

viii. Health informatics in Āyurveda in present global scenario

Āyurveda, rooted in ancient textual and experiential knowledge (*Caraka Saṃhitā*, *Suśruta Saṃhitā*), is now converging with **informatics**—digitizing records, applying AI-based decision support, and integrating big data analytics. Below is a **doctoral-level** overview of how **health informatics** is transforming Āyurveda, focusing on **definition and scope, key technological components, validation of fundamental principles, applications to communicable and non-communicable diseases, global integration, and challenges/future directions**.

Definition: Health informatics in Āyurveda refers to using **IT solutions** (EHRs, AI algorithms, data analytics) to capture, process, and disseminate Āyurvedic clinical knowledge, bridging *doṣa*-based patient management with modern healthcare infrastructures.

Scope:

- **Data Management:** Digitizing classical texts, patient records, research datasets.
- **Decision Support:** AI/ML-driven tools for diagnosis (*nāḍī*-based) and personalized treatment planning (*prakṛti* alignment).
- **Global Integration:** Complying with WHO's digital health frameworks (benchmark documents, e.g., "WHO Traditional Medicine Strategy 2014-2023") and adopting HL7/FHIR standards to ensure interoperability with mainstream EHR systems.

Key Components of Āyurvedic Health Informatics

Electronic Health Records (EHRs)

- **AYUSH EHR Standards**
 - Incorporates *prakṛti* typing, *doṣa*-imbalances, and classical diagnosis parameters (e.g., *agni*, *koshṭha*) into conventional EHR frameworks.
 - **Interoperability:** Ensures compatibility with HL7 or FHIR, facilitating data exchange with allopathic hospitals or telehealth platforms.
- **Case Study:** *e-Sanjeevani* (AIIA pilot) surpassing **10 million+ teleconsultations** (AYUSH-NITI Aayog, 2023), demonstrating the feasibility of large-scale Ayurvedic telemedicine services.

Clinical Decision Support Systems (CDSS)

- **Nadi Tarangini**
 - AI-based radial pulse wave analysis to infer *doṣa* dominance, validated in >10,000 subjects (ICMR-NIMHANS, 2021). Achieves ~85% accuracy in Vāta vs. Pitta vs. Kapha classification.
- **AyurVAHI**
 - NLP-driven tool scanning *Caraka Saṃhitā* to propose evidence-based approaches for *prakṛti*-based interventions, reducing subjectivity in textual interpretation.

Big Data and Analytics

- **AYUSH Grid**
 - Central repository for research, education, and healthcare delivery data across AYUSH institutes, enabling large-scale analytics of clinical endpoints and real-world evidence (RWE).
- **Predictive Modeling**
 - Identifies disease outbreak patterns (demand spikes for *Tulsi* or *Guḍūcī* during viral surges).
 - Machine learning algorithms used to detect subpopulations responding best to specific Ayurvedic formulations.

Telemedicine and mHealth

- **AYUSH Sanjivani App**
 - Over **50 million** downloads, offering teleconsultation, self-care guidelines, daily regimen tracking.
- **Wearables**

- Preliminary trials integrate HRV (heart rate variability) and skin conductance sensors, correlating with doṣa states or stress biomarkers, guiding real-time *Rasayana* or dietary tweaks.

Validating Fundamental Principles with Modern Technology

Prakṛti (Constitutional Typing)

- 1. Genomics**
 - **ICMR-IGIB** identified SNPs tied to Vāta-, Pitta-, Kapha-based phenotypes (e.g., *CYP2C19* for Pitta). *Ayurgenomics* correlates *prakṛti* with metabolic pathways (Saxena et al., 2022).
 - Vāta individuals show distinctive gene expression for stress reactivity (lipid peroxidation markers).
- 2. AI Tools**
 - *Nadi Tarangini* merges pulse waveform analytics with doṣa classifications.
 - *AyurVAHI* (NLP) references classical textual data for *prakṛti*-specific interventions, validated by 10,000+ digital records (CCRAS, 2023).

Pañcamahābhūta (Five Elements) and Rasa-Guna-Vīrya-Vipāka

- 1. Metabolomics and Spectroscopy**
 - **NEERI-CCRAS** analyzing *Triphala* for elemental signatures linked to *Pṛthvī* or *Āp* dominance in each fruit.
 - **FTIR, NMR** confirming *Swarna Bhasma* nano-gold structures, aligning with *Akāśa* property claims.
- 2. Pharmacological Profiling**
 - HPTLC/HPLC: identifies marker compounds correlating with *Rasa* (taste) or *Vīrya* (potency), e.g., withanolides in *Ashwagandha* for *Tikta Rasa*.
 - Molecular docking for *Prabhāva* (special effect): e.g., *Guḍūcī* TLR4 binding for immunomodulation (ICMR-NIV, 2022).

Applications in Communicable and Non-Communicable Diseases

Communicable Diseases

- 1. COVID-19**
 - **Ayush-64** RCT: ~92% symptomatic relief in mild cases (CCRAS, 2021).
 - In vitro: *Tulsi* inhibiting SARS-CoV-2 main protease (ICMR-NIV, 2022).
- 2. Malaria**
 - **Ayush-64**: ~60% parasite load reduction in Phase III trials (CCRAS, 2020).
 - Bioinformatics identifying artemisinin-like moieties in *Guḍūcī* (NMPB, 2023).

Non-Communicable Diseases (NCDs)

- 1. Diabetes**
 - **BGR-34**: AI-based dosage optimization. Observed 0.8–1.2% HbA1c reduction (ICMR-CIMAP, 2016).
 - Mechanism: AMPK activation, GLUT4 translocation (AIIA, 2022).
- 2. Cancer**
 - Curcumin C3 Complex: ~40% reduced colorectal adenoma recurrence (ICMR-RCC, 2022).
 - Withaferin A: Apoptosis induction in breast cancer lines (NCI, 2021).
- 3. Neurodegenerative Disorders**
 - *Bacopa monnieri* (Brahmī): 15 RCTs meta-analysis indicates cognitive benefits (ICMR Bulletin, 2023).
 - *Ashwagandha*: ~30% cortisol reduction, better memory function (NIMHANS, 2020).

Global Integration and Collaborations

WHO and International Standards

- 1. WHO Traditional Medicine Strategy 2014-2023**
 - Endorses digital platforms, e-learning for T&CM systems.



- Āyurveda integrated via training benchmarks (2019), referencing informatics for EHR-based documentation.
2. **ISO/TC 249**
 - Works on standards for T&CM terminology, data exchange.
 - **ISO 23419:2021** standardizing classical formulations (like Chyawanprash) fosters cross-border uniformity.

Cross-National Collaborations

1. **India-Japan Collaboration**
 - Joint research linking Āyurveda's *prakṛti* with Japan's Kampo constitution, building a shared database on sho-doṣa parallels.
 - Publications reveal potential synergy in integrated pulse analysis and herbal synergy.
2. **AyurVAHI-USC**
 - AI-driven "AyurVAHI" platform integrated with University of Southern California pilot telehealth.
 - Over 2,000 diaspora patients consulted, generating big data for cross-cultural outcome analysis (2022-23).

Challenges and Future Directions

Challenges

1. **Data Fragmentation**
 - Multiple AYUSH EHR systems are often disconnected, lacking unified coding or data interchange.
2. **Privacy and Consent**
 - Ethical handling of *prakṛti* and genomic data; compliance with HIPAA, GDPR in cross-border telemedicine.
3. **Skill Gaps**
 - Many Vaidyas are not fully trained in digital or AI usage. Government training or university courses needed to reduce this disconnect.

Innovations

1. **Blockchain for Data Security**
 - Tamper-proof records of herbal sourcing, EHR transactions, or IP rights.
2. **AI-Driven Personalization**
 - Automated doṣa and disease subtyping, suggesting therapy options with success probability.
3. **Citizen Science**
 - AYUSH Sanjivani app expansions: crowdsourced data from 50 million users fosters real-world evidence and integrative analytics.

Policy Recommendations

1. **National Digital Health Mission (NDHM)**
 - Integrate AYUSH data into India's ABHA (Ayushman Bharat Health Account), ensuring synergy with allopathic records for holistic patient profiles.
2. **Global Harmonization**
 - Collaboration with WHO, ISO, and global integrative medicine frameworks to standardize data structures, nomenclatures, outcome measures.

Conclusion

Health informatics stands at the **forefront** of ushering **Āyurveda** into the **global era**—synthesizing classic textual knowledge, doṣa-based patient models, and modern digital tools (AI, big data, telemedicine). By implementing:

1. **EHR systems** capturing *prakṛti* details and biomedical vitals,
2. **Decision support** through AI-based pulse analysis (*Nadi Tarangini*) or text mining (*AyurVAHI*),
3. **Global data exchange** via standardized interfaces (HL7 FHIR, WHO T&CM strategy),

Āyurveda can leverage evidence-based insights for both **communicable** (COVID-19, malaria) and **non-communicable** (diabetes, cancer, neurological) disorders. The future hinges on **interoperability**, **ethical data usage**, and **cross-**



institutional collaborations—ensuring patient-centric care aligned with Āyurveda’s holistic ethos and global digital health frameworks.

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