RESEAPRO
JOURNALS

MINI REVIEW

OPEN ACCESS

Dental informatics and its impact on oral health: Revolutionizing dentistry

Swayam Sarvani Sahoo

Department of Microbiology, Utkal University, Bhubaneswar, India

ABSTRACT

Biomedical informatics is one of the upgrading maturing disciplines. One of its subdisciplines, dental informatics, is beginning to emerge as its own entity. While there are numerous trained dental informaticians, dental faculty, and administrators, in general, they are not very familiar with dental informatics as an area of scientific inquiry. Scientific investigations in informatics center primarily on model formulation, system development, system implementation, and the study of effects. Informatics draws few of its scientific methods mainly from information science, computer science, cognitive science, and telecommunications. Dental informatics provides many types of research questions and methods from its parent discipline, biomedical informatics. However, there are indications that certain research questions in dental informatics require concrete solutions that have not yet been developed in other informatics fields. This article provides an overview of the unique features of biomedical and information sciences.

Introduction

Dental informatics is a branch of biomedical informatics that applies computer and information science to enhance various aspects of dentistry, including practice, research, education, and management. It's important to note that dental informatics is not simply the use of computers in dentistry but rather a research discipline focused primarily on information. This field draws from various disciplines, such as information science, computer science, cognitive science, and telecommunications [1].

While dental informatics often leads to the development of computer programs and devices, it is distinct from information technology. The field is relatively new and still developing, with significant potential to improve patient care in clinical settings. However, many dentists are not yet familiar with dental informatics, its objectives, accomplishments, or how they can participate in its advancement [2].

The applications of dental informatics in clinical practice are diverse, ranging from disease diagnosis to drug prescription guidance. To make informed decisions, dentists need to stay updated on these developments. In modern healthcare, it's becoming increasingly difficult to practice effectively without the appropriate integration of information technologies.

It's crucial to understand that informatics prioritizes information over technology, with the latter serving as a tool to optimize information use [3]. Friedman's "fundamental theorem" of informatics emphasizes that the field aims to use technology to enhance human cognitive tasks rather than replace human expertise [4].

Dental informatics also contributes to the development of Evidence-Based Dentistry (EBD) databases [5]. This approach improves oral healthcare by integrating systematic assessments of clinically relevant evidence with specific clinical interventions, aiming to achieve the best possible health outcomes within available resources.

Dental Informatics in Public Health Practice

Public Health Informatics (PHI) refers to the application of information and computer science and technology to public health practices. It encompasses the technologies used to support and enhance public health activities. To create efficient public health information systems, it's crucial to understand PHI, which systematically applies these technologies to public health practice, research, and learning [6,7].

The primary areas where PHI is applied include:

1. Biostatistics: Using statistical methods to analyze health-related data.
2. Community health education: Employing technology to disseminate health information and promote health literacy among communities.
3. Geospatial Information System (GIS): Utilizing geographic data to analyze health trends and patterns, which also includes teledentistry - the use of information technology and telecommunications for dental care, consultation, and education over a distance.

These applications of PHI contribute to more effective public health strategies and interventions.

Research and Biostatistics

The field of public health regularly requires gathering information from large populations. This data collection must be conducted periodically to evaluate the prevalence and incidence of different diseases within a population and to monitor trends over time.

To manage and analyze such extensive datasets, several software tools have been developed. These include:

1. SPSS (Statistical Package for the Social Sciences)
2. SAS (Statistical Analysis System)
3. Microsoft Excel

*****Correspondence:** Ms. Swayam Sarvani Sahoo, Department of Microbiology, MITS School of Biotechnology, Utkal University, Bhubaneswar, India, e-mail: swayamsarvani@gmail.com

4. EPI-INFO

These software programs have significantly simplified the process of analyzing large-scale public health data. They provide user-friendly interfaces and powerful computational capabilities, making it easier for public health professionals to process, interpret, and draw meaningful conclusions from complex datasets. This technological advancement has greatly enhanced the efficiency and accuracy of public health research and practice [8-10].

Community Health Education

In India, the use of informatics in dental care is still in its early stages. While most dentists incorporate computers into their daily routines, only a small number utilize them to enhance patients' dental health through educational software and oral hygiene awareness programs.

Several patient education software programs have demonstrated effectiveness in clinical settings. These include:

1. GURU
2. Patient oriented problem solving
3. Casey patient education software
4. ORASPHERE

These tools have proven valuable for improving patients' dental health knowledge in clinical environments [11-14]. However, there's a need to explore how these software programs can be adapted for community health education new programs specifically designed for community settings.

One potential approach is to install simple health education software programs at primary health centers. These could be used by primary health workers to raise awareness about both general health and oral health issues in the community. This strategy could help bridge the gap between clinical dental informatics and broader public health education efforts, particularly in areas where access to dental professionals may be limited.

GIS (Geospatial Information System) and Teledentistry

Teledentistry is a crucial solution for underserved populations with limited access to dental care. It combines telecommunications technology, the Internet, and dental practice to create a new approach to oral healthcare delivery [15].

This emerging field has the potential to significantly transform current dental practices due to rapid technological advancements. Teledentistry can be defined as the use of electronic information and telecommunications technologies to support long-distance clinical oral health care, patient and professional health-related education, public health initiatives, health administration. The benefits of teledentistry include increased patient access to dental care, improved quality of care, and enhanced cost-effectiveness.

A typical teledentistry visit involves:

- Setting up video conference equipment and an internet connection at both the hub site (specialist's location) and remote site (patient's location)
- Patient check-in at the remote clinic
- Patient completing a questionnaire
- A hands-on examination by a dentist or assistant at the remote clinic
- Transmission of the questionnaire, examination results, and any relevant imaging or documents to the hub via an online electronic patient record system
- Specialist review of the transmitted information
- Online consultation between the specialist and patient through video conferencing

This approach allows for expert dental care to be provided remotely, potentially increasing access to specialized dental services in underserved areas.

Major Challenges Impeding Dental Informatics as an Independent Discipline

Geographical challenges

India faces a pressing need for a robust oral health information management system due to stark disparities in affordability and access to oral healthcare between urban and rural populations. This need is exacerbated by several factors, including insufficient government funding for oral health initiatives and a scarcity of both human resources and material assets in the dental sector. The situation is further complicated by various challenges such as natural disasters, including floods and earthquakes, as well as famines, disease outbreaks, and a rising prevalence of oral health issues. Compounding these problems is the state of Dental Informatics in India, where the field suffers from a severe shortage of experienced and trained researchers. The growth of this specialized workforce remains disappointingly slow and stagnant, hindering the development and implementation of effective dental informatics solutions that could potentially address some of these critical healthcare delivery challenges across the country [16].

Underrepresentation in dental informatics

The scarcity of skilled personnel in remote rural areas poses a significant challenge for implementing and maintaining information and communication technologies (ICTs) essential for health informatics. Public dental healthcare facilities often lack proper equipment and staff, with oral health receiving low priority in budget allocations. Technical issues in rural areas can lead to prolonged downtime for tele-consultation centers due to limited local support. Additionally, most public health workers are unfamiliar with informatics, further complicating its integration into healthcare systems [16].

Literature gap

India's contribution to dental informatics literature is limited, with fewer than 10% of global publications originating from the country. Of the approximately 4,266 informatics-related articles worldwide, dental informatics research is dispersed across 176 journals. The International Journal of Computerized Dentistry, the sole periodical dedicated to dental informatics, primarily focuses on CAD/CAM technology, limiting its scope. This scarcity of Indian publications and the lack of a comprehensive journal devoted to dental informatics hinder the field's growth in India. The country's representation in international dental informatics research remains minimal, impeding the development and application of this discipline within the Indian healthcare context [17].

Educational awareness

In India, dental informatics is absent from the curriculum, leaving students, faculty, and administrators unfamiliar with this scientific field. Dental graduates often lack awareness of community oral health's importance. Resistance from health professionals, managers, and system users can hinder the implementation and adoption of ICT systems. Cultural barriers, low literacy rates, and language diversity across Indian states further impede the acceptance of dental informatics. Rural areas face additional challenges due to inadequate connectivity, transportation, and electricity. These factors collectively limit the potential use of telemedicine facilities in primary health centers and hamper the overall growth of dental informatics in India [16].

Financial constraints

Financial constraints significantly hinder the growth of public health informatics in India, particularly for e-health initiatives. Substantial start-up costs for both personnel and advanced technology pose a major challenge. The World Health Organization recommends countries invest about 5% of GDP in public health, yet India's current investment is a mere 1.2%. Achieving the WHO-recommended level requires considerable political will and commitment, presenting a formidable obstacle to the advancement of dental informatics and broader public health initiatives in the near future [18].

Public health systems development

Developing comprehensive national public health information systems presents a significant challenge for dental informatics in India. Essential requirements include clearly defined data needs and sources, standardized collection and communication methods to ensure quality and comparability, and policies for effective data access and distribution. Creating a unified health information framework is crucial. However, establishing interoperability standards and providing adequate bandwidth for data sharing among diverse stakeholders, including government and private healthcare providers, is a daunting task in the Indian healthcare landscape. These challenges must be addressed to create an efficient and integrated public health information system that can support dental informatics and improve overall healthcare delivery [18].

Data security concerns

In India, the implementation of informatics systems in healthcare raises significant concerns regarding privacy, confidentiality, and security. These issues require ongoing attention and resolution. The country still grapples with prioritizing security measures, necessitating the development of specific guidelines and policies for data access and usage authentication. Safeguarding patient data and ensuring system security are paramount to prevent data misuse, particularly in the Indian context where such protections may be less established. Addressing these challenges is crucial for the successful adoption and public trust in dental informatics and broader health information systems throughout the country [19].

Digital divide

Access to high-speed Internet is crucial for the development of Informatics in India. Both patients and dentists need increased access. The hindrance posed by the "digital divide" will persist and impede efforts to advance these sophisticated systems. This divide refers to unequal access, usage, or effects of information and communication technologies among various groups, which can be delineated by social, geographical, or geopolitical factors.

Patient data management

India, the world's second most populous nation with 1.38 billion people, continues to grapple with a significant burden of oral diseases resulting from neglect of oral health. The development of these systems will necessitate the creation of extensive repositories of patient information. There has been substantial public resistance so far towards automating the capture, integration, and synthesis of data to establish real-time, knowledge-driven clinical surveillance systems. These systems must incorporate data from diverse sources, ranging from continuously available digital data to intermittently accessible analogue data, which vary widely in accuracy and reliability.

Recommendations for Policy and Practice in Dental Informatics

To advance dental informatics and enhance oral health care systems, policymakers and practitioners can implement several strategic recommendations. Firstly, investing in comprehensive education and training programs for dental professionals in informatics is crucial. This ensures they are equipped to utilize advanced technologies effectively and integrate them into clinical practice. Secondly, securing adequate funding for research and development in dental informatics is essential to drive innovation and address emerging challenges. Thirdly, developing robust infrastructure, such as secure and interoperable electronic health record systems, promotes seamless information exchange and enhances patient care coordination. Lastly, fostering collaboration between academia, industry, and healthcare providers encourages the development of innovative solutions tailored to the unique needs of oral health care. By implementing these recommendations, policymakers and practitioners can create a supportive environment for dental informatics, ultimately improving patient outcomes and advancing the field's impact on oral health care systems.

Conclusions

Niccolò Machiavelli's assertion captures the daunting challenge of pioneering a new era, fittingly reflecting the hurdles faced in dental informatics. While computer technology has already transformed daily life, the extent of its impact on dentistry remains uncertain. Globally enhanced oral health information systems could bolster healthcare structures, with operational research aiding in applying knowledge effectively to prevention and health promotion, especially for underserved populations. Implementing informatics theories demands substantial commitment and resources, yet many initiatives will inevitably falter. Dentistry must glean lessons from both failures and triumphs to fully harness the potential of informatics.

In summary, dental community of the future will require a much higher level of computer literacy than today's dental professionals. Using newer technology appropriately will facilitate a higher level of care with greater efficiency and productivity. Patients will also benefit from these technological advances, but it is a challenge for the dental profession to incorporate them into everyday dental routines.

Disclosure statement

No potential conflict of interest was reported by the author.

References

1. Hersh W. A stimulus to define informatics and health information technology. BMC Med Inform Decis Mak. 2009;9:24. https://doi.org/10.1186/1472-6947-9-24
2. Schleyer T. Dental informatics: An emerging biomedical informatics discipline. J Dent Educat. 2003;67:1193-1200. https://doi.org/10.1002/j.0022-0337.2003.67.11.tb03710.x
3. Patwardhan N, Bhaskar DJ, Bumb SS, Agali C, Punia H. Dental informatics in planning an effective oral health information system: A review article. TMU J Dent. 2015;2(1):12-16.
4. Bates D. The quality case for information technology in healthcare. BMC Medical Informatics and Decision Making. 2002;2:1-9. https://doi.org/10.1186/1472-6947-2-7
5. Schleyer T. Dental informatics: A work in progress. Adv Dent Res. 2003;17:9-15. https://doi.org/10.1177/154407370301700104
6. Yasnoff WA, O'Carroll PW, Koo D, Linkins RW, Kilbourne EM. Public health informatics: Improving and transforming public health in the information age. J Pub Health Manag Pract. 2000;6(6): 67-75. https://doi.org/10.1097/00124784-200006060-00010
7. Athavale AV, Zodpey SP. Public health informatics in India: The potential and the challenges. Indian J Public Health. 2010;54(3):131-136. https://doi.org/10.4103/0019-557x.75735
8. Sector P. An Introduction to the SAS System (internet),(cited on 15 th April 2013), available from: www.stat.berkeley.edu/classes/s100/sas.pdf
9. MS- EXCEL (internet), cited 15th April 2013, available from: http://www.hrdiap.gov.in/Downloads/04.MS%20Ex%20cel.pdf
10. CDC, Epi-Info Community Health Assessment Tutorial, published by: Centers for Disease Control and Prevention, october (2005) cited 17th April 2013. Available from ftp://ftp.cdc.gov/pub/software/epi_info/EIHAT_WEB/IntroductoryMaterials.pdf
11. Acharya A, Wali T, Rauch J. GURU: Patient Education Software. J Dent Edu. 2009;73(1):137-139. https://doi.org/10.1002/j.0022-0337.2009.73.1.tb04647.x
12. Chiodo G, Tolle SW, Bartley M. Antibiotic prophylaxis for dental treatment. Review and update III, Dent J. 1990;59(7):599-560.
13. Patterson dental system, CASEY SMILE CHANNEL user guide 2009, cited 12th April 2013, available from: https://pattersonsupport.custhelp.com/euf/assets/Training/CAESY/OnDemand/Smile_Channel_9_DVD_Users_Guide_091709.pdf?nointercept/1
14. ORASPHERE Dental Patient Education Solution (internet) cited 21st March 2013. available from: http://www.orasphere.com/products/product.php?p =dvd
15. Chen JW, Hobdell MH, Dunn K, Johnson KA, Zhang J. Teledentistry and its use in dental education. J Am Dent Assoc. 2003;134(3): 342-346. https://doi.org/10.14219/jada.archive.2003.0164
16. Schleyer T, Thyvalikakath T. From information technology to informatics: The information revolution in dental education. J Dent Educ. 2012;76(1):142-153. https://doi.org/10.1002/j.0022-0337.2012.76.1.tb05241.x
17. Sittig D, Kirshner M, Maupomé G. Grand challenges in dental informatics. Adv Dent Res. 2003;17:16-19. https://doi.org/10.1177/154407370301700105
18. Rawat P, Goswami P, Kaur G, Vyas T, Sharma N, Singh A. Knowledge, attitude, and behavior toward evidence based dentistry among dental professionals in Jodhpur, Rajasthan, India. J Contemp Dent Pract. 2018; 19(9):1140-1146. https://doi.org/10.5005/jp-journals-10024-2395
19. Schleyer T. Should dentistry be part of the National Health Information Infrastructure? J Am Dent Assoc. 2004; 135:1687-1695. https://doi.org/10.14219/jada.archive.2004.0120

Oral Health Maxillofac. Res., 2024, 1, 5-8

© Reseapro Journals 2024
https://doi.org/10.61577/ohmr.2024.100008

8