

## Teledentistry: An Integrated Approach in Dental Education

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### Abstract

Dental care is being constantly transformed by the opportunities which are provided by technology and telecommunication. Teledentistry provides the means for a patient to receive services when the patient is in one physical location and the dentist or other oral health care provider overseeing the delivery of those services is in another location. This mode of patient care makes use of telecommunication technologies to convey health information and facilitate the delivery of dental services. More and more private and public insurance are adding coverage for Tele-health and teledentistry worldwide.

**Keywords:** Teledentistry; Telehealth; Tele consultation; Telecommunication; E-health; Remote monitoring; Dental education.

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### Introduction

Technologic innovations in the medical field have been extensive in recent years. Just as communication technology and use of electronic information has developed over the years, terms to describe health care services at a distance, such as Telehealth and telemedicine, have also evolved. Telemedicine may be defined as "the combined use of telecommunications and computer technologies to improve the efficiency and effectiveness of health care services by liberating caregivers from traditional constraints of space and time and empowering consumers to make informed choices in a competitive marketplace [1].

Dental care, being constantly transformed by these latest innovations, in a synergistic combination with telecommunications technology and the Internet, has yielded a relatively new

and exciting field that has immense potential called "Teledentistry" [1]. "Tele" in greek means "Distance" and "Medri" in latin means "To Heal" [2]. Teledentistry as defined by Cook is "the practice of using video conferencing technologies to diagnose and to provide advice about the treatment over a distance". It is a combination of telecommunications and dentistry, involving the exchange of clinical information and images over remote distances for dental consultation and treatment planning [3].

Due to the enormous growth of technological capabilities, teledentistry possesses the potential to fundamentally change the current practice and the face of the oral health care [4]. It has the ability to improve access to oral healthcare, improve the delivery of oral healthcare, and lower its costs. It also has the potential to eliminate the disparities in oral

health care between rural and urban communities.

### Historical Background and its Origin

In its simplest form, telehealth has been around for decades. The beginning of telemedicine can be traced long back in 1924, when physicians started consulting patients in remote areas using telephones and radios as the means of communication. Radiology was one of the earliest medical specialties to utilize telecommunication as early as 1959 when Albert Jutra used communication cable to transmit videotaped telefluoroscopy examinations between two hospitals in Montreal, five miles apart (Weinstein *et al.* 1987) [4].

In 1989, the Westinghouse Electronics System Group in Baltimore conducted a conference focused on drafting a blueprint for dental informatics, combining computer and information science, engineering and technology in all areas of oral health [5]. The US Army's total dental access (TDA) project is seen as being at the frontier of teledentistry. Begun in 1994, this project initially used a traditional plain old telephone system (POTS) with two different communication methods: real-time and store-and-forward. They concluded that teledentistry reduced total patient care cost, improved dental care to distant and rural areas, and provided beneficial information regarding deeper analyses [1,6].

In 1995, Rocca *et al.* conducted a pilot study in Haiti to connect a general dentist to a dental specialist in Washington DC, via a satellite system. Two years later, integrated services digital network (ISDN)- based teledentistry was tested in Germany, Belgium and Italy. Studies have also been conducted in Scotland, Japan, England and Taiwan to examine ISDN-based teledentistry. Since then, the era of teledentistry is expanding worldwide and teledentistry is gaining ground in developing countries [6].

### Forms of Teledentistry

Teleconsultation with specialists, through electronic health records, telecommunications technology, digital imaging, and Internet, can take place by several methods. According to the ADA's Comprehensive Policy Statement on Teledentistry, patient care and education can be delivered using, but not limited to, the following modalities: [8]

- *Live video (synchronous):* Live, two-way

interaction between a person (patient, caregiver, or provider) and a provider using audiovisual telecommunications technology. It is also called Real Time Consultation.

- *Store-and-forward (asynchronous):* Transmission of recorded health information (for example, radiographs, photographs, video, digital impressions and photomicrographs of patients) through a secure electronic communications system to a practitioner, who uses the information to evaluate a patient's condition or render a service outside of a real-time or live interaction.
- *Remote patient monitoring (RPM):* It may be home based or hospital based, where patients are monitored at a distance. Personal health and medical data collection from an individual in one location is transmitted via electronic communication technologies.

### Technological Requirements

A typical system consists of a computer with substantial hard drive memory, a speedy processor, adequate RAM, digital camera and/or intra oral camera for capturing images, an internet connection and a modem. A printer, scanner and a fax machine may also be required in some cases [9].

To enable live videoconferencing, a standalone IP/ISDN videoconferencing solution may be used, or a PCI codec board may be installed into the system. A live group session would require a multipoint control unit that can bridge three or more involved parties. The codec must be able to accommodate audio and visual functions [10].

There is not a recommended list of equipment, hardware or software, for designing a tele dental model. However, a few important factors should be considered while selecting the technology and equipment for designing the tele dental model like budget, information technology infrastructure, telecommunications services, networks, data security, store-and-forward communication versus real-time video conferencing, and comfort with technology. Another important aspect while choosing or designing the model is the tele dental application and imaging software. Components to consider when choosing such an application are dental records storage, dental billing, and appointment scheduling. Dental records storage allows the collection of data critical in the clinical management of patients, including patient charts

and histories. Dental billing and the revenue component of management software allows the management of patients' financial records.

Appointment scheduling permits the management of appointments, and scheduling can be a part of management software. The software is designed to track patients from the moment they are entered into the system and also keeps the track of missed, rescheduled and cancelled appointments. For the first time, teledentistry codes are included in the 2018 edition of the ADA's Code on Dental Procedures and Nomenclature (CDT Code). Having a code provides the measurement tool (metric) and the opportunity to measure outcome data.

### Modes of Transferring Information

- POTS
- Networked Programs
- Point - to - point connections
- Primary or speciality care to the home connections
- Home to monitoring centre links
- Web- based e-health patient service sites

*POTS* (Plain old telephone system) works through the telephone company with low speed and sometimes unreliable connection. However, it is still commonly used because of its low maintenance and technical support costs. Information exchange is still possible with the help of faxmachine [11].

*ISDN* (Integrated services digital network) provides a higher speed, and information can travel in both directions simultaneously, which increases reliability and accessibility in Teledentistry. But designing such an international ISDN network is too expensive and impractical [12].

Unlike ISDN, web-based Teledentistry does not require a special network, and hence it is more cost effective. However, there are no rules on the internet: there is little accountability and no verification and accountability. Hence, concerns regarding privacy and security remain an issue because of hackers and crackers. An ISDN network, on the other hand, is connected from one point to another with no network sharing. Live interactive videoconferencing can be conducted via satellite.

There are several programs on computerised dental services. Some are [13]:

- Fluoride probe
- Electromyography: like the procera system

- Digital dental photography
- Electronic patient record system
- Intra oral camera and computer imaging

Networked programs link hospitals and clinics with outlying clinics and community health centers in rural or suburban areas by the use of dedicated high-speed lines or the Internet. Point-to-point connections using private networks are used by hospitals and clinics that deliver services directly at ambulatory care sites.

Primary or speciality care to the home connections involves connecting primary care providers, specialists and home health nurses with patients using single line phone video systems for interactive clinical consultations. Home to center monitoring links are used for patient monitoring, home care and related services that provide care to patients in the home, using normal phone lines and internet.

With the help of *EPR* (electronic patient record) system, it is now possible to make/get cumulative data (longitudinal record) of the patient from different dental clinics, which will aid in the diagnosis and proper management of the patient. Data storage does not require much space and there are less chances of damage or losing of data. Data retrieval also becomes easy and quick and there is greater legibility of information [11].

The universal dental diagnostic coding system (*SNODent*—The Standard Nomenclature for Dentistry) is developed which consists of diagnostic terms, terms describing symptoms, clinical signs and findings, radiographic observations and related test findings. It can provide a basis for designing into the digital record forms of artificial intelligence to further assist the dental care provider in making more accurate diagnostic decisions [14].

*Dental-Consults* is a web-based 'teledentistry' consultation system developed for use by dentists. In this, the referring dentist logs into the secure web server, fills in the patient's details, specific reasons for consultation, chief complaints, and provisional diagnosis information and uploads intraoral images as well as dental radiographs. The specialist reviews the consult and suggests his diagnosis and treatment plan within five working days after receipt of the complete patient case.

The *Dental-Consults* teledentistry system uses secure sockets layer (*SSL*) to encrypt the information that flows between the web browser and the web

<b>Advantages</b>	<b>Limitations</b>
<ul style="list-style-type: none"> <li>• Reduces the cost of service and improves quality of care</li> <li>• Decrease in peer isolation and increase in specialist support and education</li> <li>• Diagnosis is done and treatment plan is developed without seeing the patient</li> <li>• Improved diagnostic services and integration of Dentistry into a better health care delivery system</li> <li>• Better communication with insurance industry with respect to requirements</li> </ul>	<ul style="list-style-type: none"> <li>• A back up communication system and technical support group is required. Proper internet connection is mandatory for video conferencing</li> <li>• Privacy and security is an important issue</li> <li>• Chances of misdiagnosis. due to technical problems occurring during data transfer, is higher. This may lead to a malpractice claim</li> <li>• Reimbursement of services provided through this means of care is limited</li> </ul>

server receiving the referral. When the lock or solid key is visible, the browser has established a secure encrypted connection with the server, meaning it is safe to send sensitive data. Confidentiality comes with SSL during the transmission of patient information [15].

### **Scope of Teledentistry**

Teledentistry improves access to oral health care, improve the delivery of oral healthcare, and lower its costs. It also has the potential to eliminate the disparities in oral healthcare between rural and urban communities. It is the fastest way to bridge the rural-urban health divide and also can help to bring specialized healthcare to the remotest corners of the world [16]. Inter professional communications will improve dentistry's integration into the larger healthcare delivery system. The use of specialist consultations and continuity of care will provide aspects of decision support and facilitate a sharing of the contextual knowledge of the patient among dentists [16].

Tele education is gaining popularity to supplement traditional teaching methods in dental education and provide new opportunities for dental students and dentists [17]. Formal online education can be divided into two main categories: Web-based self-instruction and interactive video-conferencing.

The web-based self-instruction educational system contains information that has been developed and stored before the user accesses the program. The advantage of this is that the user can control the pace of learning and can review the material as many times as he or she wishes. The limitations have been noted in areas of satisfaction (lack of face to face communication with peers

and instructors) and accuracy (lack of face to face patient examination) [16,17].

Interactive videoconferencing (conducted via POTS, satellite, ISDN, Internet or Intranet explained earlier in the chapter) includes both, a live interactive videoconference (with at least one camera setup where the patient's information is transmitted or at both locations) and supportive information (such as patient's medical history and radiographs) that can be sent before or at the same time as the videoconference (with or without the patient present). The advantage of this educational style is that the user (typically the patient's health care provider) can receive immediate feedback. Dental chatrooms are available through numerous dental organizations and study clubs, as well as through individual practitioners who exchange information on a variety of topics [17].

In the noble context of benefiting the grass root population of India, the Indian Space Research Organization (ISRO) has successfully implemented a number of projects in telemedicine/telehealth, which is of great social relevance to the country for enabling specialty healthcare to the remote, rural and underserved population. ISRO has successfully linked various hospitals and healthcare centers in remote rural areas with specialty hospitals in cities through INSAT satellites.

Thus, connectivity between patients at the remote end and the specialist doctors at urban centers has been effectively established [22].

### **Application of Teledentistry**

#### **➤ Oral and Maxillofacial Surgery**

Use of new technologies in dental surgery provides better diagnosis, situational analysis and planning of appropriate treatment solutions.

Technologic development is at a highest level in computerized support in dental implants placement, where it is possible to observe the patient in one part of the world and in the other part make a digital project of complete implant and prosthetic construction and route the direction for navigational technique of dental implantation. Some very good telemedical results have been achieved in one of the principal areas of oral Surgery i.e. impacted wisdom teeth. Smart phones are able to read and display 3D computer reconstructions of head skeleton, giving instantly the necessary information to distant teleconsultants [18].

➤ *Orthodontics*

Orthodontists, after taking dental impressions of the jaws, instead of pouring models, send the impressions by special postal service to specialised companies for 3D digitisation of working models. The 3D models are created using patient protected systems for 3D scanning and digitization, form a computer file, and return it via internet to the specialist. Measurements and assessment of relationships are done by using software to process the Images. The two most renowned computerized digitization systems are Orthocad and emodels [19].

➤ *Pediatric and Preventive dentistry*

In addition to its basic role in providing dental screening in distant, rural and other inaccessible areas, the Method of teledentistry has been demonstrated as a high quality alternative in children afraid of dentists, reducing their fear and anxiety compared to clinical examination in real time [20].

➤ *Oral medicine*

High resolution images and a broad spectrum of colours (32 bit or more) is able to provide high quality consultation even with colleagues at a distance of several hundreds of kilometres (sometimes 2-or more experts at a time) lesions are electronically photographed using a 50 macro lens and circular illumination system, and this data is stored in a textual file with minimal resolution 600 dpi [19].

➤ *Dental prosthetics*

Dentists and dental technicians who are not very skilful benefit from Teledentistry with the help of computerised dentistry specialists. The resulting project file is encrypted and sent by email to a teleconsultant for a model analysis, projection of the shape of restoration, of its height and inter jaw relationship using a virtual articulator. The completed project is then encrypted and returned to the clinic, usually by e-mail. 21 CAD/CAM (computer-aided design and computer-aided manufacturing) systems are gaining priority in the manufacturing of individual dental crowns, dental inlays and Onlays, over traditional hand modelling and casting of prosthetic reconstructions.

➤ *Endodontics*

Periapical lesions are the most common pathology faced by dentists. Any faults in differential diagnosis and prognosis of treatment of periapical lesions can cause complications, problems, a waste of time and money, sometimes can lead to complete revisions of prosthetic restorations based on poorly treated teeth. However, these lesions are not always treated by specialists. In this regard, modern technology systems help in seeking timely expert advice and formulating treatment plan.

With the use of teledentistry methods, diagnosis of periapical lesions can be adequately assessed, and a necessary plan can be devised for a proper endodontic management of the lesions. The method includes digital information for each of tooth of interest. Distant consultants, specialist in endodontics, are informed via their mobile phones about the received request, after which they download the digital images and accompanying anamnestic data. They establish the diagnosis and suggest a treatment, then post this information on an on-line server, which informs the consultation requester dentist about the received response [23].

Baker *et al.* (2000) demonstrated no statistically difference in the assessment of periapical lesions between the images viewed locally and those transmitted via a videoconferencing system and viewed on monitor screen [24].

## Concerns in the use of Teledentistry

### *Legal issues*

Largely still untested by law and with significant variation among countries, issues such as accountability, jurisdiction, liability, privacy, consent, and malpractice are crucial to consider, when attempting to use this mode of communication. The medico legal issue arises mainly due to lack of any well defined standards. Currently, there is no method to ensure safety, quality, efficiency, or effectiveness of information and its exchange. The most significant barrier to a nationwide teledentistry practice even in developed countries is the traditional system of state by state licensing [27]. In 2000, 20 states in the US enforced strict licensure laws requiring Teledentistry practitioners to obtain full licenses to practice across states [25].

### *Confidentiality*

Patients should be made aware that their information is to be transmitted electronically and the possibility exists that the information will be intercepted, despite maximum efforts to maintain security. The form should contain the name of both the referring and consulting practitioners to ensure adequate coverage for malpractice, and the consulting doctor should acquire a copy of the informed consent before any form of patient contact is established.

### *Liability*

Teledentistry raise concerns about liability. There is no law to clarify the role of the teledoctor and their liability [23]. The payment of the health care professional who provides teleconsultation has been a major issue in the recent years. The National rural Health Research and Policy analysis centre has recommended reimbursement of care provided by tele-consultants, eliminating separate billing for telemedicine, increasing reimbursement for the originating telemedicine sites, and providing reimbursement for store and forward procedures [26].

In the US, Medicare, Federally Qualified Health Centres, Medicaid, California Children's services are some of the payers for telemedicine reimbursement. Private insurances such as Blue Cross of California are also available for such care [27]. But none of these programs that re-imbure

telemedical consultations have included tele-dental as yet. Hence, the payment remains a big question.

### *Future Prospects*

Health care is being changed dramatically by the use of computers and telecommunications. Presently, teledentistry has not yet become an integral part of mainstream oral health care. In the near future, teledentistry will be just another way to access an oral health care, especially encouraging for isolated populations who may have difficulty accessing the oral health care system due to distance, inability to travel, or lack of oral health care providers in their area.

Although internet based dentistry has taken precedence over other ways of communication, potential shortcomings still exist like necessity for proper training, an instant response, message misunderstanding, privacy concerns and possibility to overlook/neglect the messages. It is important that practitioners choosing to include this form of delivery of care should educate themselves as to the legal, technological, and ethical issues associated with this. They must make an initiative to become up to date and comfortable with the technology they are using. The instructors of teledentistry education courses need to be well versed with computer knowledge.

Future advances in technology will enable teledentistry to be used in many more ways, such as clinical decision support, quality and safety assessment, consumer home use, medication prescribing, and simulation training. In spite of some issues which need to be resolved, the potential of teledentistry is tremendous in developing countries, which needs to be explored.

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