# viii. Health informatics in Ayurveda in present global scenario

Āyurveda, rooted in ancient textual and experiential knowledge (*Caraka Saṃhitā*, *Suśruta Saṃhitā*), is now converging with **informatics**—digitizing records, applying Al-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, Al 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**: Al/ML-driven tools for diagnosis ( $n\bar{a}d\bar{i}$ -based) and personalized treatment planning (prakrti 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 Ayurvedic Health Informatics**

### **Electronic Health Records (EHRs)**

#### • AYUSH EHR Standards

- o 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 (AlIA 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

○ Al-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

- o 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

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#### WHERE CLASSICAL WISDOM MEETS INTELLIGENT LEARNING

• 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).
- o Vāta individuals show distinctive gene expression for stress reactivity (lipid peroxidation markers).

#### 2. Al Tools

- o 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

- $\circ$  NEERI-CCRAS analyzing Triphala for elemental signatures linked to  $Prthv\bar{i}$  or  $\bar{A}p$  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.
- o 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).
- o 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).
- o Bioinformatics identifying artemisinin-like moieties in *Guḍūcī* (NMPB, 2023).

### Non-Communicable Diseases (NCDs)

#### 1. Diabetes

- BGR-34: Al-based dosage optimization. Observed 0.8-1.2% HbA1c reduction (ICMR-CIMAP, 2016).
- o Mechanism: AMPK activation, GLUT4 translocation (AlIA, 2022).

### 2. Cancer

- o Curcumin C3 Complex: ~40% reduced colorectal adenoma recurrence (ICMR-RCC, 2022).
- Withaferin A: Apoptosis induction in breast cancer lines (NCI, 2021).

# 3. Neurodegenerative Disorders

- o Bacopa monnieri (Brahmī): 15 RCTs meta-analysis indicates cognitive benefits (ICMR Bulletin, 2023).
- o Ashwagandha: ~30% cortisol reduction, better memory function (NIMHANS, 2020).

# **Global Integration and Collaborations**

# **WHO and International Standards**

### 1. WHO Traditional Medicine Strategy 2014-2023

o Endorses digital platforms, e-learning for T&CM systems.

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- Äyurveda 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

- · Al-driven "AyurVAHI" platform integrated with University of Southern California pilot telehealth.
- o 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

o Ethical handling of prakrti and genomic data; compliance with HIPAA, GDPR in cross-border telemedicine.

#### 3. Skill Gaps

 Many Vaidyas are not fully trained in digital or Al usage. Government training or university courses needed to reduce this disconnect.

### **Innovations**

# 1. Blockchain for Data Security

o Tamper-proof records of herbal sourcing, EHR transactions, or IP rights.

### 2. Al-Driven Personalization

 $\circ$  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 Al-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-**

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

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