

Dental Informatics - A Paradigm Shift in Dentistry

Dr Teenu Vijayan, Dr Swetalin Das

Abstract: *Computer education of medical students is progressively being introduced in medical schools in many countries, and several national organizations have recommended its integration in the medical curriculum. The justification for this measure resides in the belief that more information about computers may help the successful implementation of medical applications of computers, that the uses of computers in medicine are becoming more frequent and doctors must be prepared to use them, and also that the use of computer-assisted instruction (CAI) is becoming widely available and students must be familiar with computers in order to use that material available on daily basis. The aim of dental informatics is the application of computer and information science to improve dental practice, research, education, and management. The way it has eased up the working conditions is truly remarkable and hence need to be explored more.*

1. Introduction

It is the application of computer and information science to improve dental practice, research, education and management of oral health care. This comes as a sub-discipline of biomedical informatics.¹

Dental Informatics is a specialization within Health Informatics which in itself is a multi-disciplinary field that seeks to improve health care through the application of Health Information Technology (HIT) and information science to health care delivery, health information management, health care administration, research, information gathering and synthesis, and knowledge sharing.²

It is the understanding, skills and tools that enable the sharing and use of information to promote oral health and improve dental practice, research, education and management.³ It encompasses electronic health records, CAD/CAM technology, diagnostic digital imaging and administrative information for all dentistry disciplines.⁴

As such, it draws on a wide range of disciplines, including cognitive science, psychology, decision science, human factors engineering, and mathematics (Schleyer et al., 2003).⁵

Friedman defines four categories of informatics research (Friedman, 1995)⁶:

- 1) Model formulation—develop the models, taxonomies, and ontologies, which can be used as building blocks for problem solving;
- 2) System development—design usable systems that will integrate into the workflow and needs of clinicians as well patients;
- 3) System installation—successfully implement, adopt, and sustain systems by considering the psychology and cultural characteristics of the people and organizations affected by the system; and
- 4) Study of effects—consider the outcomes of the systems on the health of individuals, groups, and populations.⁷

The field of Dental Informatics is concerned with the intersection of Health Informatics and Dentistry as a whole.³ This is a growing area of interest within the profession, both in academic circles and among practicing dentists; more and more dental schools and dental practices are implementing Electronic Health Records (EHR) systems and

Health Information Exchanges (HIEs) are beginning a transformation in health care communications.⁵

The demands of federal and state programs to promote EHR adoption among certain health care providers are also beginning to affect dentists across the country.⁵ As a result of these changes, dentistry is engaging information technology to meet its clinical, administrative, research, and educational needs more than ever.¹

Dental informatics aims at dealing dental problems using scientific communication by four layered structure namely, model formation, system development, system installation and evaluation and modification.⁷

While many new technologies have become available for clinical dental practice, research, and education, many fundamental problems remain to be addressed with informatics research.¹ Recommendations to augment the research capacity in dental informatics include creating a stronger worldwide dental informatics research community, drawing more biomedical informatics researchers to dental research areas, providing career opportunities for dental informatics researchers, addressing grand challenges together as a community, and recruiting subsequent generations of dental informaticians.⁸

Advancement in the dental informatics is the emergence of electronic patients records (EPR). They avoid the usage of age old paper records and EPR are used in policy makers and for other fund regarding issues.² They are even used to produce standard reports of the patient. Future of dental informatics is based on the three consecutive developments namely computing clinical applications, creation of standard computer coded terms and new computational dentistry.⁵

While many new technologies have become available for clinical dental practice, research, and education, many fundamental problems remain to be addressed with informatics research.⁷ Recommendations to augment the research capacity in dental informatics include creating a stronger worldwide dental informatics research community, drawing more biomedical informatics researchers to dental research areas, providing career opportunities for dental informatics researchers, addressing grand challenges together as a community, and recruiting subsequent generations of dental informaticians.²

Practical goal of this regime is:

- The main goal of dental informatics is to improve patient outcomes
- Secondary goal is to make the delivery of dental care more efficient
- Informatics is key in helping practitioners solve clinical problems
- Help practitioners maintain their continuing competency.
- Longitudinal, lifetime, comprehensive & patient-centered dental records
- Universally accessible patient records that ensure privacy & confidentiality
- Significant reduction of practice management & administrative overhead⁶

Clinical care based on empirically determined best practices to develop a knowledge based ontology of dental practices, an evidence base of etiology, diagnosis, prevention, treatment, & treatment outcomes, develop a nationwide oral health database and develop learner centered educational systems.⁹

- Political and Social Obstacles
- Universal patient identifier
- Collections of large databases of patient information³

Dentistry is undergoing very significant changes which will influence its systems of education and delivery of care for many years to come. Due to the changing dental disease patterns and changing demographic characteristics of the patient clientele, dental care is becoming more complex.² An important result is the need for dentists to manage a much larger body of knowledge with more frequency than in the past. This body of knowledge of necessity includes a huge base of factual information, the daily utilization of which can assist dental practitioners in meeting new challenges in patient management.⁴ It is important to recognize that the dental community is experiencing a need to improve the organization, storage, retrieval, and utilization of ever growing amounts of factual data. This can only be done effectively by the application of computer and information science and technologies.⁶

It did not receive its name until 1974, and it was not until the 1980s that the term 'dental informatics' began to be used by some health practitioners. Computer applications have been utilized by various groups of dental professionals in dental education and in the provision of dental care.⁷ The future will see a rapid increase in use of computers for patient education and for the continuing education of the dentist. Clinical decision support is one area where computer systems have excellent potential.²

It can provide the dentist with a large base of factual information concerning diagnosis and treatment for instant electronic retrieval and thus assist in delivering a higher quality of care.³ Another area where computers will have a big impact is the computer-aided design and computer-aided manufacturing system (CAD/CAM) for restoring teeth and as these systems become less expensive and more refined, they are likely to have a major impact on the clinical practice of dentistry.⁹

The use of computers in private dental practice has increased greatly during the past decade. A survey of computer use in private dental practice showed a four-fold increase in practice computerization from 9 per cent in 1983 to 37 per cent in 1991.⁵ The increasing acceptance of personal computers, their decreasing cost and increased availability of dental packages are certainly contributing factors for the increase. The American Dental Association developed and marketed a computerized dental office management system in 1985 through a wholly owned subsidiary.²

Attempts have also been made by the American Dental Association to start a nationwide electronic communication network for dentists. Individuals in the dental profession and private industry have developed various specialized systems and have started to address data format and communication standards.¹⁰

In 1989 the Executive Committee of the American Association of Dental Schools asked that a special committee be formed to address the topic of dental informatics on behalf of the entire dental profession.⁹

A working group comprised of dentists and advocates for informatics was formed and the first conference was held in August 1989. As an outcome of the conference five goals were identified and these goals could be adopted to outline a plan for the future of dental informatics.⁸

Proposed goals are as follows:

Goal 1. Define the parameters of dental informatics across all levels of dental organization and activities. Develop a consortium for dental informatics which would be composed of representatives from professional organizations, educational institutions, government, and industry which would:

- 1) Develop co-operative policies for the field of dental informatics.
- 2) Identify the resources and expertise needed to pursue its goals.
- 3) Identify and seek external funds.
- 4) Identify centres of excellence which will play a leading role in developing appropriate standards, products, and services related to dental informatics. Identify the most appropriate media for reporting dental informatics activities.⁵

Goal 2. Develop strategies that will foster optimal use of dental informatics resources. Generate a catalogue of informatics resources and interests.⁶ Establish a nationwide electronic communication network for the distribution of dental informatics news as well as conferences to foster collaboration and compatibility of information systems.⁹

Goal 3. Identify specific areas of research and development in dental informatics where the various segments of the dental profession could concentrate their efforts and dental informatics technologies as applied to the practice of dentistry and work towards the development of standards for information systems.³ The designated centres of excellence should prepare and distribute a set of guidelines for dental informatics research proposals. To develop continuing

education programmes which would train current practitioners in applying dental informatics in the practice setting. Representatives from the five dental schools should form a working group to develop and distribute dental informatics educational guidelines to be used in Faculty development and dental education programmes at all levels.⁹

Goal 4. Identify areas for co-operative ventures and projects between professional organizations, educational institutions, government, and industry Identify individuals and groups to establish standards in patient records, database design, and data communication.¹ Establish a work force comprised of representatives from dental education, dental practice, dental manufacturers, government dental services, informatics experts, and dental insurers to address standards in the dental record and related database design considerations for practice informatics systems. Establish informatics training opportunities by joint collaboration between educational institutions and other interested agencies.⁷

Goal 5. Lay the foundation for a co-operative strategic plan for dental informatics for the entire dental profession, so that individual components of dentistry can co-ordinate and accommodate their informatics planning and activities with the overall plan for dentistry.¹ The strategic plan for the dental profession should contain a short-term action plan for the immediate 5 years, a mid-range plan for years 5 to 10, and a long-range plan for years 10 to 20.¹⁰

International initiatives Clearly, dental informatics as an emerging field of endeavour involves a number of multinational-based initiatives and thus already has national and international dimensions. Efforts have been made to organize dental informatics at the international level.²

An International Conference on Medical Informatics, MEDINFO 90, sponsored by the International Association of Medical Informatics (IMIA) was held in Singapore in December 1989.⁶

The objectives proposed for consideration by a Working Group on Dental Informatics that was established were as follows:

- 1) Identify and define the elements which constitute the field of dental informatics and how they can impact on dental practice, education, and research.
- 2) Identify individuals who are leaders in research, development, and application of dental informatics in all sectors of the dental profession.
- 3) Promote the utilization of information technologies in all sectors of the dental profession.⁴
- 4) Identify areas in dental informatics where joint ventures can develop between individuals, other health professionals, organizations, institutions, and nations to expand the field.
- 5) identify specific areas of research and development to expand the knowledge base of dental informatics.
- 6) Promote training programmes to increase the number of dental informaticians.
- 7) Plan and sponsor meetings, conferences, and symposia to focus on research development and applications of dental informatics.⁸

- 8) Maintain liaison with appropriate national organizations with an interest in health informatics generally and dental informatics specifically.

The use of information technology (IT) in dentistry is far ranging. In order to produce a working document for the dental educator, this paper focuses on those methods where IT can assist in the education and competence development of dental students and dentists (e.g. e-learning, distance learning, simulations and computer-based assessment). Web pages and other information-gathering devices have become an essential part of our daily life, as they provide extensive information on all aspects of our society. This is mirrored in dental education where there are many different tools available, as listed in this report.³

IT offers added value to traditional teaching methods and examples are provided. In spite of the continuing debate on the learning effectiveness of e-learning applications, students request such approaches as an adjunct to the traditional delivery of learning materials. Faculty require support to enable them to effectively use the technology to the benefit of their students.⁶ This support should be provided by the institution and it is suggested that, where possible, institutions should appoint an e-learning champion with good interpersonal skills to support and encourage faculty change. From a global perspective, all students and faculty should have access to e-learning tools.² This report encourages open access to e-learning material, platforms and programs. The quality of such learning materials must have well defined learning objectives and involve peer review to ensure content validity, accuracy, currency, the use of evidence-based data and the use of best practices. To ensure that the developers' intellectual rights are protected, the original content needs to be secure from unauthorized changes.⁷

Strategies and recommendations on how to improve the quality of e-learning are outlined. In the area of assessment, traditional examination schemes can be enriched by IT, whilst the Internet can provide many innovative approaches. Future trends in IT will evolve around improved uptake and access facilitated by the technology (hardware and software).³ The use of Web 2.0 shows considerable promise and this may have implications on a global level.

In essence, simple technology can overcome many of the barriers to learning. IT will always remain exciting, as it is always changing and the users, whether dental students, educators or patients are like chameleons adapting to the ever-changing landscape.⁹

The development and application of dental informatics in support of patient care, teaching, research and dental care administration should be promoted. There is an overriding need to ensure development of standards for dental informatics.⁷

Telemedicine in Dentistry (Teledentistry)

Internet is the basis of modern systems of teledentistry, being up-to-date and fast, and able to transport large amounts of data.⁵ Almost all new systems of teledentistry are Internet based (fixed and mobile), as well as all kinds of

distant consultation (Real Time, Store and Forward, but Late as well). As the result of all the qualitative and quantitative characteristics of Internet, all other Internet-independent forms of telecommunication are thought to be of secondary importance.⁶

It is clear that Internet offers the highest speeds in sending documents or accessing desired information. If international teledentistry is concerned, Internet is the oasis of speed with minimal associated costs, being indispensable in peer-to-peer and dentist-patient communication.¹¹⁶ Cheap and rapid transfer of digital documents, images, radiographs, laboratory assays is unrivalled both nationally and locally. Using on-line communication, dental patients can be instantly advised or referred to other available Internet resources.⁸

References

- [1] Assari S, Ahmadyar M. Dental research in Iran: a bibliometric analysis of electronically available literature. *International dental journal*. 2009 Aug 1;59(4):210-4.
- [2] Hou AY, Barnard PD. Dental informatics for Australia. *Australian dental journal*. 1994 Oct 1;39(5):321-3.
- [3] Brumini G, Špalj S, Mavrinac M, Biočina-Lukenda D, Strujić M, Brumini M. Attitudes towards e-learning amongst dental students at the universities in Croatia. *European Journal of Dental Education*. 2014 Feb 1;18(1):15-23.
- [4] Daniel SJ, Kumar S. Comparison of dental hygienists and dentists: clinical and teledentistry identification of dental caries in children. *International journal of dental hygiene*. 2017 Nov 1;15(4).
- [5] Funkhouser E, Agee BS, Gordan VV, Rindal DB, Fellows JL, Qvist V, McClelland J, Gilbert GH. Use of online sources of information by dental practitioners: findings from The Dental Practice-Based Research Network. *Journal of public health dentistry*. 2014 Jan 1;74(1):71-9.
- [6] Almeida Geraldino R, Rezende L, Melo LV, da-Silva CQ, Almeida JC. Remote diagnosis of traumatic dental injuries using digital photographs captured via a mobile phone. *Dental Traumatology*. 2017 Oct 1.
- [7] Grigg PA, Stephens CD. A survey of the IT skills and attitudes of final year dental students at Bristol University in 1996 and 1997. *European Journal of Dental Education*. 1999 May 1;3(2):64-73.
- [8] Miller PR, Grigg PA, Vowles RV, Stephens CD. Clinical informatics and the dental curriculum. *European Journal of Dental Education*. 2000 Nov 1;1(4):153-61.
- [9] Schleyer T, Spallek H. Dental informatics: a cornerstone of dental practice. *The Journal of the American Dental Association*. 2001 May 1;132(5):605-13.
- [10] Schleyer TK. Dental informatics: A work in progress. *Advances in dental research*. 2003 Dec;17(1):9-15.
- [11] Kirshner M. The role of information technology and informatics research in the dentist-patient relationship. *Advances in dental research*. 2003 Dec;17(1):77-81.