

Informatics Innovation in Dental Care: A Visionary Scenario for Dentistry

Abstract

Technology in dentistry is a novel science and it will continue to grow in future. Health informatics (also called health care informatics, healthcare informatics, medical informatics, nursing informatics, or biomedical informatics) is a discipline at the intersection of information science, computer science, and health care. It deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine. Oral health information system is important in the evaluation of public health initiatives as well as for the assessment of achievements of goals for health. Health informatics helps doctors with their decisions and actions, and improves patient outcomes by making better use of information making more efficient the way patient data and medical knowledge is captured, processed, communicated, and applied. These challenges have become more important since the internet made access to medical information easier for patients.

Key Words

Health informatics; dental informatics; public health informatics

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INTRODUCTION

Information technology has developed very rapidly in a short span of 40 years and touched almost every aspect of the society. According to Merriam Webster it is defined as “the technology involving the development, maintenance, and use of computer systems, software, and networks for the processing and distribution of data.”^[1] Some authors treat informatics as a synonym for information science. Because of the rapidly evolving, interdisciplinary nature of informatics, a precise meaning of the term “informatics” is presently difficult to pin down. Regional differences and international terminology complicate the problem. Some people note that much of what is called “Informatics” today was once called “Information Science” at least in fields such as Medical Informatics. According to Merriam-Webster’s Collegiate Dictionary, informatics is derived from the term “information science,” which is the collection, classification, storage, retrieval and dissemination of recorded knowledge treated both as a pure and applied science.^[2] When applied to a specific domain of health sciences, it becomes Medical, Dental or Nursing “informatics”.

The field of Health Informatics is on the cusp of its most exciting period to date, entering a new era where technology is starting to handle Big Data, bringing about unlimited potential for information growth. Health Informatics is a combination of information science and computer science within healthcare. There are numerous current areas of research within the field of Health Informatics, including Bioinformatics, Image Informatics (e.g. Neuro informatics), Clinical Informatics, Public Health Informatics, and also Translational Bio Informatics (TBI). Research done in Health Informatics (as in all its subfields) can range from data acquisition, retrieval, storage, analytics employing data mining techniques, and soon.^[3] Each of the studies done in a particular subfield of Health Informatics utilizes data from a particular level of human existence.^[4] Bioinformatics uses molecular level data, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. Neuroinformatics employs tissue level data, Clinical Informatics applies patient level data, and Public Health Informatics utilizes population data (either from the population or on the population). A simple,

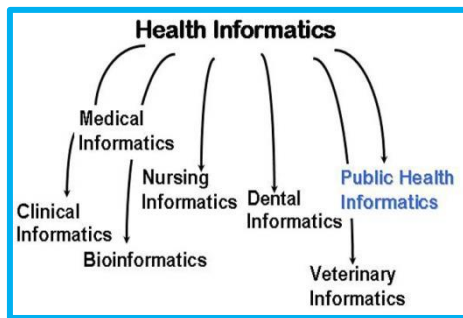


Fig. 1:

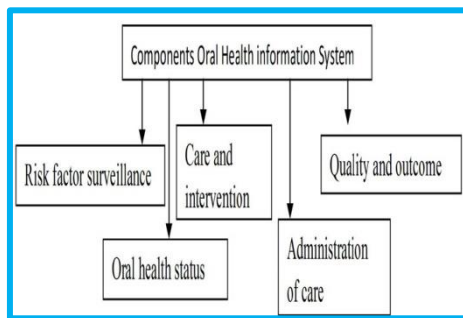


Fig. 3

but cogent, definition of dental informatics is “the application of computer and information science to improve dental practice, research, education and management,” which was derived from an earlier definition that was coined in 1992.^[5] A common misconception is that informatics is the same as information technology (IT).^[6] Informatics is focused primarily on research, development and evaluation of information models and computing applications. IT, on the other hand, is concerned with the implementation and application of computer technology and telecommunications. Despite the larger conceptual division, limited areas of overlap between informatics and IT exist, such as custom development of software and evaluation of implemented systems. Dental informatics combines dentistry and several research disciplines, such as computer science, information science, cognitive science, and telecommunication.^[7] The distinguishing features that make medical informatics different from dental informatics is the way, by which it performs examinations, methods of reimbursements and development of treatment data.^[8] Most of the design work that forms the development of computer-based medical records is not applicable to computer-based dental records. Dentists collect, display and analyze data differently than do their medical counterparts. While the general medical and medication histories collected by both physicians and dentists share many common elements, the dental history and the oral health status have no equivalent in medicine. As a

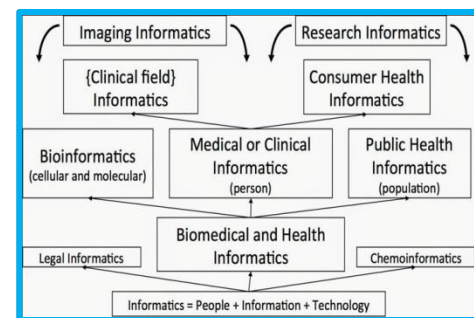


Fig. 2:

consequence, developing, implementing and evaluating complete computer-based dental records is both a challenge and an opportunity for dental informatics, as are many other domain-specific aspects.

A brief note on history and evolution of Dental Informatics

The word ‘computer’ is an old word that has changed its meaning several times in the last few centuries. Originating from the Latin, by the mid-17th century, it meant ‘someone who computes’. The American Heritage Dictionary (1980) also defines it similarly. The computer remained associated with human activity until about the middle of the 20th century when it became applied to “a programmable electronic device that can store, retrieve, and process data” as Webster’s Dictionary (1980) defines it. Dental informatics has developed significantly since the 1960s, when the first uses of informatics approaches to address dental issues were documented. In the 1960s, the National Library of Medicine (NLM) in the USA began to accumulate in a computer the bibliographic citations of the more than 3000 biomedical journals stored and indexed by the NLM. A search programme called ELH ILL was developed to retrieve these references. By 1971, these references were available in MEDLINE, the first interactive online medical bibliographic database. Since 1979, MEDLINE has included all references contained in the index to Dental Literature and is the most comprehensive bibliographic database of the published dental literature. Interest in dental informatics rose gradually, and the first conferences and workshops on the subject such as the Symposium on Second Generation Clinical Databases and the Electronic Dental Record (1990) took place.^[9,10] In the early 1990s, some professional organizations—such as the International Medical Informatics Association, the American Medical Informatics Association, and the American Dental Education Association—began to organize interest groups in dental informatics. A

key development was the initiation of funding for dental informatics training by the National Institute of Dental and Craniofacial Research (NIDCR) in 1996, which for the first time recognized the need for a formal education of dental informaticians. (The National Library of Medicine [NLM] had been funding similar training in medical informatics since 1972 [Braude, 1991]).^[12] The evolution of Dental Informatics in India has been a new-comer. The vast strides made by the country in the field of Information Technology have helped popularize the use of computers in Dentistry. Several dental software programs have been indigenously developed for clinical care, patient education, for practice management last but not the least for data analysis.^[11] The literature for the present review was obtained from the following sources: Published articles, Internet news clippings, Online manuals and books. The literature on dental informatics was identified by searching the biomedical databases for primary research material. The following search terms were employed to retrieve the relevant literature: Medical informatics, Dental informatics, Electronic oral health records, Software in clinical record maintenance, Software in public health systems, Telemedicine and Teledentistry, Oral health information system, Health management information system, Dental informatics in clinical practice, Dental informatics in public health practice. The literature with these search terms anywhere in the title or abstract was considered in the initial phase. The literature (Review articles) focusing on medical informatics, dental informatics, telemedicine, teledentistry, dental informatics in public health practice, HMIS (Health Management Information systems, OHIS (Oral Health Information systems) were considered for review in this paper. The literature on dental informatics from India and other developing countries was scanty.

Goals of Dental Informatics?

The main goal of dental informatics is to improve patient outcomes. Thus, the discipline must support and improve diagnosis, treatment and prevention of disease and traumatic injury; relieve pain; and preserve and improve oral health. And also to make the delivery of dental care more efficient; for example, by maintaining or improving cost-benefit ratios. Dental informatics also must support research and education, and improvements in these areas and often do, translate into improved patient care.

Informatics is key in helping practitioners solve clinical problems and keep current. Most educational programs still subscribe to the philosophy that everything dentists need to know can be learned in dental school. The trend toward problem-based learning and the development of critical-thinking skills tells a different story.^[16,17] Dentists must be as familiar with the problem solving process as they are with the problem domain itself. Computers can help practitioners maintain their continuing competency, and many dentists already are using computers to keep abreast of new developments.^[18,19]

Dental Standards

Dental standards are to help keep everyone on the same page and ensure the highest level of patient safety. There are a variety of architectures developed for electronic transference. Some readers are familiar with the DICOM (Digital Imaging and Communication in Medicine) standard used for transferring digital radiographs. In September 2009, the American Dental Association (ADA) signed an agreement with Health Level Seven International (HL7), a leading global authority on health-care information interoperability and standards, to develop consistent dental IT standards in order to enhance coordination between medical and dental offices.^[13] The ADA Standards Committee on Dental Informatics (SCDI) helps dentists streamline and empower their practices through the use of information technology.^[14] Jean Narcissi, ADA Director of Dental Informatics, presented a program on September 13, 2011, updating ADA's current work on the X12/5010 updates, WEDI, SCDI, SCDP, ISO TC 215, ISO TC 106, IHE, and IHTSDO.^[15] It has been the absence of standards for electronic health record (HER) that has created major obstacles in the past.

Dental informatics in public health practice

The technologies that are used to maintain public health practices can be categorized under the heading Public Health Informatics. Development of effective public health information systems requires understanding public health informatics (PHI), the systematic application of information and computer science and technology to public health practice, research, and learning.^[20,21] The main areas of application can be in: (a) biostatistics, (b) community health education, and (c) geospatial information system (GIS), including teledentistry. A brief note on various Software programs used in public health practices:

A) **Research and Biostatistics:** Public health practice invariably involves collection of data from an extensive population. This data needs to be collected on a periodic basis to assess the prevalence and incidence of various diseases in a population as well as to keep a track on the trends. The various software programs like SPSS (Statistical Package for the Social Sciences),^[22] SAS (Statistical Analysis System),^[23] Microsoft EXCEL^[24] and EPI-INFO,^[25] have made the analysis of such an extensive data simple and easy to compute.

B) **Community health education:** Use of informatics for dental care in India is still in its infancy. Almost all dentists use computers in their daily life but very few use them to improve dental health of the patient by educating them through patient educating software and creating awareness towards improving the oral hygiene. Many patient educating software can be used to help and enhance patient's knowledge towards dental health under clinical settings. Software programs such as GURU,^[26] PATIENT ORIENTED PROBLEM SOLVING,^[27] CASEY PATIENT EDUCATION SOFTWARE,^[28] ORASPHERE,^[29] have been proven to be effective in a clinical setting. The feasibility of utilizing these software programs for community health education as well as developing alternate programs applicable in a community setting need to be evolved. The health education GIS (Geospatial Information System) and Teledentistry software programs, which are simple, may be installed at the primary health center level and these may be used for creating awareness on health as well as oral health by the primary health workers.

C) **Geographic information system (GIS):** is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems. GIS is the merging of cartography, statistical analysis, and database technology. GIS uses map overlay techniques which view data pertaining to demographics, social infrastructure, health care institutions, and patient's geopositioned points-all in one view. Public health applications of GIS include infectious disease surveillance and control, especially vector-borne diseases; to meet the demands of outbreak

investigation and response (where prompt location of cases, rapid communication of information, and quick mapping of the epidemic's dynamics are vital); analyzing spatial and temporal trends; mapping populations at risk; stratifying risk factors; assessing resource allocation; planning and targeting interventions and monitoring diseases and interventions over time.^[21] Teledentistry is a synergistic combination of telecommunications technology, Internet and dental practice. It is a relatively new field and due to the extensive growth of technological capabilities, teledentistry possesses the potential to fundamentally change the current practice and the face of the dental care. 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, and health administration. It increases patient access to dental care, improves quality of care and the cost effectiveness. For a typical teledentistry visit, special video conference equipment and a video/internet connection is set up at both the hub site and remote site. Questionnaire, examination and any imaging or documents that are included in the dental record are transmitted to the hub via the online electronic patient record system. With the review of the information in hand, the specialist starts an online consultation with the patient through video conferencing. Telemedicine have been successfully implemented in many developed countries.^[30] Whereas Teledentistry still needs to form its roots in developed countries. The scope of teledentistry in India is enormous. But, poverty, illiteracy, and lack of infrastructure, are major challenges to the implementation of teledentistry in our country.^[31,32]

DISCUSSION

Governments of many developed countries, have already channelled information and communication technologies in the field of healthcare, including dental sectors. In India the need for a proper oral health information management system arises because of the glaring disparities in equality and access to oral healthcare between urban and rural regions; increasing burden of oral diseases; difficult terrain for the reach of health services especially in north and north-eastern states; alarming situations such as disasters, famine floods, earthquakes, epidemics of diseases, etc. In 1988, All India Institute of Medical Sciences (AIIMS) developed open source software called Health Management

Information System (HMIS). It is a process where information is recorded (input) stored, retrieved and processed for decision making (output).^[33] Till now no such software programs has been developed for oral health care sector in India. Petersen P.E et al has introduced an oral health information system model where Data on oral health status for monitoring disease patterns and trends over time represent an essential component of the system.^[34]

Risk factor surveillance: For effective oral health surveillance, WHO has suggested that regular oral health surveys should be conducted every 5-6 years in the same community or setting. Surveillance provides ongoing (i.e. continuous or periodic) collection, analysis and interpretation of population health data, and the timely dissemination of such data to user. The goal is to frame oral health indicators to prevent and measure the outcome of the disease. A stepwise approach for effective risk factor surveillance (e.g., data on Socio economic status, tobacco usage, sugar consumption etc.) has been suggested by WHO. The approach has been designed in such a way that it adapts to the local and international needs.

2. **Oral health status:** organized and periodic oral health surveys are an approach in determining the oral health status of a country or community. Data obtained from oral health surveys can be stored in database so that it is accessible worldwide and, measures can be taken to prevent dominant and highly prevalent diseases. In developing country like India changing life style and the increased consumption of sugars continues to have a negative impact on oral health and the amount of dental caries tends to increase particularly in young children. To reduce the burden of disease use of public health software programs on community level can be an initiative which will help in creating awareness and educating people about maintenance of oral health care.

3. **Care and intervention:** Once prevalence of a disease is established through database collected from various surveys, the type and amount of public health services provided through public health system has to be quantified, Information Technology (IT) can help at this stage by making use of electronic oral health records (EOHR) for maintaining data related to oral health.

4. **Administration of care:** The important objective is to support program managers in monitoring and supervision of the workers. An effective management is essential to scaling up the

quantity and quality of health services and improving population health. Similarly, in OHIS monitoring and assessing the health worker's performance in a more objective manner can be done. The recording and listing of activities in work plan makes supervision easier. A six monthly review of program performance using oral health indicators can be generated which will make the workers understand the need for the data collected and also to take timely action if needed.^[35]

5. **Quality and outcome:** measuring outcome from an oral health care program is an essential component as it decides the effectiveness of a program. Outcome can be measured through ORHQOL (oral health related quality of life). It takes into account both social and psychological impact of oral disease on an individual. It includes the following domains:-

- survival of the individual (i.e. absence of oral cancer),
- absence of impairment, disease or symptoms,
- appropriate physical functioning associated with chewing and swallowing,
- absence of pain or discomfort,
- emotional functioning associated with smiling,
- social functioning associated with performance of normal roles,
- perceptions of excellent oral health; satisfaction with oral health; and
- no social or cultural disadvantage due to oral health status.^[34]

Oral health information system is important in the evaluation of public health initiatives and program and for the assessment of achievements of goals for health. Over the past two decades, there have been significant achievements in oral health in India, but, it still remains a challenge to achieve the establishment of a database for monitoring and surveillance. The software used in clinical dentistry will improve the oral health related quality of life.

CONCLUSION

The purpose of informatics is to solve practical problems for researchers, practitioners and educators. Before informatics can be helpful, however, its "customers" must understand exactly what informatics is and what it is not. Unfortunately, the confusion about the nature, differences and commonalities of informatics and IT has resulted in many misconceptions and false starts. To be truly useful, informatics must be understood as what it is: a research discipline aimed at uncovering generalizable principles. With a better

understanding of its goals and methods, individuals in applied areas will be able to identify more easily how informatics could potentially help them in their own work. Conversely, informaticians must learn as much as possible about the research issues and problems in the applied areas, so they can target their work at the resolution of real, fundamental problems. Dentistry, however, should learn from the failures as much as it does from the successes. Only then will we realize the promise of informatics.

REFERENCES

1. Merriam Webster (internet). An encyclopediabrittanica company (cited 2013 March 20) available from: <http://www.merriamwebster.com/dictionary/information+technology?show=0&t=1370172581>
2. Merriam Webster (internet). An encyclopedia brittanica company (cited 2013 March 20) available from: <http://www.merriamwebster.com/medical/informatics>.
3. Herland M, hoshgoftaar TMK, Wald R. A review of data mining using big data in health informatics. *Journal of Big Data* 2014;1:2.
4. Chen J, Qian F, Yan W, Shen B. Translational biomedical informatics in the cloud: present and future. *Bio Med Res Int* 2013;8. [<http://dx.doi.org/10.1155/2013/658925>]
5. Eisner J. The future of dental informatics. *Eur J Dent Educ* 1999;3(1):61-9.
6. Silverstein S. What is medical informatics, and why is it an important specialty? Available at: "members.aol.com/informaticsmdsmd". Accessed Dec. 5, 2000.
7. Schleyer TKL. Dental Informatics: An Emerging Biomedical Informatics Discipline *J Dent Edu* 2003;67(11):1193-1200.
8. Button PS, Doyle K, Kartis JM, Selhorst C. Automating clinical documentation in dentistry: case study of a clinical integration model. *J Healthc Info Manag* 1999;13(3):31-40.
9. Erstad TL. Analyzing Computer based Patient Records: A Review of Literature. *J Healthc Info Manag* 2012;17(4):51-7.
10. Heid DW, Chasteen J, Forrey AW. The electronic oral health record. *J Contemp Dent Pract* 2002;3(1):43-54.
11. Emmot L. Choosing Practice Management software. *Dental Products Report* 2003:66-8.
12. Schleyer TK. Dental Informatics: A Work in Progress. *Adv Dent Res* 2003;17:9-15.
13. Health Level Seven and the American Dental Association Sign Agreement to Develop Joint Healthcare IT Standard Initiatives. September 2, 2009. Available at: http://www.hl7.org/documentcenter/public/pressreleases/HL7_PRESS_20090902.pdf Accessed 7/25/12.
14. Standards. American Dental Association. <http://www.ada.org/275.aspx> Accessed 7/25/12.
15. Narcisi J. Update from ADA. American Dental Association. September 13, 2011. http://www.nadp.org/Libraries/CONVERGE/SNODENT-Dental_Diagnostic_Coding_Narcisi_9_13_11.sflb.aspx Accessed 5/1/12.
16. Barrows HS. The essentials of problem-based learning. *J Dent Educ* 1998;62(9):630-3.
17. Fincham AG, Baehner R, Chai Y. Problem-based learning at the University of Southern California School of Dentistry. *J Dent Educ* 1997;61(5):417-25.
18. Kalkwarf KL. How the licensure process will evolve. *JADA* 1999;130:1737-42.
19. Schleyer T, Forrest J, Kenney R, Dodell D, Dovgy N. Is the Internet useful for clinical practice? *JADA* 1999;130:1501-11.
20. 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.
21. Athavale AV, Zodpey SP. Public Health Informatics in India: The potential and the challenges. *Indian J Public Health* 2010;54(3):131-6.
22. IBM, SPSS statistics 20 brief guide 2010, (cited on 22nd March 2013) available from : ftp://public.dhe.ibm.com/software/analytics/spss/documentation/statistics/20.0/en/client/Manuals/IBM_SPSS_Statistics_Brief_Guide.pdf
23. Sector P. An Introduction to the SAS System (internet),(cited on 15th April 2013), available from: www.stat.berkeley.edu/classes/s100/sas.pdf
24. MS- EXCEL (internet) , cited 15th April 2013, available from: <http://www.hrdiap.gov.in/Downloads/04.MS%20Excel.pdf>

25. 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
26. Acharya A, Wali T, Rauch J, GURU. Patient Education Software. *J Dent Edu* 2009;73(1):137-9.
27. Chiodo G, Tolle SW, Bartley M .Antibiotic prophylaxis for dental treatment. Review and update III. *Dent J* 1990;59(7):599-60.
28. 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
29. ORASPHERE Dental Patient Education Solution (internet) cited 21st March 2013. available from : <http://www.orasphere.com/products/product.php?p=dvd>
30. Rao B, Lombardi A 2nd. Telemedicine: current status in developed and developing countries. *J Drugs Dermatol*. 2009;8(4):371-5.
31. Chhabra N, Chhabra A, Jain RL, Kaur H, Bansal S. Role of Teledentistry in Dental Education: Need of the Era. *J Clin Diagn Res* 2011;5(7):1486-8.
32. Chen JW, Hobdell MH, Dunn K, Johnson KA, Zhang J. Teledentistry and its use in dental education. *J Am Dent Assoc* 2003;134(3):342-6.
33. Krishnan A, Nongkynrih B, Yadav K, Singh S, Gupta V. Evaluation of computerized health management information system for primary health care in rural India. *BMC Health Services Research* 2010;10:310:1-13.
34. Petersen PE, Bourgeois D, Bratthall. D, Ogawa. H. Oral health information systems - towards measuring progress in oral health promotion and disease prevention. *Bull World Health Organ* 2005;83(9):686-93.
35. Bourgeois DM, Llodra JC. European Global Oral Health Indicators Development Project 2003 Report Proceedings. France: Quint Int; 2004.