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Bite to Bytes...Transition towards Electronic Dental Records- A Review

Dr. Santanu Sen Roy [α], Dr. Ritika Bhambhani [σ] & Dr. Ipsita Maity [ρ]

Abstract- Patient health records (both dental and medical), if accurately maintained not just help in better clinical decisions for the welfare of the patient but also have legal and other security benefits for the doctor. As digitization has paved its way in every stream, the same has occurred to maintaining of patient records, which when electronically controlled are termed as the Electronic patient records (EPR) or Electronic dental records (EDR) or Electronic medical records (EMR) pertaining to the dental details or the medical respectively. They would provide the advantages of well maintained paper records with benefits of cross-referencing the data by consulting specialists and help to integrate the medical and dental fraternity.

The use of EDR is more widespread internationally in US and European countries compared to the developing ones. Many challenges do exist for a complete transition, including financial restraints, skill development, confidentiality of records and their standardization. In developing countries demographics makes it more difficult to apply the EDR but efforts are ongoing. This narrative review discusses the various systems of EDR, their benefits and functioning, and also the hindrances in path of their acceptance.

Keywords: electronic dental records, electronic patient records, electronic health records, digitized records, paperless office/clinic, teledentistry, HIPAA, DISHA, NeHA.

I. Introduction

It's a known fact that our lives are getting dependent on technology and digitization, and perhaps why not, there are endless advantages to it. Even the present day dental practice is closely linked to the utilization of computer-based technology. The Digitization has paved its way towards the diagnostic and treatment procedures in health sciences. Digitization refers to "capturing an analog signal in a digital form or representing any object by a discrete set of points, could be an image, sound or a document" [1]. In today's technology based life, smart phones have brought almost everything at the user's fingertips; where it is possible to access and achieve almost anything even when on a move. How could the medical and dental fraternity hence stay unaffected for long? With the use of digital techniques in almost all spheres, it had to seek application in maintaining medical/dental records.

Dental or medical records have always been a challenge to maintain. Updating them, reproducing the older records and sharing them has been difficult. As the name suggests the electronic records are patients' details managed electronically without physically handling the paper files. They have also been termed as computer based records [2]. The paper files would result in a bulk of endless files in a dental set up. On the contrary digitization of the same would offer multiple advantages like ease of storing and referring back, portability of patient's information, interoperability, integration within fraternity, patient participation and of course paperless offices. This is hence a patient friendly, operator friendly and environment favoring methodology and in turn promotes better practice management [2,3]. But no change comes easy; this transition has obvious disadvantages of greater costs involved and its use also is largely affected by demographics. Widespread use of electronic record softwares has become inevitable in United States of America and many European countries, considering the benefits. Multiple steps have been taken by their respective governments for the needed implementation. [4, 5]. But at the same time greater challenges are to be faced especially in developing countries like ours.

The review aims to include the benefits of EHR, its applications, limitations, needed standards and the hindrances to achieve the same.

II. The History and Development of Present Systems of EHR

Dr. Lawrence L. Weed was one of the pioneers to mention about an automated system to reorganize patient medical records. With the initial efforts of physicians and the IT experts, the PROMIS project was used in 1967 at the University of Vermont. The project aimed towards a timely and sequential access to patient data, enabling rapid collection of data for epidemiological studies, medical audits and business audits. Based on the above a Problem-Oriented Medical Record or POMR was formed in 1970 and was first used in a medical ward of the Medical Center Hospital of Vermont. Touch screen technology had also been incorporated into data entry procedures; other options like detailed drug information were added to the core

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program, for permitting a check on drug actions and interactions, dosages, side effects and allergies. During the 1970s and 1980s, various academic and research institutions refined electronic medical record systems. These include- a hospital-based 'Technicon system', 'Harvard's Costar system' for ambulatory care, 'The HELP system' and Duke's 'The Medical Record' are some examples of early inpatient care systems; 'Indiana's Regenstrief record' was among the earliest combined inpatient and outpatient systems [6, 7]. The technical boom of the 1990sincluding the advancements in computer and diagnostic applications further helped to spur the growth of electronic medical record systems in medical practices [4].

The application of EHR in medical practice is at a greater pick up than dentistry. The American dental Association (ADA) recognizes 'Dental Informatics' as a separate specialization within Health Informatics; which is a multi-disciplinary field that seeks to improve health care through the application of health information technology (HIT). The use would finally have an impact on health information management, health care administration, research, information gathering and synthesis, and knowledge sharing [8,9]. The use of this technology interests both the academicians and even practitioners. The students need to be exposed to the new technologies so as to keep them abreast with the growing demands of practice; also the research and many longitudinal studies come handier with such digital records. The birth of 'Teledentistry' is also closely related to the advent of digitization in dentistry.

The National Institute of Health and Medicine, USA in 1991 mentioned the greater need of adapting to EDR. The national health library too has been a major participant in this development. In 2009 the US Congress and Obama administration offered benefits to the health care community for promoting use of EHR. The HITECH i.e. Health Information Technology for Economic and Clinical Health Act, authorized incentive payments through Medicare and Medicaid to clinicians and hospitals who started to use electronic records [8,4]. The above mentioned Act was promoted as an element of the *American Recovery and Reinvestment Act (ARRA) 2009.*

The British government aimed for modernization of National Health Services under a program termed the 'BIG BANG approach' and has been one of the largest IT procurement plan. In Canada a similar agenda as 'INFOWAY' was started in 2001 and in Australia as 'HEALTH CONNECT' was begun [2,10]. INFOWAY is a not for profit organization funded by federal governments, working mainly to accelerate the development, adoption and effective use of digital health across Canada.

The ministry of Health and Family welfare (MoH & FW), India also notified the EHR standards for India in 2013, which were later revised in 2016[11].

a) Existing Systems

The development of EHR includes the collaboration of IT individuals, health care professionals and government officials. EHR is "electronic record of health related information of an individual that conforms to nationally recognized interoperability standards and can be created, managed and consulted by the authorized clinicians and staff across more than one health organization". The basic purpose of such softwares has been to capture, store, present, import and export needed patient records. The software should allow a better organization, easier retrieval in sequential way, chronological details of treatment performed and quick sharing of the same. If kept updated and shared amongst the various specialties they can present the whole longitudinal history of the patient to the service provider [12, 13].

EHR would include a range of data, that is- *personal data:* patient identification information, personal statistics like age and weight, vital signs, *comprehensive medical history*, diagnostic aids like laboratory test results, radiology images, clinical photographs, referral letters and consultants' reports; *drug records* including drug allergies, active medication, immunization status; *business records* like billing information, documentation of informed consent etc. This large amount of information is essential to be maintained, and digitizing the records provides an easy alternative of storing the above. The written records would always face issues like clarity of writing, fading away of ink, place to keep records [2, 3, 4, 8].

The way digital images have paved their way in daily practice even the digitized records would do the same; As by Dr. Lavine "a day would come when the paper records would become archaic" [14]. Peer pressure and patient demands, competition and aim of having a better approach to organizing records would lead more practitioners to accept EHR. Shifting rightly on time and being equipped to ride this wave would be a boon rather than being engulfed by same [15].

Dental informatics includes collaboration of the IT and medical-dental sector and has resulted in various practice management softwares paving their way out. Some are listed: ADSTRA dental software suite (by ADSTRA systems), Aerona Dental care (by Aerona software systems), Dentrix (By Henry Schein), Diamond dental software (by Diamond dental), Easy Dental (by Easy dental), e patient (by dental symphony), Galaxy dental systems (by galaxy systems), iSmile dental software (by iSmilesoftwares), Prime dental (by Prime dental software), Practice web dental (by practice web),Saral dental soft (by Saral computers),Total Dental (by total dental) and many more[16]. These softwares permit clinical charting, appointment management, imaging, document management, billing, payment history, treatment planning, reminders etc. As the files are saved as one unit it is easy updating them and no

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duplicates or multiples are created. It reduces the chances of data replication as there is only one modifiable file. Opening a document is easier and not time consuming when compared to relocating the paper records. The patient name or an id can be used to open and refer to the details hence the patient can just walk in without any records- rightly termed the paperless offices. The following benefits too could be considered-- patients may register online, the doctor would be able to check appointment schedule from anywhere, electronic prescribing may be done, the treatment and medical history can be retrieved easily and seen at one screen when patient walks in, including old treatment records too; managing payments and applying for insurance claims gets easier, business gets more integrated, digital images are preserved as attachments, not the least the back-up of all details is maintained. An updated clinical charting with all health details of a patient as one file, would also allow more evidence based recommendations. The software companies need to be in compliance with the regulatory policies and set standards [13-19].

Maintaining records is an ethical and legal responsibility. It would also aid in forensics and mass disasters [20-21].

Thes~~e~~ storage softwares are broadly of three types- *Cloud based EDR* like Dovetail office, Liptak DDS rescue, Patterson Eaglesoft Clinicianor *Client server based records* or even the *hybrid types* using features of both. EDR which are cloud based, store all information in space and is termed a cloud; these systems also claim disaster protection. The server based EDR store the records in the client office itself and in the hybrid type maintain the backup over a rented server [2,15]. What would be important is to provide training sessions to office staff and the operators during installations with intermittent free webinars for better understanding of the system. The EDR are apt for today's clientele where the patients would want to do some basic consultations or appointment scheduling even on a move, could be over a phone or a laptop or tablet or even a desktop.

Teledentistry is an exciting new area of dentistry putting together the electronic health records with telecommunications technology and digital imaging; also termed the marriage of computers and telecommunications [22- 25]. Here the Internet service providers play the key role in linking health providers in different places, could be rural or remote communities. This would aid in providing quality care for patient located in underserved areas by sharing EDR over internet and providing videoconferencing with the best of dentists; termed the teleconsultation. A specialist located many miles away would make a diagnosis and recommend treatment options if EDR is shared well. It is also considered to be a boon for education [24]. The initiation of the telehealth system began in 1990's and was given a new definition by Cook in 1997 for its role in videoconferencing and opening a new course of dental treatment. Its implementation would improve the primary health care services and could permit communication with a peer dentist. All details could be viewed on one screen making it easy to share and discuss. The Teledentistry has been divided as two types- 1) Two way interactive or real time consultation and 2) Stored and forward Teledentistry. It is bound to have revolutionary changes on practice management, professionalism, patient care and management, referrals and competition.

Telehomecare by various virtual services being provided to patients to self support and prepare themselves for certain situations at home especially patients with chronic problems needing palliative care [10].

Storing indefinitely and legal benefits: The guidelines for preservation time of paper records vary amongst different countries. For example: The Department of Health for National Health Service (NHS) organization in England states community dental records to be maintained for a period of 11 years for adults, and 11 years for children from the date they turn 18. RCS (Royal College of Surgeons) present with similar guidelines of 10 years for adults and 10 years for children once they turn 18. The guidelines adopted by the Provincial Dental Board of Nova Scotia, consider this time period as 2 years following treatment completion. In Texas dental records need to be stored for 5 years. They have a well laid set of guidelines mentioning different retention periods for different records and describing other necessary rules for disposition like shredding of paper records and deletion of EDR. In India, the MCI (Medical Council of India) regulations 2002, every physician shall maintain medical records pertaining to his/her indoor patients in a standard proforma for 3 years from commencement of treatment. IDA (Indian Dental Association) recommends maintenance of records up to a minimum of 5 years considering both consumer needs and the judiciary. The electronic records hence provide a practical approach to indefinite storage of records without really affecting storing space issues [26-28]. Multiple acts like the CPA (Consumer protection act) passed by the Indian Parliament in the year 1986 and some other legal avenues exist to safeguard and protect the interest of consumers. The preservation of record would come in interest of the doctors in such situations.

In patients with systemic diseases like diabetes miletus, immune compromised states where patient is under the treatment of multiple specialties, sharing the salient information becomes essential to avoid complications, drug interactions and to provide better care. This requires a change in the method of practice towards a more integrated form amongst various specialties and to move towards evidence based approach. Interdisciplinary treatment in dentistry

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involves mainly departments like Prosthodontics, Periodontics and Restorative dentistry and the sharing of patients' details is important for full mouth rehabilitations. [29, 30].

A study conducted at The Brigham Hospital and The Women Hospital at Massachusetts both using electronic records, helped conclude that by maintaining electronic records of patients the repetitions of many diagnostic tests was avoided, many individuals had undergone recent tests or investigations which could be used in further consultations. But to utilize the records in the manner as in the conducted study, a wise access to the records and exchange of salient information is essential amongst various specialties and the files need to be updated. [31-33]

Every individual's healthcare events can be recorded in longitudinally arranged manner. It hence demands collection of various records which can get generated during any clinical encounter and with strict implementation of every visit and revision.Problems like gap reporting, missing links in shared responsibility, problem with billing codes have been the practical hunches.

Other benefits of EDR particularly pertaining to dentistry would be the ease in maintaining records of full mouth rehabilitation cases and patients with mutilated dentitions needing complex and multidisciplinary treatment plans. Even interactions with laboratory would profit if certain needed images (dentition shape/size/ interrelationships/colouretc) could be shared for better end results [34]. The communication between dentist and the technician plays a very significant role in dental procedures and digital communication and make interactions quicker and accurate.

III. Standardisation

Standardization of these systems is very important to achieve integration of the records and safety. These should also allow privacy and active participation of patient for complete benefits of the system. If the software promotes alerts or reminders it would help in better involvement of patients. Internationally the HITECH Act and HIPAA govern the software policies. The ADA aims to standardize the EDR's which would be regulated by set rules as under specification no. 1001. Standards to be followed include areas like identification and demographics, patient identifiers, architecture requirements (ISO18308:2011 Health informatics), functional requirement (ISO HL710781: 2015 Health Informatics), reference model and composition (ISO 13940 Health informatics – system of concepts to support continuity of care), terminology (SNOMED CT), coding system (Logical observation identifiers names and codes – LOINC, WHO-FIC), scanned or captured records, imaging (DICOM- digital imaging and communications in medicine), data exchange, discharge summary, e prescription, data privacy (ISO /TS 14441:2013 health informatics.), integrity and encryption.

To maintain the needed standardization a continuous evolution and timely maintenance is a must. IHTSDO releases SNOMED CT twice annually and NHS mentions use of same for dental, nursing and drug related information. The standards have been set for the diseases/health conditions to be mentioned in softwares as abiding by WHO-FIC (The WHO family of international classification). Similarly e-prescription has to follow the pharmacy practice regulations 2015, (PCI).

Regulatory policies like Health Insurance Portability and Accountability Act (HIPAA) -1996, SNODENT®, dental subset of SNOMED CT etc. have been laid mainly to standardize and integrate various softwares. The later has been initiated by *The International Health Terminology Standards Development Organization (IHTSDO) and its Dentistry Specialty Interest Group (SIG)* to manage health information exchange safety. To a greater credit, the Open EHR is a non-profit organization which aims to develop interoperability and computability in e-health and focuses on EHRs. It provides reference model specifications and consists of a library of data points or groups; called the Archetypes – ISO 13606-2. [11, 35-41]

The Security Concerns of using these softwares are significant. The records are a possession of the patient and the operator or doctor concerned. The privacy and safe record keeping is an utmost requirement. Certain inclusions in the EDR would help making the records more secure: like use of login details like username and password, sticky policies for transferring and editing of data to maintain security, the system should make it possible to see when and why was a patient file accessed, provision for changing passwords and use of firewalls so as to maintain the details safe and free from hacking and other malpractice. Authorization too has been suggested for maintaining confidentiality.

Certifications of these program softwares by ONC/ONCHIT (Current Office of National Coordinator for Health Information Technology) have been fully operational since 2012 in US, before which a Temporary Certification Program (TCP) was functional since 2010. A similar system exists in Europe by name Eurorec, to help maintain quality of record keeping through digital means [36].

All the certified products have been included in CHPL or Certified Health Product List. This includes programs of two types 1) The complete EHR and 2) Modular EHR. Complete EHR as the name suggests meets all requirements of security and privacy concerns along with the utility criteria. The latter does not meet all the set requirements for certain edition of ONC certification, and also demands for eligible providers to implement additional software to meet all the

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certification criteria. Indian government has presented with an act named DISHA that is digital information security in healthcare; which hereby suggests the following to avoid breach and its consequences- 'Anonymization', that is deleting personal information from digital health data, or 'Deidentification' in a manner that it can be connected again (planned by NeHA). The privacy and confidentiality of EDR would be the dentists' responsibility. Discarding files in electronic media is safer and can be deleted from all records so as not to allow access to anyone. When in store, the access to all people should be restricted and right training of office staff and trust is a must. Threats to health care information and its privacy could be by certain human threats, such as employees or hackers; or from technology failures, such as a system crashing; and also from natural and environmental threats such as earthquakes, hurricanes and fires. These threats can either be internal, external, intentional and unintentional. Another big challenge is the errors involved due to wrong human and computer interactions [41-46]. The accuracy of EDR may get affected while inputs of the data are made by the staff involved. Standardized software with a database to cross check medical terms, drug doses etc may reduce such errors.

IV. Barriers and Hindrances in Acceptance of EDR

EDR helps to organize the practice better and provide other multiple advantages, but no science comes easy, be it the financial aspect, training requirements or the employment of a new system on a wider basis, all need a very good management and support. Dentistry lags behind medical fraternity in terms of the quality of record keeping. Medical doctors must comply with stringent record keeping regulations, even on paper as the stakes involved are more. Dental practitioners do not yet face this level of pressure to comply, although changes in this direction are just a matter of time. Mandating this compliance for the dental community, the quality of care could improve. In one perspective 'Teledentistry' could be a benefit in developing countries to improve patient care, the same time finances to create such a huge network matter more. Surveys suggest the poor maintenance of paper records by dentists in many Indian states and hence needless to mention digitizing would come much later. A very low percentile of about 38% of surveyed dentists was found to maintain records, whereas 62% of them were maintaining no records at all, in a study regarding awareness, in one of the states of India. Astekar M. et al found in their cross-sectional survey based on telephonic conversation that few dentists (surveyed) were aware of the legal mandate for dental records and were ignorant about the laws governing their profession [21]. A similar situation was found in another state by Preethi *et al* where 21% of the target or surveyed dentists did not maintain any form of dental record and only 12% maintained complete dental records. This trend could be reflected in other parts of the country and is a very alarming situation as most dentists are unaware of the ethical and legal implications of inadequate or improperly maintained dental records [47]. But the Indian law [Article 51 A(h) of the Constitution of India] mentions of the moral obligation on the doctor and the legal duty, to maintain and preserve medical, medicolegal, and legal documents in the best interests of social and professional justice. Also it is necessary to maintain accounts to avoid action from Income Tax authorities under Section 44 AA of the Income Tax Act, 1961 [34]. India faces greater problem due to a larger population, diverse culture and spread over a larger region of varied geographical landscapes. The interoperability and all models based on similar principles is very important. International Trade Administration's Health IT top markets report estimated global health care expenditure as US $ 7trillion, in 2015, and likely to exceed US $ 9trillionby 2020.

Only an involvement of various government sectors, The Ministry of Electronics and IT, Ministry of Health and Family welfare and NITI Aayog or erstwhile planning commission of India can together make changes happen [44].

The integration of EMR and EDR is another very big challenge. Which is what is the actual benefit of the system. Medical fraternity would benefit if gets an access to dental records, as many systemic ailments are first noted in the mouth like some carcinomas, Sjogrens syndrome, diabetes milletus, eating disorders, syphilis and gonorrhea. A survey in US Medical Records Institute, on the EHR trends found a 70% positive response for the need of sharing patient information with others and mentioned it to be quite helpful for practice and patient benefits [2, 15]. A single consolidated record would also be a great aid in research. Such longitudinal records would really help in better and more evidence based decisions.

The benefits of EDR are many, but the financial aspect would remain a major consideration and the endless comparison of these benefits against costs would exist. Clinicians and researchers understand the significance of EDR to proceed further or improve the practice, and to keep pace with the digitized times of today. Studies have shown it to be cost effective in a long run and in hospitals or multispecialty centers where employing and training staff exclusively for maintaining these records becomes worthwhile. Smaller or individual units would find the latter difficult. After the investment is done towards the digital management of records, it is only with time the benefits would be reaped. The more number of staff in bigger setups could be trained to manage these duties better. The number of dentists

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worldwide who are trying to adapt to latest trends is increasing.

A study in 2006 found 90% of surveyed dentists using practice management software and turning their offices into paperless; of which 47% were new and 42% the established dentists [13]. A study suggested the amount spent annually over stationary, staff time, operator and x ray films would be more than costs involved in electronic records [37].They are expensive in terms of training institutes but considering better future prospects, investments can be justified. The costs on patients would get higher but it allows a better retrievability of records and whole lot of other benefits.

It is also to be noticed that application of EPR requires help of health information management professionals and they should integrate the whole medical fraternity to reap true benefits. Present state may not be really helpful unless intraoperability and integration or records achieved. The benefits could be achieved in one context and not in the other depending on the clinical routine and control over programming errors, errors in human computer interactions, and data entry errors in copying from notes, of vital signs or drugs or cut paste errors. The EDR seem to be more beneficial for larger set ups in terms of cost effectiveness, also the interoperability is really needed for a patient and the changing staff. Researchers mentioned that it makes sense but may not suit all. Hence being applicable to a greater sector needs lot of hurdles to be crossed [50].

If not well handled it may also lead to adverse consequences like wrong alerts, not sufficiently updated records resulting in wrong clinical decisions. Some researchers have found present scenarios not upto the mark and needing improvements, and damage caused by improper use of EPR has been also stated as e- iatrogenesis [51,52].

Authors' point of view

The greater challenges remain in demographically developing sectors. To achieve the goals set for EPR, it would need to first begin at educational institutions where the training dentists realize the importance of dental records, and hence apply later in practice. The exposure to technological changes and software managements would remove the associated inhibitions. The aid by governments towards the teaching institutes becomes must hence to implement this.

V. Conclusions

The accurate health/dental history provides important and valuable information for the dentist, prior to beginning treatment and hence the importance of taking and keeping records and updating them. Records needed for legal implications, insurance, consumerism, good quality care and electronic records can help achieve all. It is an independent field not just involving the medical and dental fraternity but the health information management and informatics sector. More and more dentists are perhaps turning towards paperless offices internationally yet much is to be achieved when it comes to standardization and integration in true sense. It demands a periodic review and update for the document to be living document.

Abbreviations

ADA- American Dental Association
ARRA- American recovery and reconstruction act
CHPL – Certified health IT product list
DISHA-Digital information security in healthcare
EDR- Electronic Dental Records
EMR- Electronic Medical Records
EPR- Electronic Patient Records
IDA- Indian Dental Association
LOINC- Logical observation identifiers names and codes
MCI – Medical Council of India
NeHA-National electronic health authority of India
ONC/ONCHIT- Current Office of National Coordinator for Health Information Technology
HIPAA- Health Insurance Portability and Accountability Act of 1996
HITECH- Health information technology for economic and clinical health act (2009)
HIT- Health Information Technology
TCP – Temporary certification program
PCI- Pharmacy council of India
WHO-FIC- The WHO family of international classification

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