation of Ayurveda is not high. The process can be institutionalized by raising AYUSH-specific HTA units in national and state research councils.[34]

International HTA agencies like INAHTA and EUnetHTA might help to exchange knowledge, build capacity, and harmonize methods in collaboration systems between the Ministry of AYUSH, ICMR, DHR, and international organizations. In addition, incorporating HTA outcomes into the National AYUSH Mission (NAM) and Ayushman Bharat programs will be able to facilitate equal and evidence-based care provision.[35]

International topicality and future projections

Traditional, complementary, and integrative medicine (TCIM) in the world is of increasing interest as part of the Traditional Medicine Strategy 20252034 suggested by the World Health Organization. Some countries like China, Thailand and South Korea have already put HTA in place in their existing medical systems. India can take a lead in establishing an Ayurveda-specific HTA model to establish the international standard on how to assess the technologies of traditional medicine.[36]

Future research should focus on developing standardized HTA protocols adapted to Ayurvedic epistemology, encouraging transdisciplinary training for Vaidyas, economists, and biostatisticians, promoting public–private partnerships (PPP) for large-scale evidence generation, and strengthening international collaborations to share best practices in integrative health technology assessment (HTA). These efforts will enable Ayurveda to move beyond a culturally conserved heritage system to become a worldwide recognized evidence-based medical technology to promote the health of the planet and sustainable wellbeing.

Philosophical synthesis: to a pluralistic evidence paradigm

Lastly, HTA of the Ayurveda has nothing to do with the accommodation of the antique knowledge into the mechanical format, it is rather the creation of the

pluralistic paradigm of evidence where the wisdom of the experience, the empirical observation and the scientific validation are complementary. Assessed through the lens of modified HTA, Ayurveda reconfigures the definition of technology, which has been diminished to instrumentation as understandable and clever, this-to-us system of healing.[37] It is a new science and spirituality, mosaic and creativity, conservation and solidarities, affordability and caring and carries with it the ethos of inclusive and caregiving world health.

CONCLUSION

The evolution of worldwide healthcare systems Health Technology Assessment (HTA) being incorporated in the Ayurveda paradigm is a revolution in the history of global healthcare. It does not simply represent a meeting of long-time wisdom with the new assessment science, but rather a re-formulation of the notion of what technology is in health and healing. Ayurveda, due to its multidimensional nature of body, mind, spirit and environment, provides technologies that are biological, behavioural, cultural and ecological way beyond the mechanical or pharmacological domain of the modern biomedicine. It is these varied elements that are being recognized, or assessed in a systematic manner, that would allow Ayurveda to commence a discussion within mainstream healthcare on the basis of scientific validity and societal applicability. Conventional HTA models are fitted to linear and unidimensional interventions (like drugs, "equipment" or diagnostic procedures). Contrastingly, Ayurvedic interventions are multi component, personalized and dynamic and they combine pharmacological, procedural and lifestyle technologies. Therefore, HTA implementation to Ayurveda requires a paradigm shift, which is a disease-focused to a systemic and wellness-focused assessment.

This redefinition is what makes HTA not only focusing on disease outcomes, but also improving vitality, immunity, mental balance and quality of life the real indicators of health in Ayurveda. With the inclusion of HTA in Ayurveda, the system may transform into evidence-based practice rather than experience it without losing the spirit. The HTA is a clear and ordered guideline to show the government the effectiveness, safety, and cost-efficiency of the Ayurvedic interventions to the policymakers, insurance companies, and healthcare professionals. Health Technology Assessment Ayurvedic in Ayurvedic insights is not just an academic experiment, it is a strategic ultimatum to future of healthcare in the world. It has enabled Ayurveda to prove its worth in more policy-acceptable quantitative measures without detriment to its age-old wisdom. It also puts HTA to task to become more than reductionist, to heal in complexity and in the human. An Ayurveda context-sensitive and pluralistic HTA model can be used to provide a global example of assessing other traditional healthcare systems, resulting in more inclusive, equitable, and sustainable healthcare paradigm. Therefore, HTA and Ayurveda are not the convergence of two systems they form the development of a new system of integrative science of wellbeing, one that balances the ancient and the modern, the quantitative and the qualitative, and the local and the universal.

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