

## 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 (*nādī*-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*, *koshtha*) 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 *Gudūcī* 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-Virya-Vipāka

1. **Metabolomics and Spectroscopy**
  - **NEERI-CCRAS** analyzing *Triphala* for elemental signatures linked to *Prthvī* 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 *Virya* (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-dosha* 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 *dosha* 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, *dosha*-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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