



ARTIFICIAL INTELLIGENCE AND DIGITAL TRANSFORMATION IN ROGA NIDANA: A CONCEPTUAL REVIEW

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ABSTRACT

Roga Nidana, the Ayurvedic branch concerned with disease diagnosis, etiology, pathogenesis, prognosis, and differential understanding, has long emphasized individualized assessment and early recognition of disease. In modern era, Artificial Intelligence (AI), machine learning, digital health platforms, wearable technologies, and telemedicine have transformed healthcare systems worldwide. The integration of these innovations with Roga Nidana offers significant opportunities to modernize Ayurvedic diagnostics while preserving classical principles. AI-assisted pulse analysis, digital Prakriti assessment, symptom-based predictive models, electronic health records, and tele-Ayurveda systems may improve diagnostic consistency, accessibility, preventive care, and personalized treatment planning. However, challenges such as standardization of Ayurvedic parameters, data quality, validation, ethical concerns, and practitioner training remain substantial. This conceptual review explores the relevance of AI and digital transformation in Roga Nidana, highlighting current possibilities, benefits, limitations, and future prospects for evidence-based advancement of Ayurvedic diagnostic science.

KEYWORDS: Roga Nidana, Ayurveda, Artificial Intelligence, Digital Health, Machine Learning, Diagnostics, Personalized Medicine.

INTRODUCTION

Roga Nidana is one of the most important branch of Ayurveda which deals with diagnosis, causation, pathogenesis, prognosis, and differentiation of diseases. It uses principles such as Nidana Panchaka, Trividha Pariksha, Ashtavidha Pariksha, and Dashavidha Pariksha to evaluate disease comprehensively. Unlike symptom-based approaches, Roga Nidana emphasizes causative factors, doshic imbalance, strength of patient, tissue

involvement, disease progression, and constitutional individuality. Modern healthcare is experiencing a technological revolution through Artificial Intelligence, big data analytics, wearable devices, electronic medical records, telemedicine, and remote monitoring systems. AI is increasingly used for pattern recognition, risk prediction, medical imaging interpretation, clinical decision support, and personalized healthcare. The convergence of these technologies with Ayurvedic

diagnostics may create a new paradigm where classical wisdom is strengthened through modern tools. This review examines how AI and digital transformation can contribute to Roga Nidana in theory and future practice.

MATERIALS AND METHODS

This article is a narrative conceptual review based on classical Ayurvedic literature, contemporary scientific publications, and digital health resources.

Sources Reviewed

- Classical Ayurvedic texts discussing Roga Nidana
- Review articles on AI in healthcare
- Literature on machine learning, telemedicine, wearable devices, and predictive medicine
- Sources discussing integrative and personalized medicine

Method of Analysis

Available information was organized thematically under:

- Core principles of Roga Nidana
- AI applications in diagnosis
- Digital transformation in healthcare
- Integration opportunities
- Challenges and future scope

Concept of Roga Nidana

Roga Nidana is one of the fundamental branches of Ayurveda concerned with the diagnosis, identification, causation, and understanding of diseases. The term “Roga” means disease and “Nidana” means cause or diagnosis.^[1] Roga Nidana provides a systematic framework for recognizing diseases, understanding their origin, progression, and prognosis, and thereby guides appropriate treatment. Unlike modern diagnostic approaches that often focus primarily on pathological changes, Ayurvedic diagnosis emphasizes a holistic evaluation of the individual, considering physical, psychological, environmental, and constitutional factors.

A central concept in Roga Nidana is Nidana Panchaka, the fivefold diagnostic approach.^[2] It includes Nidana, which refers to the causative factors responsible for disease development, such as improper diet, lifestyle, environmental influences, and psychological stressors. Purvarupa denotes the prodromal or premonitory symptoms that appear before the disease becomes fully manifested. Rupa refers to the characteristic signs and symptoms through which a disease is clinically recognized. Upashaya and Anupashaya involve therapeutic tests in which relief or aggravation of symptoms following specific interventions helps confirm the diagnosis. Samprapti describes the pathogenesis of the disease, explaining the sequence of doshic imbalance, tissue involvement, and disease progression.

Ayurveda employs various methods of clinical examination for comprehensive diagnosis. Trividha Pariksha, the threefold examination, consists of Darshana (inspection), Sparshana (palpation and touch), and

Prashna (history taking and questioning).^[3] These methods help assess the patient’s physical condition and disease status. Ashtavidha Pariksha, the eightfold examination, includes assessment of Nadi (pulse), Mutra (urine), Mala (stool), Jihva (tongue), Shabda (speech and voice), Sparsha (skin and touch), Drik (eyes), and Akrti (general body appearance).^[4] This examination provides detailed information about the balance of Doshas and the overall health of the patient.

Further, Dashavidha Pariksha, the tenfold examination, evaluates factors such as Prakriti (body constitution), Vikriti (pathological state), Sara (tissue excellence), Samhanana (body build), Pramana (body measurements), Satmya (adaptability), Satva (mental strength), Ahara Shakti (digestive capacity), Vyayama Shakti (physical endurance), and Vaya (age).^[5] This assessment enables individualized diagnosis and treatment planning.

Thus, Roga Nidana offers a multidimensional, patient-centered, and personalized diagnostic model. By integrating disease causation, symptomatology, pathogenesis, and comprehensive patient evaluation, it forms the foundation for accurate diagnosis, prognosis, and effective management in Ayurvedic practice.

Artificial Intelligence in Healthcare

Artificial Intelligence (AI) refers to computer systems that perform tasks normally requiring human intelligence, such as learning from data, recognizing patterns, reasoning, and supporting decision-making.^[6]

Major Applications

- Clinical decision support
- Risk prediction
- Disease screening
- Medical imaging interpretation
- Remote monitoring
- Personalized treatment suggestions
- Natural language processing for records

AI has improved speed, efficiency, and precision in many areas of medicine.

Scope of AI in Roga Nidana

Scope of Artificial Intelligence (AI) in Roga Nidana

Artificial Intelligence (AI) has emerged as a transformative technology in healthcare and has significant potential to enhance the principles and practices of Roga Nidana. Since Roga Nidana focuses on disease diagnosis, understanding causative factors, identifying disease patterns, and predicting disease progression, AI can serve as a valuable tool for improving diagnostic accuracy, efficiency, and personalization while complementing the clinical expertise of Ayurvedic practitioners.

One of the most promising applications of AI in Ayurveda is **AI-based Pulse Diagnosis (Nadi Pariksha)**. Traditionally, Nadi Pariksha requires extensive clinical experience and subjective

interpretation of pulse characteristics. Modern digital sensors, wearable devices, and machine learning algorithms can record and analyze pulse parameters such as rate, rhythm, amplitude, variability, and waveform patterns. AI systems can process these large datasets and identify subtle variations that may correspond to Vata, Pitta, and Kapha predominance. Such technologies may help standardize pulse assessment, reduce observer variability, and support practitioners in making more objective diagnostic decisions.

Another important application is **Digital Prakriti Assessment**. Determination of an individual's Prakriti is fundamental to Ayurvedic diagnosis and treatment planning. AI-powered mobile applications and web-based platforms can utilize structured questionnaires, anthropometric measurements, facial analysis, behavioral patterns, and physiological data to classify Prakriti. Machine learning models can analyze multiple variables simultaneously and generate personalized constitutional profiles. This approach can facilitate large-scale screening, improve consistency in Prakriti assessment, and make Ayurvedic evaluation more accessible to the general population.

AI also has significant potential in **Symptom Pattern Recognition**. Ayurvedic diagnosis often involves identifying complex symptom clusters and correlating them with doshic imbalances and disease states. AI algorithms can analyze patient-reported symptoms, clinical findings, laboratory data, and historical records to detect patterns that may not be immediately apparent. By comparing current symptoms with large databases of previously diagnosed cases, AI systems may assist practitioners in identifying probable disease conditions, dosha involvement, and stages of disease progression. Such pattern recognition can strengthen the diagnostic process and support evidence-based Ayurvedic practice.

A particularly valuable area is **Early Disease Prediction and Preventive Healthcare**. Ayurveda emphasizes prevention and early intervention before disease becomes clinically manifest. AI can integrate information related to diet, lifestyle habits, sleep quality, physical activity, environmental exposures, stress levels, and early warning symptoms. Through predictive analytics, machine learning models may identify individuals at risk of developing metabolic disorders, cardiovascular diseases, digestive disturbances, or stress-related conditions. This capability aligns closely with the Ayurvedic principle of maintaining health and preventing disease through timely corrective measures.

Challenges and Limitations

Challenges and Limitations of Artificial Intelligence in Roga Nidana

Despite the immense potential of Artificial Intelligence (AI) in enhancing Roga Nidana, several challenges and limitations must be addressed before its widespread adoption in Ayurvedic practice. One of the major

obstacles is the **lack of standardized data**. Ayurvedic diagnosis relies heavily on qualitative assessments such as Prakriti, Vikriti, Nadi Pariksha, and various subjective clinical observations. These parameters often vary among practitioners due to differences in training, experience, and interpretation. The absence of universally accepted standards for measuring and recording such variables makes it difficult to develop robust and reliable AI algorithms. For effective machine learning applications, large, high-quality, and standardized datasets are essential, which are currently limited in Ayurveda.

Another important challenge is the **need for scientific validation**. AI systems intended for diagnostic or predictive purposes must undergo rigorous clinical testing and validation before they can be integrated into routine healthcare. The recommendations generated by AI models should be supported by strong evidence from clinical studies, multicentric trials, and real-world practice. Without adequate validation, there is a risk of inaccurate diagnoses, inappropriate clinical recommendations, and reduced trust among practitioners and patients. Therefore, establishing the reliability, accuracy, and reproducibility of AI-based tools is a critical requirement.

The **preservation of Ayurveda's holistic approach** is also a significant concern. Ayurveda emphasizes individualized assessment, physician intuition, patient-practitioner interaction, and consideration of physical, psychological, social, and environmental factors. AI systems primarily depend on data-driven analysis and may not fully capture the subtle nuances of patient experiences and clinical judgment. Consequently, technology should function as a supportive tool rather than a replacement for the expertise and wisdom of the Ayurvedic physician. Maintaining the human element in healthcare is essential for preserving the core philosophy of Ayurveda.

Ethical and legal concerns represent another important limitation. AI systems often require the collection and storage of large amounts of personal health data, raising issues related to privacy, confidentiality, and informed consent. There is also the possibility of algorithmic bias if the training data are incomplete, unrepresentative, or skewed toward specific populations. Such biases can lead to inaccurate predictions and unequal healthcare outcomes. Furthermore, questions regarding accountability and responsibility in cases of diagnostic errors remain unresolved. Appropriate regulatory frameworks and ethical guidelines are therefore necessary to ensure the safe and responsible use of AI in Ayurvedic healthcare.

Finally, successful implementation of AI in Roga Nidana requires adequate **training and capacity building among practitioners**. Many Ayurvedic professionals may have limited exposure to digital technologies, data

analytics, and artificial intelligence. Effective utilization of AI tools demands a basic understanding of computational methods, data interpretation, and interdisciplinary collaboration between Ayurveda experts, clinicians, data scientists, and software developers. Continuous education and skill development programs will be essential to bridge this gap and promote the meaningful integration of technology into Ayurvedic practice.

Future Prospects

Future possibilities include:

- Smart pulse diagnostic devices
- AI-based dosha imbalance prediction
- Personalized Ayurvedic treatment engines
- Integrated Ayurvedic digital hospitals
- Multilingual virtual health assistants
- Predictive wellness dashboards
- Real-time lifestyle correction systems

With appropriate research, these innovations may strengthen Ayurveda globally.

DISCUSSION

Roga Nidana serves as the foundation of Ayurvedic clinical practice by providing a systematic framework for understanding disease causation, pathogenesis, diagnosis, and prognosis. The diagnostic principles of Nidana Panchaka, Trividha Pariksha, Ashtavidha Pariksha, and Dashavidha Pariksha emphasize a holistic and individualized approach to patient assessment. Unlike conventional diagnostic systems that often focus on isolated pathological findings, Roga Nidana evaluates the interplay of Doshas, Dhatus, Agni, mental status, lifestyle factors, and environmental influences. This comprehensive perspective enables personalized diagnosis and treatment planning, which remains one of the unique strengths of Ayurveda.

Recent advances in Artificial Intelligence (AI) have created new opportunities for strengthening diagnostic processes in healthcare. AI technologies, particularly machine learning, deep learning, predictive analytics, and digital health platforms, have demonstrated significant utility in clinical decision support, disease prediction, pattern recognition, and personalized medicine. The integration of these technologies into Roga Nidana has the potential to enhance both the objectivity and reproducibility of Ayurvedic diagnosis.

One of the most promising applications is AI-assisted Nadi Pariksha. Traditional pulse examination relies heavily on practitioner expertise and subjective interpretation. Sensor-based pulse acquisition systems combined with machine learning algorithms can capture and analyze pulse characteristics with greater precision and consistency. Such systems may facilitate standardization of pulse assessment while preserving the diagnostic significance attributed to doshic variations. Similarly, AI-driven Prakriti assessment tools can analyze multidimensional data obtained from

questionnaires, anthropometric measurements, facial features, and physiological parameters, thereby supporting individualized healthcare approaches.

AI-based symptom pattern recognition and predictive analytics also align closely with the preventive philosophy of Ayurveda. By analyzing large datasets containing patient symptoms, lifestyle habits, environmental exposures, and clinical outcomes, AI models can identify subtle disease patterns and predict future health risks. This capability supports the Ayurvedic objective of early detection and intervention before disease reaches an advanced stage. Furthermore, digital health records and telemedicine platforms can improve documentation, continuity of care, and accessibility of Ayurvedic services, especially in remote regions.

Despite these advantages, significant challenges remain. The subjective nature of many Ayurvedic diagnostic parameters and the lack of standardized datasets limit the development of robust AI models. Variability in practitioner interpretations may affect data quality and algorithm performance. Moreover, AI systems require extensive scientific validation through clinical studies to establish their reliability, accuracy, and applicability in real-world Ayurvedic practice. Ethical concerns related to patient privacy, data security, informed consent, and algorithmic bias must also be carefully addressed.

Importantly, AI should not be viewed as a replacement for the Ayurvedic physician. The principles of Ayurveda emphasize individualized care, clinical judgment, physician intuition, and therapeutic interaction, aspects that cannot be fully replicated by computational systems. Therefore, the most appropriate approach is the development of collaborative human-AI models in which technology serves as a decision-support tool while final clinical judgment remains with the practitioner. Such integration can preserve the holistic essence of Ayurveda while benefiting from technological advancements.

CONCLUSION

Artificial Intelligence offers significant potential to enhance the practice of Roga Nidana by improving diagnostic accuracy, standardization, disease prediction, and personalized healthcare delivery. Applications such as AI-assisted Nadi Pariksha, digital Prakriti assessment, symptom pattern recognition, predictive analytics, and electronic health records demonstrate promising opportunities for integrating modern technology with traditional Ayurvedic principles. However, challenges related to data standardization, scientific validation, ethical considerations, and preservation of Ayurveda's holistic approach must be addressed before widespread implementation. AI should function as a supportive and complementary tool rather than a substitute for clinical expertise. With interdisciplinary collaboration, rigorous research, and appropriate regulatory frameworks, the integration of AI into Roga Nidana can contribute to

more objective, evidence-based, and patient-centered Ayurvedic healthcare while maintaining the core principles of traditional Ayurvedic medicine.

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