



Indian Knowledge System for Cancer: A Proposal for Complementary Alternative Medicine

Jagdish Sharma

Scientific Officer, Tata Memorial Hospital, Dr. E Borges Road, Parel, Mumbai - 400 012 India

E mail: jagdish1@hotmail.com

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The allopathic medical system, has practically taken over traditional medicine systems due to its evidence-based knowledge generation and documentation. Traditional medicine still faces challenges in proper information sharing and documentation. However, in the context of holistic medicine, the Complementary and Alternative System (CAM) is gaining importance in treating diseases like cancer and their management. The lack of a suitable mechanism for sharing and preserving knowledge has caused the knowledge of traditional medicine (know-how) to disappear. To address this, ICT and internet-based systems are being advocated, and libraries should focus on managing and preserving Indigenous Knowledge (IK). Librarians' knowledge of information storage and retrieval is useful in the semantic web environment too. One of the limitations of a CAM-related information system is, the meaningful mapping with the modern medicine system. This constraint can be overcome by integrating various classification schemes that are used for traditional literature management. The most common controlled vocabularies used for the allopathic medicine system include Medical Subject Headings (MeSH) and Unified Medical Language System (UMLS), Tumour Neoplasm Metastases (TNM) and others. Some of the commonly used schemes for knowledge organisation in the web environment are taxonomies and ontologies. Now natural language processing (NLP) is gaining momentum for information retrieval. It needs to be used fruitfully for organising CAM literature. While dealing with disease data (patient records), modern medicine predominately uses International Classification Disease (ICD). A suitable mechanism for mapping the CAM system with the modern medicine records is likely to be useful for any information system for any given disease, including cancer (oncology). A meaningful integration of such techniques and tools is essential for developing an information system in CAM for disease management.

Even though CAM is viewed as important in terms of a holistic medicine system, there are a few constraints; to name a few, the modern medicine system is based on an evidence-based approach, and thus proper information management about adverse drug reactions (ADR) is important. While there are some concerns and constraints in the use of CAM in comparison to the modern medicine system, which is based on an evidence-based system, proper information management about ADR, and recalibration of drugs dosage in terms of units of CAM with those of allopathy is necessary.

This paper is an attempt to discuss the present status of cancer treatment and care with special reference to India. Additionally, how a CAM system can effectively become a part and parcel of the holistic medicine system. The slant is towards the information and knowledge management system. Useful studies from some of the other countries are also cited as success stories.

Keywords: Cancer, Complementary Alternative Medicine, Controlled Vocabularies, Data Librarianship, Indian Knowledge Systems, Natural Language Systems, Pharmacovigilance

Introduction

Before the advent of the modern healthcare system (allopathic medical system, also referred to also as conventional medicine or western medicine or whole medical systems-(WMSs) herein referred to as allopathy) local/traditional medicine systems prevailed. Gradually the modern allopathy has become the main system for diagnosis, treatment (cure) and management of the disease and patients. One of the reasons for this system to become the first line of disease management is, systematic evidence-based knowledge generation, its organisation, continuous development and

documentation of literature. Second, the modern medical literature is predominately available in English language, that for practical purpose, is one of the universal accepted languages in the modern healthcare system. While the traditional medicine system or complementary alternative medicine (CAM) has proven itself in many cases but somewhat lacks in terms of proper information sharing and documentation as per the current practices followed by the modern medical practitioners.

However, realising the importance and potential benefits of these local/traditional medicine systems, efforts are underway to promote the CAM. Some of

the reasons for promoting include; availability of medicinal ingredients locally and at a lower cost than some of the modern drugs. Second, the increasing focus on alternative treatments for diseases like cancer arises when patients and their families feel that conventional approaches, such as chemotherapy or radiotherapy, are ineffective¹. The other important reason is that the modern healthcare system has realised the importance of holistic approaches in disease management. The holistic approach to healthcare considers the mind, spirit, and body as a whole in treatment, incorporating treatment with drugs and alternative remedies like herbs and massage. Thus, the CAM field is upcoming and gaining acceptance as a therapeutic method to increase patients' confidence and reduce the impact of ailment. However, the lack of a suitable mechanism for sharing and preserving knowledge of CAM has resulted in its decreased popularity. To overcome such a situation, use of Information Communication Technology (ICT) and internet-based system, including cloud computing is very useful and now being advocated and used (Naz *et al.*, 2021)².

This article discusses a slanted conceptual viewpoint based on a review of literature for (a) cancer information/knowledge management system and (b) for health/medical records management. Furthermore, the article discusses the state of cancer care in India and the opportunities for integrating CAM in cancer care and management. It highlights the contributions of the Indian Council of Medical Research (ICMR) in medicinal plants and traditional medicine, modernisation of Ayurveda, and the role of pharmacovigilance in India. The article also discusses the status of herbal drugs in India, data management in clinical research, and ethical challenges. It proposes an Indian Knowledge System, a cloud-based knowledge sharing system for CAM. In this regard, considering the business-market point of view the amount of investment and expenditure globally, CAM use is likely to flourish.

This is evident in the CAM market, which was valued at US\$ 144.68 billion in 2023 and is projected to expand at a compound annual growth rate (CAGR) of 25.3% from 2024 to 2030. In 2018, global oncology spending totalled US\$ 90 billion and rose to US\$193 billion in 2022. Drug discovery from natural sources is gaining momentum, with new possibilities and advanced technologies emerging. Natural products may be key in filling gap for new agents to

treat immuno related diseases. Wainwright *et al.* (2022)³ in their in-depth review discuss about a joint effort between the International Union of Basic and Clinical Pharmacology (IUPHAR) Natural Products and Immunopharmacology Sections and leading researchers, provide a "position statement" on the immunomodulatory activity of natural products in the search for new drugs. With such efforts, one can argue that herbal and other alternative medicine have a scope to play a role in healthcare.

It is considered that CAM must be integrated with the allopathy system for its promotion and acceptance in the cancer treatment and supporting care. Since, there is a lacune in systematic documentation and evidence about the (adverse) effects of CAM and practical concern are raised by the health insurance companies. Thus, a surveillance system is advocated.

The current study explores critical issues related to CAM in the context of cancer. It highlights two key components: literature management and patient record management, emphasising the significance of the Indian Cancer Information System in addressing CAM-related matters and its advocacy for improved practices.

Successful implementation and operationalisation of the NISSAT sectoral approach and decentralised input and standardised output of the International Nuclear Information System (INIS) and International System for Agricultural Science and Technology (AGRIS) can be guiding principles in designing and implementing the Indian Cancer Information (knowledge) System. Use of the present and potential power of the computing system can provide the desired support.

What is CAM and its role in modern medicine and challenges

CAM is a non-standard medical approach used by cancer patients to cope with side effects, ease stress, and support their own care. Integrative medicine combines conventional medicine with CAM practices, focusing on patient preferences and addressing mental, physical, and spiritual health aspects (<https://www.cancer.gov/news-events/cancer-currents-blog/2017>)⁴. CAM comprises a group of diverse medical and healthcare systems, practices, and products that are not generally considered part of conventional or allopathy medicine.

Kumar *et al.* (2016)⁵ consider CAM, Complementary and Integrative Health (CIH)

therapies as nontraditional treatments such as acupuncture, and aromatherapy used alongside conventional medicine. While Complementary Alternative Therapy (Medicine) such as herbal remedies used instead of prescription drugs or Ayurveda and Homeopathy as a primary treatment for a condition includes both complementary and alternative practices without focusing on integration (NCI Dictionary of Cancer Terms). Even though there is some difference among such therapies for convenience, a common term CAM is used throughout this article.

In the context of a holistic approach, besides the clinicians, the role of supporting professionals such as nurses in patients' treatment, care and their capability become important. Consequently, there is a recognised necessity to enhance their understanding of CAM, and this education ought to be integrated into the nursing curriculum. It is essential that this knowledge be conveyed to both caregivers and family members. On similar lines, use of CAM in non-communicable diseases like cancer can help in improving the quality of life in certain cases (Zeighm & Soltani-Nejad, 2020)⁶.

Indigenous systems of medicine worldwide use medicinal plants as ancient healthcare products. They are also used in health supplements, nutraceuticals, cosmetics, and herbal tea. ICMR is actively researching medicinal plants, contributing to the consolidation of Indian research. These efforts aim to provide better drugs and remedies for various diseases while promoting the use of indigenous medicine and plant drugs as alternative therapies (Tandon & Yadav, 2017)⁷.

One limitation with CAM being local medical system across globe is that of language variation. On the other hand, WM is in advantageous position for, English being the prominent language. An important reason for the popularity of WM is the rigorous documentation and evidence-based approach. Furthermore, the patient records management and integration with the allopathy system is a challenge for CAM. This is essential as the modern medicine system emphasis on potency, efficacy (expiry date or best used), adverse effect and pharmacovigilance of the drugs are some of the other critical concerns. The safety of herbal medicines and use of heavy metals is often influenced by regulatory policies, as they are often classified as foods or dietary supplements in developed countries (Bolan *et.al.* 2017)⁸. Another

reason is that herbal medicine is often perceived as safe (being natural) despite the lack of scientific validation for its claims, leading to widespread self-medication that can result in adverse effects. Esters and Dignass (2014)⁹ have described the allopathic practitioner physician's issue about their use due to methodological problems, thereby difficult to inform their patients adequately.

Drug safety and pharmacovigilance (often used interchangeably) both collect adverse event data, but pharmacovigilance is more strategic and focuses on monitoring and managing drug safety after patients begin treatment. It involves detecting, assessing, understanding, and preventing adverse effects or other drug-related issues. This is one of the areas where CAM practitioners need to improve documentation (Lucas *et al.*, 2022).¹⁰

Furthermore, the current pharmacovigilance frameworks are primarily geared towards synthetic drugs, posing challenges in monitoring the safety of herbal medications due to differences in their usage and potential toxicological risks. Comprehensive pharmacovigilance is essential to gather reliable safety data and formulate effective usage guidelines for herbal remedies. This discourse also addresses the pharmacovigilance of herbal supplements in cancer therapy, evaluating national and international policies aimed at minimising adverse events and exploring strategies for monitoring alternative treatments. Given the rising significance of herbal medicine safety as a global health priority, insights derived from this analysis can assist oncology providers in effectively managing patients who utilise these alternative therapies. Reporting methods such as spontaneous reporting (SR), stimulated reporting, and prescription event monitoring (PEM) are important for documenting ADRs associated with herbal supplements

(Liebling *et al.*, 2019; Sanghvi *et al.*, 2023).^{11,12}

Role of World Health Organization (WHO)

The WHO's 2019 report notes that 88% of member states recognise CAM, many of which have implemented policies supporting its use, indicating a global trend (WHO global report on traditional and complementary medicine, 2019, pp. 10-11)¹³. In this direction, the WHO Traditional Medicine Strategy 2014-2023 aims to support Member States in developing proactive policies and action plans to strengthen traditional medicine's role in maintaining population health. The strategy prioritises health

services and systems, including traditional and complementary medicine products, practices, and practitioners, with objectives to build knowledge, strengthen quality assurance, and promote effectiveness (World Health Organization, 2013)¹⁴. India supports WHO's efforts to strengthen traditional medicine systems globally for universal health coverage, particularly through the Global Centre in Jamnagar, benefiting all Member States. India has committed US\$85 million over 10 years to support the WHO Global Traditional Medicine Centre, a program aimed at strengthening the evidence base for traditional medicine during 2022-2032 (Mackenzie Lindsay, 2024).¹⁵

Aware *et al.*, (2022)¹⁶ have discussed that according to a WHO estimate more than 80% of the population of developing countries relies on traditional medicine, mainly herbal medicine. Furthermore, WHO is encouraging the integration of traditional medicine within national health systems, offering guidance and support for research. They have developed International Standard Terminologies for various Ayurvedic practices, though these primarily highlight fundamental concepts rather than specific formulations. Accordingly, a thesaurus focused on Rasa Shastra and Bhaishajya Kalpana is essential to create a unified vocabulary in Ayurvedic pharmaceutical science. The Ayurvedic Pharmacopoeia of India (API) and Ayurvedic Formulary of India (AFI) serve as important resources. However, a thesaurus, like MeSH, would provide a controlled vocabulary and a standardised terminology. In this direction, the use of artificial intelligence (AI) for drug development may be advocated.

According to Sagar *et al.* (2022)¹⁷ the Indian sub-continent, rich in herbal resources, is well positioned to meet global demand for environmentally safe and cost-effective herbal remedies. However, challenges such as biodiversity loss, over-exploitation, industrialisation, and inadequate regulatory frameworks hinder the growth of herbal medicine. Prioritising conservation, traditional knowledge research, quality control, and proper documentation are essential for progress in the 21st century. Key challenges include regulatory policies, good laboratory and manufacturing practices, herbal and allopathic drug interactions, and monitoring and clinical research of herbal drugs. In India, various pharmacopoeia and research laboratories, including those under the Central Council for Research in

Ayurveda and Siddha (CCRAS) now named as Central Council for Research on Ayurveda, Central Council for Research in Unani Medicine (CCRUM), and the Council for Scientific and Industrial Research (CSIR), are actively involved in regulating and ensuring the quality and safety of polyherbal formulations.

Why Cancer and CAM

According to Rezaei *et al.* (2024)¹⁸ cancer is second leading cause of death worldwide and a global health issue-causing one in six deaths, especially affecting low- and middle-income countries (LMICs). LMICs account for 80% of the global cancer burden (Mao *et al.*, 2022a; Kaur *et al.*, 2023)^{19,20}. According to Gerson-Cwilich (2006)²¹, cancer ranks as the second leading cause of death in Mexico, especially among young women who possess a higher education level. These patients often resort to CAM and integrative medicine after having discussions with their families, particularly when they are in advanced stages of the disease. The same situation prevails in other countries. Cancer is one of the leading causes of morbidity and mortality in India. However, the 2020 WHO report shows India reported only 1.32 million new cancer cases, compared to 2.28 million in the USA. India faces cancer challenges due to regional disparities, inadequate infrastructure, patient awareness, and high care costs, necessitating innovative solutions and addressing distorted clinical research. This is due to differences in epidemiology, infrastructure, socioeconomics, environmental factors, biological, and genetic factors, potentially affecting treatment needs. (Chintapally *et al.*, 2023)²².

In Saudi Arabia, a substantial number of cancer patients—between 25% and 80%—turn to CAM, primarily natural products like vitamins, minerals, and herbal remedies. Various factors, including media exposure and personal networks, influence this trend. However, comprehensive research into the motivations for this preference is still lacking (Alsharif, F 2021).²³

Aljawarneh *et al.*, (2023)²⁴ show a positive outlook towards CAM in the United Arab Emirates; however, there is an urgent necessity for improved regulatory measures to enhance its safety and efficacy, as current practices are inconsistent. Balneaves and Watling (2022)²⁵ study underlines the need for standardised assessment and institutional support for CAM in oncology, encouraging the integration of

complementary medicine into established cancer care protocols to promote safe and informed treatment options for patients.

Research indicates that while many cancer patients seek alternative therapies, however, there is insufficient data on the impact of these treatments on survival rates (<https://www.cancer.gov/news-events/cancer-currents-blog/2017>)⁴. Manohar *et al.* (2015)²⁶ viewed that people are consuming herbal and dietary supplements along with western medication simultaneously, and drug-supplement interactions that can cause adverse events; necessitating pharmacovigilance. However, studying these interactions requires standard terminology for herbal and dietary supplements. Second, databases like UMLS, MeSH, SNOMED CT, NDFRT only and RxNorm, partially cover supplement terms, suggesting a need for a comprehensive terminology resource for supplements and better drug-supplement interactions. Moreover, common people look for CAM-related information on the Internet, which is often incomplete, misleading or promoted for marketing purposes but considered factual, and in case of any adverse effect, trust in such a system becomes questionable. Thus, there is a need for a proper Indian Cancer Information System. Horneber *et al.* (2012)²⁷ in their systematic survey of 18 countries found the increase in CAM use in cancer care and treatment from 25% in the 1970s to almost 49% post-2000.

Balneaves and Watling (2022)²⁵ undertook a provincial cancer agency study that underscores the need for institutional and professional support to integrate CAM as a part of standard cancer care and treatment practices. Recommendations include streamlined processes for assessing and documenting CAM, enhanced training for healthcare professionals, and systematic integration. Further, they advocate for informed treatment decisions.

Integrative oncology seeks to merge traditional, complementary, and integrative medicine (TCIM) with conventional therapies to enhance patient-centered care, emphasising lifestyle modifications and mind body approaches. This collaboration between conventional medicine (WM) and TCIM aims to provide cancer care that is effective, accessible, and culturally appropriate. In this regard, American Society of Clinical Oncologist (ASCO) recommend acupuncture for managing joint pain in adult cancer patients. Reflexology, acupressure, hypnosis, and massage therapy are suggested for general cancer or

musculoskeletal pain. However, evidence for other mind-body interventions and natural products remains inconclusive, especially in paediatric cases (Mao *et al.*, 2022).¹⁹

As a positive measure, the Office of Cancer Complementary and Alternative Medicine (OCCAM) was established in October 1998 to coordinate and enhance the activities of the National Cancer Institute (NCI) in the arena of CAM

(Complementary and Alternative Medicine (CAM) for Health Professionals, 2018).²⁸

India: Cancer treatment and management present status

India ranked 145th out of 195 countries and territories in the healthcare access and quality index (HAQI) in 2016, trailing behind neighbouring China (48th), Sri Lanka (71st) and Bangladesh (132nd). Cancer was the fourth leading cause of death in India in 2017. WHO-integrated people-centered health services approach emphasizes the need for a broader definition of value-based care that integrates patient centeredness and process-oriented indicators in performance evaluation (Bhadelia, 2021).²⁹

In India the government, community trusts, or private entities run many hospitals. Primarily, the allopathic medical system is advocated and used to provide cancer treatment and care. To name a few, Tata Memorial Hospital is one of the innumerable contributions from the house of Tata's in 1941 exclusively devoted to cancer treatment, education and research. Since 1962 it is under the financial and administrative control of the Department of Atomic Energy (DAE). Regional Cancer Centers (RCCs) are cancer care hospitals and research institutes operating in India under the joint control and funding of the Government of India and the respective state governments. Currently, there are 62 of these centers spread across all of India's states and union territories. This system operates under the Ministry of Health and Family Welfare's National Cancer Control Program, which was launched in 1975 (India). Initially, there were five RCCs for each of the country's five designated regions. However, cancer treatment exclusively using CAM is very limited (Reginal Cancer Centres: In Wikipedia contributors, 2025)³⁰. Indian Cancer Society has been established in 1951 is India's first voluntary non-profit, national organization for awareness, detection and cure. Its official publication is Indian Journal of Cancer.

Society also publishes Indian Cancer Registry of Mumbai (1963) and Pune (1972), and their data is accepted for scientific publication. The society has also published 60 monographs.

The Clinical Trials Registry—India (CTRI) plays an important role in promoting evidence-based medicine in the country by fostering transparency and reducing redundancy, especially in Ayurveda, Yoga, Unani, Siddha, and Homeopathy (AYUSH) trials. While randomized controlled trials remain limited, AYUSH practices are significant in addressing non-communicable diseases. Nonetheless, challenges such as misclassification and inconsistencies must be addressed to uphold the registry's integrity (Devi *et al.*, 2021)³¹. India has a rich history of herbal medicine, referenced in texts like the Atharvaveda and Sushruta Samhita, with an estimated 15,000 to 25,000 medicinal species, of which 7,000 to 8,000 are actively used. To enhance its position as a leading exporter of herbal treatments, India must standardise scientific methods for herbal drug preparation, a need addressed by the government's AYUSH program.

Historical records suggest the presence of ailments akin to cancer, but detailed documentation emerged only during the 17th century. A pivotal study indicated that cancer significantly contributed to adult mortality during (1917 to 1932), and between 1964 and 2012, reported cancer cases in India rose fourfold due to changes in epidemiology and diagnostic advancements. Currently, one million new cancer cases annually highlight ongoing challenges, particularly for developing countries facing similar cancer treatment issues (Smith & Mallath, 2019; YouYouTu, 2018).^{32,33} Thus, it is evident that LIS by virtue of their professional can help in documenting the tacit indigenous knowledge about the medicinal plants. Importantly, the Council of Scientific and Industrial Research (Government of India) publishes Medicinal Aromatic Plants Abstracts (MAPA). This is a bimonthly abstracting journal covering global current literature on all aspects of medicinal, aromatic and allied plants, including lower plants. It was started in 1979 as a printed publication. A landmark distinction of MAPA is its inclusion in the elite list of prior art scientific journals in the non-patent literature as part of the requirement of Patent Cooperation Treaty (PCT) (Devi *et al.*, 2021).³¹

India and CAM present status

India's healthcare system is a blend of traditional

and modern approaches to healing, including Ayurveda, Yoga, naturopathy, Unani, Siddha, Sowa, Rigpa, and Homeopathy. These systems, collectively known as AYUSH have been used for centuries and are now widely available in modern medicine, particularly in oncology. The system values pluralism and seeks to provide patients with a comprehensive approach to healing. As chronic illnesses like cancer, diabetes, and cardiovascular diseases rise, healthcare providers need to find innovative solutions. Ayurveda, an ancient Indian medical system, offers remedies for chronic diseases like cancer, and its integration into healthcare research programmes is necessary for global wellness, disease prevention, and control, particularly in cancer treatment. Integrating Ayurveda into healthcare research programs can help optimize immunity, resilience, and overall health (Kotecha, 2024).³⁴

Ayurveda, a traditional medicine system, has been instrumental in drug discovery and development. Its refinement and development have led to the emergence of modern allopathic medicine. To preserve traditional and modern medicines, an uninterrupted connection with ethnomedicine is important. India's rich plant wealth and traditional knowledge can lead to improved human health and longevity. Furthermore, Mukherjee, *et al.*, (2014)³⁵ emphasise about the drug production industry, safety and efficacy of herbal medicine and the prospects for traditional remedies on a national and international scale.

ICMR is actively researching medicinal plants and traditional medicine, recognising their importance in treating various diseases. ICMR's efforts are significant due to their multifaceted use and potential to provide better treatment. The development of quality standards and review monographs aids regulators, pharmacopoeial bodies, and the drug industry in producing quality herbal drugs or traditional medicine preparations. These initiatives align with the WHO's advocacy for herbal medicines as a valid alternative therapy (Tandon & Yadav, 2017).⁷

Role of Library and Librarians

Librarians play an important role in the acquisition, preservation, documentation and sharing of indigenous knowledge, actively educate and even collaborate with stakeholders on issues such as intellectual property rights, data sovereignty, and sustainability. The rise of information and communication technology (ICT) emphasises the

need for open access to indigenous knowledge, highlighting the importance of standardised data and metadata formats for seamless integration and usability. They are also recognised as experts in the field and in a position to promote open science and education principles while honouring cultural protocols that govern sensitive knowledge. Simultaneously they educate and create awareness about the FAIR and CARE principles, which is necessary for ethical governance of indigenous data dissemination. This presents an opportunity for the librarians to reposition their role for such an information system (Chetia & Hangshing, 2024; Chigwada & Ngulube, 2023).^{36,37}

Indigenous knowledge (IK) is important for sustainable development, but its survival is threatened due to its tacit nature. Libraries should focus on managing and preserving IK, as individuals can directly access it. Sarkhel (2017)³⁸ study explores the roles of library professionals in managing and preserving IK, highlighting the International Federation of Library Associations and Institutions (IFLA) mandate and activities associated with IK management. Library professionals should be proactive in devising strategies to ensure access to this valuable resource. They should proactively manage and preserve indigenous knowledge resources, including oral knowledge (IK), by preparing inventories, developing collection development policies, developing standardised tools for indexing and cataloguing, making IK accessible to the community, especially young people, and compiling bibliographies of IK resources, considering intellectual property implications and storage media preservation.

The Indian Knowledge System (IKS), rooted in Vedic literature that also includes Ayurveda, is integrating research into digital learning platforms to tackle societal challenges. Chakravarty and Mahajan (2010)³⁹ consider traditional knowledge to be an asset for any country as it plays a vital role in making the nation more progressive and transforming its society and discusses the need for preserving traditional knowledge. They have described the role of the Traditional Knowledge Digital Library (TKDL) and its activities in preserving traditional medicinal knowledge in India.

Need for CAM related Informatics and initiatives

According to Paul and Jena (2024)⁴⁰; Pau and Chatterjee (2014)⁴¹ informatics focuses on information activities such as collection, organisation, and its delivery through ICT. Information systems and networks play key roles in the information transfer cycle and can be topic specific. They enhance fields like Agricultural Informatics to improve farming and address financial and social challenges. Technological advancements are reshaping practices in finance, economics, and social issues. On similar lines, an Indian Knowledge System for Cancer (IKSC) could be developed using a decentralised input and standardised output approach like AGRIS and INIS.

Data librarianship

Data librarianship is a growing trend in academic and research libraries, providing information support and training throughout the entire research lifecycle, beyond just information and training. The success of this role depends on the skills, knowledge, and expertise of library professionals and support from library leadership and higher authorities. Data literacy is important for researchers and data management professionals, as it involves critically accessing, interpreting, managing, handling, and ethically using data. Collaboration with academic programs is essential for skill development. Data literacy and technological infrastructures are required for optimal research data management services delivery in higher education and special libraries. Research data management services encompass the data life cycle of planning, digital curation, metadata creation, and conversion. However, in developing countries knowledge of research data management and services among library professionals is still in the earlier phase and not many libraries are in position to offer such services on regular basis (MurtazaAshiq & Warrach, 2022; Igbinovia Magnus *et al.*, 2024; Subaveera pandiyan & Ugwulebo, 2024; KoltayTibor, 2015).^{42,43,44,45} Data librarianship is a must for the proposed Cancer Information System.

Challenges in use of CAM and the need for Indian Cancer Information System

The following discussion regarding CAM focuses on (a) managing literature and (b) managing patient records, highlighting the significance and support of the Indian Cancer Information System for CAM.

CAM Literature and issues

The index journals are the primary vehicle for communicating the latest scientific findings. In this context, it's important to know that during 2023, Scimago index journals covered 664 cancer-related journals, including oncology nursing. Out of them, China has 22 titles indexed, while India has just nine. Likewise, 108 journals in all are covered for CAM. Just nine of them are from China, and four are from India. This clearly indicates that there is great scope for CAM literature to find a place in WM. It also shows that authentic and qualitative data about the use of CAM is less indexed than WM.

Dooley *et.al.* (2004)⁴⁶ studied the use of common information sources by clinicians while treating cancer patients for CAM. Their findings show that among the clinical information sources, commonly used databases such as Medline are the first; other sources include internet search engines or websites, databases, texts, journals, other professionals, and pharmacists. The study revealed that oncology practitioners' satisfaction with information sources regarding chemotherapy-associated breast cancer (CAM) is lacking. Oncology pharmacists seek information more frequently than oncologists, possibly because of their larger patient base. The most frequently sought information on CAM is general information and information about its efficacy and side effects. Cancer patients frequently encounter mixed opinions and often refrain from discussing their concerns during consultations to avoid seeming uninformed or ungrateful. This hesitance drives them towards exploring alternatives that are influenced by sources from dietary supplement marketers and complementary medicine practitioners. To address this issue, a Concerted Action for CAM Assessment in the Cancer Field (CAM-CANCER) has been established to offer straightforward and reliable information. Although the initiative was successful, it was discontinued when the European Union funding ceased. Nevertheless, the National Research Center in Complementary and Alternative Medicine (NAFKAM) has adopted the CAM-CANCER brand, incorporating it into its information service for Norwegian medical doctors (Fønnebo, 2015).⁴⁷

Numerous studies have shown that Medline is one of the important and primary sources of information about CAM. However, PubMed's complementary medicine filter search strategy lacks specificity, while other methods are more specific. Future indexing of CAM clinical trials with a common heading would

improve citation retrieval (Bardia *et al.*, 2006).⁴⁸

Both conventional health care providers and complementary therapists are involved in treating cancer patients, necessitating an understanding of both conventional and alternative treatments. Stub *et.al.*, (2018)⁴⁹ undertook a study comparing the information-seeking behaviours of oncology professionals and complementary therapists regarding these treatments. Findings revealed that to provide safe cancer care, physicians and nurses depend on current and evidence-based guidelines for conventional therapies. Another approach is to seek advice from colleagues or peers regarding information.

According to Patwardhan *et al.* (2005)⁵⁰ Ayurveda, the traditional Indian medicine (TIM) and traditional Chinese medicine (TCM) remain the most ancient yet living traditions. There has been increased global interest in traditional medicine. Efforts to monitor and regulate herbal drugs and traditional medicine are underway. China has been successful in promoting its therapies with more research and science-based approaches, while Ayurveda still needs more extensive scientific research and evidence base. Their review gives an overview of basic principles and commonalities of TIM and TCM and discusses key determinants of success, which these great traditions need to address to compete in global markets.

One limitation of CAM being the local medical system across the globe, and language varies. On the other hand, allopathy system is in an advantageous position for English being the prominent language. The language of classical texts complicates communication, particularly in pharmaceuticals, as English-oriented studies often lead to misinterpretations. Establishing standardized terminology is fundamental for enhancing clarity and uniformity in medical vocabulary. Other important reasons are the rigorous documentation and evidence-based approach. Ayurvedic medicine places a high value on medication therapy. The subdiscipline known as "BhaisajyaKalpanaa" is highly developed and solely focused on medication formulations (Savrikar & Ravishankar, 2010).⁵¹

Ruhila and Anjana (2023)⁵² suggest that the expansion of Ayurveda has fostered improvements in education, research, and publication. Yet challenges persist due to inconsistent terminology, which hampers worldwide acceptance and scientific validation. Second, reliance on Sanskrit within classical

texts complicates communication, particularly Pharmaceuticals, often leads to misinterpretation. The solution to these challenges is to have standardized terminology and uniformity in medical vocabulary.

Harvard University has established a prototype library of 202 authentic medicinal plant and fungal species, representing most of the commonly prescribed TCM herbal prescriptions. The initiative aims to promote systematic evaluation of herbal therapies and foster scientific discoveries with potential therapeutic benefits (Eisenberg *et al.*, 2011).⁵³

Even though TM is practiced in over 180 countries, health information systems for TM remain insufficient. Although several nations have created national classification systems for TM, they lack global standardisation and accessibility. Consequently, TM concepts are not represented in the WHO- International Classification of Diseases (ICD) until version 10. Integrating TM into ICD would promote international standardisation, aiding in measurement, comparison, and monitoring. The ICD-11 offers a modern classification framework that accommodates diagnostic concepts from both TM and WM, enhancing its relevance to a wider range of uses. However, there are some criticisms of including TM by WHO as many western trained clinicians and researchers consider TM is based on theories that lack scientific evidence and are considered pseudoscientific (Bill Reddy & Fan AY, 2022).⁵⁴

The integration of CAM with the allopathy system is important, but it faces significant challenges such as a lack of evidence and scientific recognition. Key issues include the legal framework, quality standards, the necessity for high-quality research, and resource allocation. It is imperative for future studies to address these fundamental challenges to bridge the gap between traditional therapies and conventional medicine. Furthermore, patient management presents integration difficulties, particularly considering modern medicine's focus on potency, efficacy, safety, and adverse effects or pharmacovigilance of drugs. The regulatory status of herbal medicines and the presence of heavy metals is often influenced by government policies that vary (across the globe) that categorize them as food or dietary supplements, raising concerns about their safety (Baars & Harald, 2017; Ernst, 2002).^{55,56}

A novel system was developed to assess the risk of herb-drug interactions based on clinical and

laboratory evidence, incorporating a transparent, easily updatable algorithm. The research focused on five common medicinal plants, and data was analysed using an algorithm that prioritises results from clinical trials. The key variables considered included study type, consistency of outcomes, and pharmacokinetic properties of herbal substances. The identified interaction risks were categorised and displayed in a user-friendly manner for health professionals to understand the potential interactions between herbs and oncological medications (Aware *et al.*, 2022).¹⁶

TCM studies include variables in quality, content, and focus, causing issues with their acceptability to the global scientific community. To address this, a European Union-funded consortium called "Good practice in traditional Chinese medicine" (GP-TCM) has developed guidelines and technical notes to facilitate good practice in collecting, assessing, and publishing TCM literature. The guidelines, which were developed through collaboration between experts in various TCM areas, provide a template for evaluating other types of traditional medicine, such as Ayurveda, Kampo, and Unani. The guidelines also establish a robust scoring system and minimum standards for publication in the herbal medicine field. Good quality, peer reviewed literature is crucial for maintaining the integrity and reputation of the herbal scientific community¹². Regulatory affairs are crucial in the pharmaceutical industry to ensure public health by controlling the safety and efficacy of products in various sectors. Herbal health products, including botanicals, supplements, and traditional medicines, are practiced globally under various legal systems and expert councils. In India, licensing is under the Drugs and Cosmetics Act, while globally; regulatory provisions follow the guidelines of developed countries. This communication highlights regulatory and licensing requirements for herbal products, highlighting the importance of safety and efficacy (Sharma & Kilambi, 2019).⁵⁷

There is an increasing consumer demand for CAM therapies as alternatives to medications for managing chronic illnesses. In this context, Scarton *et al.* (2019 Jan)⁵⁸ examined the interest of pharmaceutical companies in the use of CAM; their study aimed to extract semantic relationships related to CAM treatments from biomedical literature by utilising the Semantic Medline database (SemMedDB) based on subject-predicate-object triplets. Two methods were evaluated: sound Studies

and all Medline. The sound Studies method demonstrated greater precision and recall, whereas all Medline exhibited higher precision. The findings indicate that sound studies could be beneficial for extracting treatment-related predictions, though further developments are necessary to enhance the algorithm and tools. Additionally, they evaluated the prevalence of CAM, the types used, the influence of oncologists, and the consistency of EHR documentation. Thus, it can be concluded that employing control vocabularies is advantageous.

EHR present status and way forward

Ontologies and terminologies are essential in healthcare, with various classification systems in use across different domains. The International Classification of Primary Care (ICPC) codes classify health problems and diagnoses in primary care settings, while the ICD codes are utilised in secondary care. Additionally, laboratory observations are organised using Logical Observation Identifiers Names and Codes (LOINC). Despite their importance, these coding systems often exhibit limited interoperability, highlighting a significant challenge in healthcare data integration. Nowadays, HL7 FHIR is one of the most adopted standards to ensure interoperability when exchanging clinical data across different systems (Tayefi *et al.* 2021).⁵⁹

According to Sakowicz *et al.*, (2023)⁶⁰ keeping CAM documentation in EHR, since May 2019 WHO has approved an update to ICD-11, introducing a digital format and a user-friendly search engine. The coding system was redesigned for digital compatibility, with main codes of at least four characters. An important element is the change in the cluster codes in oncology. Furthermore, to meet the health insurance requirements, Poland's implementations take care with amendments to legal frameworks and reimbursement order.

The integration of CIH therapies in chronic pain management is gaining traction; however, their documentation in EHRs presents challenges. Austin *et al.* (2023)⁶¹ emphasize the need for systematic documentation practices supported by national organizations. In cancer care, patients often engage in CAM post-diagnosis, yet the quality of documentation leaves much to be desired, necessitating oncologists to proactively address CAM use and its implications (Smith & Kalra, 2008; Yeo *et al.*, 2016).^{62,63} The establishment of standardized terminologies for CIH

therapies, as identified by (Austin *et al.*, 2021)⁶⁴, offers a pathway to enhance data organization and promote research. Their study categorised 1209 CIH terms, revealing that nearly half are recognised within SNOMED CT, while future research should address the remaining unmapped terms to elucidate treatment-outcome relationships. Overall, despite the growing acceptance of CIH and CAM among cancer patients, comprehensive documentation in EHRs is insufficiently understood and warrants improvement (WHO, 2013).⁶⁵

Second, the oncologists, when asked about the use of such therapies, advised patients to get engaged in discussions about their benefits, and potential harms, often refer them to CAM specialists and thereafter do not keep track of the patient's records. This results in incomplete or poor medical records. Stan *et al.*, (2018)⁶⁶ study assesses the prevalence and types of CAM used post diagnosis, the influence of oncologists on patient usage, and the consistency of EHR documentation with self-reported CAM use. This situation makes it difficult to settle health insurance cases. It is recommended that oncologists actively inquire about and document CAM use. In addition, it is suggested that national organizations promote CIH therapies and advocate standardized documentation practices. Smith and Kalra (2008)⁶² concluded that ISO/EN 13606 model could enhance the representation of CAM in patient records, allowing for integrated communication between complementary and conventional healthcare systems. Furthermore, internet based personal health records (PHRs) can improve the disclosure of CAM use to medical professionals and be accessible in the patient's preferred language, highlighting the importance of educating CAM users about the adoption of PHRs.

Randomized Clinical Trials (RCT) are important for evidence-based medicine, but their application in clinical decision-making is limited due to their inconsistency with real-world scenarios. Strategies include replacing RCT databases with improved population-based registries or EHR systems (Kibbelaar *et al.*, 2017).⁶⁷

Integrating CAM with EHR: Enhancing Clinical Information Retrieval

There is a need for comprehensive clinical information retrieval (CIR) keeping in mind the impact of ICT and internet on both the clinicians and

patients along with their near akin or caregivers, who often turned to the internet sources for CAM- related information. Many times, clinicians and allied disciplines professionals find that the information is incomplete or not updated. While patients and their nearby are unable to determine the authenticity of internet-based information. However, internet-based resources are proliferating, profound and providing a cost effective and quick solution for information generation, exchange and retrieval.

Tamine and Goeuriot (2021)⁶⁸ conducted a comprehensive survey addressing recent advancements in information retrieval (IR) and health informatics. They highlighted the potential of semantic search methods to improve medical IR and the development of clinical decision support systems and medical search engines that benefit users in both disciplines. The authors reviewed the current state of research in IR and health informatics, emphasizing the role of semantic search techniques in enhancing medical information retrieval. Additionally, they noted significant research progress in deep learning, reinforcing the connections between these two fields.

One of the common concerns is how to design either clinical decision support systems or medical search engines capable of providing adequate support for both novices (e.g., patients and their next-of-kin) and experts (e.g., physicians, clinicians) tackling complex tasks (e.g., search for diagnosis, search for treatment). However, despite the significant multi-disciplinary research advances, current medical search systems exhibit low levels of performance.

In medical sciences, data is complex as it is a combination of both structure and non-structural in nature and along with images. Thus, for the success of CIR various studies are undertaken, one such study is by Sivarajkumar *et al.*, (2024)⁶⁹ gave a detailed analysis of CIR, examining the methods, tools, and techniques for optimizing medical information retrieval. The review highlights research gaps in indexing, ranking, and query expansion in unstructured EHR, emphasizing the need for innovative CIR systems like improving indexing, fast semantic vector search and neural information retrieval, along with ongoing research in text mining and machine learning, and the development of tools for superior CIR methodologies.

Additionally, biomedical ontologies are useful for knowledge management, data integration and decision support for CAM, which includes plants or herbal

medicine. This in turn is based on the use of standardized botanical nomenclatures and plant taxonomies. Bodenreider (2008)⁷⁰ states that clinical decision support systems typically gain advantages from ontologies and examines the role of ontologies in facilitating information exchange and semantic interoperability within biomedical applications, pointing out difficulties such as accessibility, discoverability, formal structures, integration, and quality. Thus, it can be said that biomedical ontologies play an important role in knowledge management, data integration and decision support. In this context Campillos-Llanos, (2023)⁷¹ examines ontologies like SNOMED CT, LOINC, Foundational Model of Anatomy, Gene Ontology, RxNorm, and UMLS. Ontologies are classified into three major categories: knowledge-management, data integration, and decision support. They play an important role in biomedical research, primarily as vocabulary for standardization and integration, but also as computable knowledge sources. Thus, standardization of vocabulary and mapping of terms across various data sources such as ICD, UMLS and MeSH are required. Additionally, a success case study of MedLexSp a Spanish language-based lexicon is discussed. MedLexSp was created using NLP techniques and domain corpora, including terms from various sources. Such works are likely to be useful for more meaningful and improving natural language processing (NLP) based models. It includes terms and inflected word forms with part-of-speech (PoS) tagging information and UMLS semantic types, groups, and Concept Unique Identifiers (CUIs).

An automated text classifier utilizing the MEDLINE/MeSH thesaurus is being developed to classify health news articles. This classifier assesses scientific texts and expert-annotated news. Trained on the MEDLINE dataset, the classifier automatically annotates text with relevant MeSH concepts, facilitating the exploration of health news and extraction of insights like the PubMed workflow (Costa *et al.*, 2021).⁷²

Tayefi *et al.* (2021)⁵⁹ work shows that the NLP and deep learning is gaining momentum based on the large language-based model. However, in the case of CAM it is important to take care of the system as one of the limitations of present NLP; which is based on the tokenization principle, whether to have a token for each measurable unit such as “0.4 mg”, should it be kept as one token “20.4 mg,” as two tokens “20.4”

and “mg” (as a single token or multiple tokens). If a proper distinction between the measurements is not taken care of, then the efficiency of CIR will be error prone. EHR contains valuable information about patients and the population, including unstructured data like clinical text and images. Advanced statistical algorithms, machine learning, deep learning, and radiomics are increasingly used for analysing these data. However, access to clinical data remains restricted due to data sensitivity and ethical issues. To improve data quality and accessibility, machine-learning methods can generate clinically relevant synthetic data and privacy-preserving techniques like de-identification and pseudonymization of clinical text. Open research questions include simplifying the unstructured data analysis process, protecting privacy and security, and developing novel methods for combining unstructured and structured data. Tokenization, the initial step in NLP, involves dividing text into these tokens.

Murray *et al.* (2021)⁷³ have examined MedKnowts, a software for notetaking and information retrieval in healthcare. This initiative focuses on the integration of EHR design, specifically for clinicians working in emergency services who must manage patients with unfamiliar medical backgrounds and utilize fragmented systems to record their histories, accurate diagnoses, and treatment plans. The software effectively captures structured information while allowing for natural language input, which helps in processing lengthy notes, auto-generating text, and supporting efficient information retrieval. This approach is intended to alleviate the documentation workload for healthcare professionals.

The explosive growth and widespread accessibility of medical information on the Internet have led to a surge of research activity in a wide range of scientific communities including health informatics and information retrieval (IR). One of the common concerns of this research, across these disciplines, is how to design either clinical decision support systems or medical search engines capable of providing adequate support for both novices (e.g., patients and their next-of-kin) and experts (e.g., physicians, clinicians) tackling complex tasks (e.g., search for diagnosis, search for treatment). However, despite the significant multi-disciplinary research advances, current medical search systems exhibit low levels of performance.

Botanical nomenclatures and plant taxonomy are

important in biomedical research, linking research to existing literature and preventing ambiguity in species determinations, accepted binomials. Inaccurate taxonomy can lead to issues in manuscripts, grant applications, and published literature. Consultation with a professional is essential (Bennett & Balick, 2014).⁷⁴

Elmitwalli *et al.* (2024)⁷⁵ predicted topics using social media tweets based on the Latent Dirichlet *et al* location (LDA)-based topic modeling technique as a part of machine learning. The Random Forest algorithm was implemented and obtained a prediction accuracy of 91.87%. The findings were able to provide valuable insights into the online discussion.

SNOMED CT is important for clinical documentation and patient care, while ICD is used for reimbursement, health services reporting, and population health statistics analysis. Now, there are various studies undertaken to integrate both the schemes for betterment of healthcare system. A few illustrative studies are given below describing the challenges and success achieved so far in this direction. Authors argue that on similar lines CAM can be integrated.

Chan *et al.* (2017)⁷⁶ have used an EHR system that enables clinical decision support to identify liver cancer terms and map them into ontological features using SNOMED CT. The primary predictor panel was formed, and the hepatocellular carcinoma (HCC) with no abnormality detected (NAD group) group showed a distinct association pattern. New features improved the model's sensitivity and accuracy.

Fung *et al.* (2019)⁷⁷ using de-identified outpatient clinic notes study explores the effectiveness of the NLM's SNOMED CT to ICD-10-CM map in improving manual ICD-10-CM coding. It found that map-assisted coding reduces coding time and enhances reliability, especially among experienced coders, but requires further improvements. A secure web server was used for this purpose. In second phase post coordination was used for mapping to ICD-11 between foundation entity and a SNOMED CT concept (Fung *et al.*, 2024).⁷⁸

Herrera-Hernandez *et al.* (2016)⁷⁹ have discussed their prototype web-based knowledge management system designed to explore the relationship between allopathy system and TCM. The system aims to facilitate relational medical diagnosis, integrating these healing modalities. The system was developed

from initial datasets of symptoms, known diagnoses, and treatments from both medicines. The system addresses data acquisition, modelling, organization, storage, and transfer challenges, enabling users to explore, learn, and update relational information for integrated medical diagnosis. This proposal could improve care provision and knowledge sharing, enhancing the understanding of medical diseases.

Li *et al.* (2024)⁸⁰ conducted a study at MD Anderson showing that GPT-3.5 and Llama are effective in extracting acupoint-related location relationships from textual sources, with fine-tuning achieving the highest micro-average F1 score of 0.92, advancing informatics in allopathy and CAM.

Conclusion

The article explores the increasing adoption of CAM worldwide, particularly in oncology. The appeal of CAM is attributed to its cost-effectiveness and holistic approach, especially when conventional treatments, such as chemotherapy or radiation, yield unsatisfactory results. Patients often resort to Internet-based resources, which can be misleading or commercially driven, raising concerns about the validity of such information. For clinicians, ensuring the authenticity and precision of information is critical given the evidence-based nature of modern medicine, which necessitates prior knowledge of drug efficacy and safety, including adverse drug reactions. This understanding is vital for health insurance.

Clinicians primarily rely on Medline and other specialised websites and databases as their main sources of information. However, Medline's coverage of CAM literature is notably limited, with only three Indian journals being represented among its indexed titles. Information retrieval for CAM poses challenges because of the limitations found in controlled vocabularies such as MeSH.

Maintaining EHR presents significant challenges, particularly regarding the diverse codification schemes used for disease management such as ICD and LONIC. This complexity is exacerbated when CAM documentation is integrated with conventional allopathic systems. Such integration is essential for promoting a holistic approach to healthcare and is increasingly critical for health insurance compliance. The proposed solution involves enhancing interoperability among various controlled vocabularies and codification schemes, including MeSH, UMLS, ICD, SNOMED CT and others,

thereby fostering better integration and consistency in the healthcare documentation process. This can be achieved by mapping the terms and using semantic vectors, taxonomies, and ontologies. The meaningful use of NLP is based on large language models with well-designed tokenization policies and algorithms. Such efforts promise a better organisation of knowledge and retrieval of relevant information. This is possible using the potential of the latest advancements in ICT, including cloud computing. It has been proposed that various departments and stakeholders adopt a template-based approach to capture data from the source of origin. Thus, the approach of INIS and AGRIS informatics decentralised input and standardised output is a viable solution. Given the participation of various governmental bodies, such as the Health Ministry, AYUSH, ICMR, and DST, it is advisable to implement the NISSAT sectoral approach within the Indian Knowledge System for Cancer.

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Abbreviations used

S. No.	Expanded Abbreviations	Abbreviations
1	Adverse Drug Reactions	ADR
2	American Society of Clinical Oncologist	ASCO
4	Ayurveda, Yoga, Unani, Siddha, And Homeopathy	AYUSH
5	Ayurvedic Formulary of India	AFI
6	Ayurvedic Pharmacopoeia of India	API
7	Central Council for Research in Ayurveda And Siddha	CCRAS
8	Central Council for Research on Ayurveda, Central Council For Research In Unani Medicine	CCRUM
9	Clinical Information Retrieval	CIR
10	Clinical Trials Registry—India	CTRI
11	Complementary and Alternative System	CAM
12	Complementary and Integrative Health	CIH
14	Concept Unique Identifiers	CUIS
15	Concerted Action for Cam Assessment In The Cancer Field	CAM-CANCER
19	Electronic Health Records	HER
20	Good Practice in Traditional Chinese Medicine	GP-TCM
21	Hepatocellular Carcinoma	HCC
27	International Classification Disease	ICD
28	International Classification of Primary Care	ICPC
32	International Union of Basic and Clinical Pharmacology	IUPHAR
33	Latent Dirichlet <i>al</i> location	LDA
34	Logical Observation Identifiers Names and Codes	LOINC
40	National Research Center in Complementary and Alternative Medicine	NAFKAM
41	Natural Language Processing	NLP
42	No Abnormality Detected	NAD
43	Office Of Cancer Complementary and Alternative Medicine	OCCAM
45	Personal Health Records	PHRs
46	Prescription Event Monitoring	PEM
47	Randomized Clinical Trials	RCT
48	Regional Cancer Centers	RCCS
50	Traditional Indian Medicine	TIM
52	Traditional Medicine	TM
53	Traditional, Complementary and Integrative Medicine	TCIM
54	Traditional, Complementary and Integrative Medicine	TCIM
55	Tumour Neoplasm Metastases	TNM
56	Unified Medical Language System	UMLS
57	Western Medicine	WM
58	Western Medicine & Whole Medical Systems	WMS