

A New Hope - Teledentistry

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Abstract: *Teledentistry is a combination of telecommunication and dentistry. It is used by information-based technologies and communication systems to deliver dental services. It is a smart way to overcome the distance between health care providers and patients. It can enhance the quality and efficiency of health care and also lower its cost. It has also eliminated differences in oral health care between rural and urban areas. Teledentistry requires a computer with adequate RAM, an Intraoral video camera, digital camera, modem, Internet connection, and IP/ISDN video conferencing solution. Two ways usually followed for teleconsultation are Real-time consultation and Store and forward consultation. Its role in modern times, especially in the present scenario is appreciable as brought the dental fraternity closer for support as well as develop a treatment plan without having to see the patient in person.*

Keywords: Teledentistry, COVID-19, Telecommunication, Internet, Telemedicine

1. Introduction

Human beings among smarter and intelligent species have very special attribute, learning is special capability which includes ability to understand and acknowledge the surroundings then behave and develop new and better skills and value accordingly. COVID-19 Pandemic presented medical profession with new challenges in delivering safe and effective care with reduced Face to Face contact with patient. Clinicians have to embrace changes to sustain our practice without hampering or risking the health of the patients.

Teledentistry is a rapidly forming subset of telemedicine, a field that already has considerable impact on the health care industry. When health professional will hold your appointment by talking with you on telephone or through internet. Video call option available to us are Skype, WhatsApp, Face time and Microsoft teams, Zoom, Google meet These both are synonymously known as **Remote consultation**. [1,2] **Teledentistry** is a combination of communication and dentistry. [3] It is use of information based technologies and communication systems to deliver health care [4]. The term "Teledentistry" was first used in 1997, when Cook defined it as "... the practice of using video-conferencing technologies to diagnose and provide advice about treatment over a distance." [5] According to American Dental Association (ADA), teledentistry is described as "the use of telehealth systems and methodologies in dentistry," which includes "a broad variety of technologies and tactics to deliver virtual medical, health and education services." [6, 7]

The concept of teledentistry developed as part of the blueprint for dental informatics, which was drafted at a 1989 conference funded by the Westinghouse Electronics Systems Group in Baltimore. Teledentistry is a subspecialist field of telemedicine that was started in 1994 as **US Army's total**

dental Access project aiming at improving the patient care, dental education and effective communication between dentists and dental laboratories. [8] In 2000 Pilot project aiming at (effectiveness) demonstrating the impact of teledentistry in rural areas and effectiveness of viability of remote speciality consultation. It was undertaken by *Chinshan* group health center and *National Taiwan university* were intraoral camera, digital radiographic system and software application to transfer all images of hospital, sent to Chinshan township of 17,000 people. [9] Eventually it had its impact globally as in 2006, university of *Rochester* used a project of teledentistry in elementary schools to screen children for dental caries. [10] 2010 , in Northern Ireland *community Dental services* of Home-first legacy trust and *Oralmedicine department* of school of Dentistry used teledentistry as an approach to manage oral medicine referrals and it was positively established. [11]

Key modalities of teledentistry as described by ADA [6,7]:

- 1) *Synchronous*: Live video, two-way interaction between the patient and the teledentist by utilising audio-visual telecommunication.
- 2) *Asynchronous*: Recorded medical and dental information such as clinical photographs, radiographs and videos are sent by secure telecommunication to the clinician for evaluation and advice.
- 3) *Remote patient monitoring* (RPM): Personal medical and dental data collected from an individual in one location is transmitted to the provider by secure telecommunication in a different location.
- 4) *Mobile Health* (mHealth): Use of mobile communication devices for public healthcare, education and practice.

2. Prerequisites of Teledentistry

Teledentistry for most of dental applications require [12, 13, 14] –

- a) computer with good hard drive memory, adequate RAM, speedy processor
- b) Intraoral video camera and digital camera for better imaging.
- c) Modem and Internet connection.
- d) other accessory requirements are Fax Machine, scanner, printer

For video conferencing we require IP/ISDN video conferencing solution or install PCI codec board into system.

For line group session, multi point control unit will connect two or three.

PCI CODEC must be able to connect audio and visual functions. [15]

But basic requirements mainly include use of technology and INTERNET. There is requirement of up to date and fast service of internet and ability to transfer large amount of data internet from last decade not only changed in speed method of data transfer but also reduction of cost.[16] All this has forced clinicians to rethink about teleconsultation as a valuable healthcare tool. Hence, High speed internet became a cornerstone to Remote Consultation in Dentistry. An Internet-based telemedicine program (Baby CareLink) significantly improved patient family satisfaction and lowered the costs associated with hospital to hospital transfer after neonatal intensive care unit (NICU) stay.[17] Even in academic medical centers or in continuing dental education programs internet with information has become integral part of trainings and consultations. "TME 3/347", a Web-based teledentistry consultation system developed for the US Department of Defence dental clinics, showed that videoconferencing, Web and Internet based technologies can be used to implement a user-friendly teledentistry solution. [16, 18, 19]

3. Different approaches of teleconsultation

There are different ways of teleconsultation [20]:

- Real-Time Consultation
- Store-and Forward Method
- Remote Monitoring Method
- Near-Real-Time consultation Method

3.1 Real-Time Consultation involves a videoconference in which dental experts and their patients, at different locations, may see, hear, and communicate with one another [Figure 1] [12]

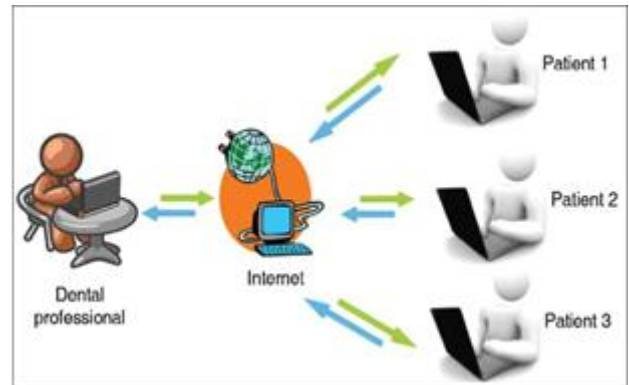


Figure 1: Real-Time Consultation

3.2 Store-and-Forward Method is a sort of conference where dental specialist can share clinical data, pictures, radiographs, starting therapy given and other clinical records for additional interview and treatment arranging. The patient is absent during the "consultation". This information sharing can be of outrageous significance for patients, particularly those needing expert counsel [Figure 2][14,4]

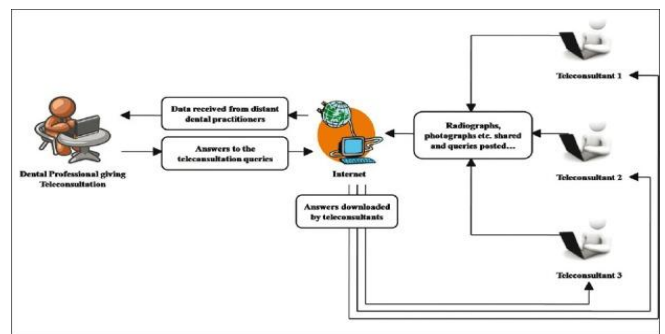


Figure 2: Store and Forward Consultation

3.3 Remote Monitoring Method, in which patients are checked a ways off and can either be medical clinic based or locally established. [Figure 3][21]

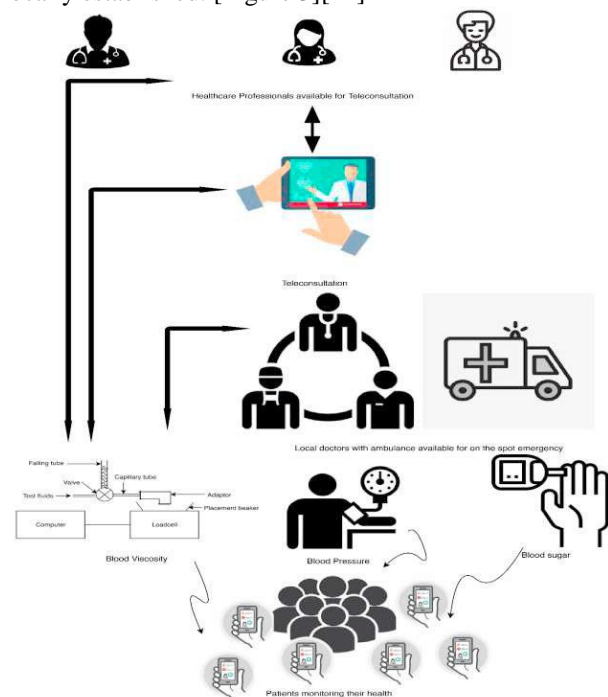


Figure 3: Remote Monitoring Consultation

3.4 Near-Real-Time consultation which involves low resolution, low frame rate product that looks like jittery television. [13]

4. Methods of Transferring Information

- Image File Transfer via Modem.
- File Image Transfer via Satellite.
- ISDN-based Teledentistry System
- POTS-based Teledentistry System
- Web-based Teledentistry Systems

4.1 Image File Transfer via Modem

Pictures are caught utilizing dental picture the executives framework and intraoral camera and communicated through modem from dental facilities to higher focuses and the other way around. [22]

4.2 File Image Transfer via Satellite

Pictures are caught utilizing high goal camera and communicated through satellites as in 1995 a CLI video remotely coordinating framework was utilized over Worldwide Sea Satellite (INMARSAT) permitting the sent dental specialists to talk up close and personal with experts at Walter Reed Armed force Clinical Center in Washington..[22]

4.3 ISDN-based Teledentistry System

This framework utilizes work area video remotely coordinating Hardware and ISDN lines at 128 Kbps information rates, an intra-oral camera and a report camera. This hardware permits live video consultations well as capacity to send still pictures. White-boarding is a component of this framework, which permits clients to do comment on a picture. In 1996, the US Division of Protection set up a clinical organization in Bosnia that associated Armed force field dental specialists with dental specialists at five provincial military clinical focuses in the United States. [23]

4.4 POTS-based Teledentistry System

The POTS-based systems consist of a desktop computer, a 28.8 Kbps modem, software and hardware (Share vision PCS3000), Intra-oral camera and a document camera. In early 1997, a POTS-based teledentistry network was tested and implemented in Germany, Italy, Belgium, England, Spain and Portugal. [22]

4.5 Web-based Teledentistry Systems

This framework comprises of a PC, a computerized camera, an Internet browser and requires Web access. Since October 1997 online teledentistry was conveyed and a large portion of the dental centers in Europe currently have a neighbourhood (LAN) and admittance to Web through the clinical emergency clinics, this framework is being utilized in more than 50 triservice dental facilities in Europe.[22]

5. Tips for use of teleconsultation in routine clinical practice: [24]

Tip 1: Regulation

Prior to leaving on distant interview of any sort, clinicians ought to acquaint themselves with direction applicable to our specific locale of training which may incorporate

- proper access to medical recovery
- content / legal mechanism for authorizing consultancy
- Adequate and appropriate indemnity in place to cover telecommunication

We have to make sure that health can provided this way should match standard of care i.e. match in person care goes otherwise

Tip 2: Appropriateness of Consultation

- It's not suitable to cause distant to counsel when patient presents intense clinical/psychological maladjustment. It could be conceivable that patient himself isn't willing for such conference.
- Or then again persistent requirements actual assessment and appraisal. So fundamentally, vital to have nitty gritty survey of clinical records.
- Sometimes patient's cultural factors needs keen consideration.

Tip 3: Technology

Decision of innovation relies upon number of variables including accessibility of web, usability, cost or more all privacy. It ought to be picked with proposal of association if working under a few. On the off chance that in centers, utilize specialized survey to choose which kind of innovation you are picking. As in video conferencing - web sufficiency, working camera/amplifier and right subtleties to contact (meeting ID) are essential prerequisites. Back up designs for contact if innovation bombs like telephone, IT contact subtleties ought to be accessible with clinical administrator.

Tip 4: Appropriate Physical Environment

Camera ought to be at similar rise as eyes to guarantee that face is obviously noticeable to prescribe to utilize earphones.

Tip 5: Beginning of Appointment

Clinician ought to present themselves with their full proficient assignment, affirm patient's personality and area and assert classification. Suitable assent should be gotten to record the meeting with an express assertion of explanation behind model: clinical record preparing. Preferably tolerant should be permitted to talk continuous on the off chance that it assists with deciding the patients grievances and clarifications

Tip 6: Prescribe Safely

Clinicians should guarantee that they have a reasonable reasoning for decision of drug and approach all data significant for remedy for example patient if medicinally undermined legitimate admittance to clinical records and different medicines he previously had in his past should be appropriately assessed.

So it ought to include a conversation of anticipated impacts, results, subtleties of dosing, consistence like all variables.

Among all factors patient's usual range of familiarity and clinicians ability zone the two holds a significant thought. Patient's customary range of familiarity ought not be stressed.

Tip 7: Documentation

A synopsis of analysis, clinical history, hazard factors (assuming any) and the executives plan ought to be recorded either in electronic configuration or otherwise. A duplicate ought to be shipped off.

6. Practice of Teledentistry [23]

- University of Minnesota School of Dentistry -Follows *real-time videoconferencing* technology.
- The Melbourne Dental School's Oral Cooperative Research Health Centre- treats aged and remote patients using the *National Broadband Network*.
- Arizona Department of Health SHealth (00H) –provided assess to oral health services underserved areas in Arizona. Also increases access to dental care for at-risk populations.
- University of Southern California's Mobile Dental Clinic and The Children's Hospital Los Angeles Teledentistry Project –provided oral health care to children of rural areas of California.
- **Practice of Teledentistry in India-** In 1999, the department of information technology (ministry of communications and information technology, govt. of India) launched a pilot project named “Development of telemedicine technology” with aim of improving national health care delivery system at 3 centres.

All india institute of medical sciences (*AIIMS*), New Delhi.

- Post graduate institute of medical education and research (*PGI*, Chandigarh)
- Sanjay Gandhi post graduate institute of Medical Sciences (*SGPGIMS*), Lucknow, U.P

7. Current applications of teledentistry

7.1 Dental Education

Teledentistry has two branches: [25]

- Self-Learning
- Interactive Conferencing.

Self-instruction instructive framework contains data that has been created and put away preceding client's entrance [25]

Interactive video-conferencing is very well might be led by means of POTS (regular telephone utility) satellite, ISDN, Internet or Intranet. It incorporates a live intuitive meeting with a legitimate camera set up where the patient's data (like the patient's clinical history, radiographs, and so on) can be communicated.

Use in rural areas:

Because of absence of thorough consideration in rustic regions due to less accessibility of experts trained

professionals. Teledentistry has expanded the availability of the experts to the country and underserved networks for their dental requirements, other than diminishing the time and the expense which are related with the strength discussions. [26]

7.2 Role in postgraduate education and dental practice

In interactive and intelligent video-conferencing, the patient data can be examined and assessed first (with or without the patient's quality). This improves the understudies' energy and gives new learning freedoms to them just as rehearsing dental specialists.[27]

7.3 In schools and child care centres:

Schools and kid care focuses ae where we can block numerous dental issues before their transformation to dental crises .This should be possible by oral screening with teledentistry, subsequently making youngsters and families mindful of required treatment. The early identification of such rot can keep the youngster from difficult and monetary injury, visits to the crisis treatment room, and at last, extractions of the teeth.[25]

7.4 Application in oral and maxillofacial Surgery

Duka *et al.*, directed an examination to explore viable convenience of telemedicine approaches in ordinary administration of oral medical procedure patients regarding dependability of set up analysis and signs for oral medical procedure therapy of the third molars.[28]They summed up that the symptomatic evaluation of the clinical conclusion of affected or semi affected third molars helped by the telemedicine approach was equivalent to the genuine appraisal of clinical finding. The act of telemedicine was exact, viable, and kept away from superfluous visits to the medical clinic and abbreviated holding up spans. The artistic works upholds teledentistry could be successfully utilized in contribution expert administrations in oral medical procedure to the patients in far areas.[29] Improved determination, situational examination and arranging of proper treatment modalities have been given by the utilization of new advancements. For example, Technologic advancement has made it conceivable to notice, review and analyze the patient requiring insert situation in one piece of the world, and in the other part make a computerized venture of complete embed and prosthetic development for navigational procedure of dental implantation.

7.5 Application in oral medicine and radio-diagnosis

Bradley *et al.*, in an examination demonstrated that teledentistry can be utilized effectively to offer counsels oral medication and radio-determination locally dental treatment, Northern Ireland [30].Telemedicine with the assistance of high goal pictures and a wide range of shadings (32-cycle or more) gives interview the partners in distant and country regions between two or a few specialists all at once. Torres-Pereira et al. showed a compelling inaccessible admittance to oral injuries and advantages of utilization of email administrations and a Store-And-Forward picture framework. [31] The approach is to such an extent that it produces acceptable outcomes, which could be improved

with exhaustive electronic patient history, containing the total history of all present and past infections, meds taken, analytic and remedial systems, and recorded any remaining variables which could have impact on the situation with as of now surveyed sore. Teledentistry has decreased holding up periods and saved assets by offering these administrations at nearby levels with expert interview.

7.6 Application in Pediatric Dentistry

As referenced under applications in school and youngster care focuses that there can be block attempt of numerous issues particularly early recognition of dental caries. In the event that dental caries can be early recognized mass sickness of caries can be stifled. Amável et al. have shown in genuine conditions that dental issues and dental treatment arrangement have been made simple by on non-intrusive imaging for analysis of far off pediatric dental patients [32]. Kopycka-Kedzierawski et al. have effectively contemplated the commonness of dental caries in kids utilizing the media transmission innovation and dental photos were taken with intraoral cameras and online stockpiling of pictures [33] These investigations have assessed a telemedical arrangement of removed efficient dental registration in kids, utilizing the transmission of computerized pictures in order to get a total knowledge into the situation with teeth of these kids, with unique accentuation on early dental caries. Advanced pictures got with high goal intraoral cameras can show beginning caries stages or veneer and dentin pigmentations. The strategy for teledentistry has been shown in giving dental separating removed, rustic, and other blocked off territories and as an option in youngsters terrified of dental specialists, subsequently lessening their dread and uneasiness contrasted with clinical assessment progressively.

7.7 Application in conservative dentistry and endodontics [34, 35, 36]

Teledentistry goes about as a mechanism for correspondence at far off places if there should arise an occurrence of criticalness helps making a paper analysis of periapical lesions accordingly influencing anticipation Digital data is made for every one of the teeth of interest: succession of computerized extraoral photos (frontal and reciprocal), arrangement of advanced intraoral photos (vestibular bit of the alveolar edge nearby at the degree of tooth root, palatal/lingual segment of the alveolar edge of the objective tooth, and dental crown), retroalveolar dental computerized X-beam. Zivkovic et al showed that finding of periapical lesions with teledentistry techniques and web can be evaluated sufficiently based on which an essential arrangement can be concocted for appropriate endodontic or oral careful methodology needed for these lesions..

7.8 Application in periodontics [37]

The Web-based teledentistry conference framework produced for the US Department of Defense dental centers showed that references to oral medical procedure, prosthodontics and periodontics had the most elevated number of counsels. Fifteen patients went through periodontal medical procedure at Fort Gordon, Georgia, and

after seven days, their stitches were eliminated at an area 150 miles away under the tele-oversight of the Periodontist. Just 1 patient made the return-trip for a subsequent system.

7.9 Application in prosthodontics [38]

Teledentistry helps in assessment of patients requiring dental prosthesis and acquires general thought regarding decision of prosthesis and gross expense. It additionally assumes a significant part in the CAD/CAM framework. Ignatius et al explored utilization of videoconferencing for determination and treatment making arrangements for patients requiring prosthetic or oral recovery methods. The subsequent task document is scrambled and sent by email to a teleconsultant for model investigation, projection of the state of reclamation, of its stature and interjaw connections utilizing a virtual articulator; the finished undertaking is then encoded and gotten back to the facility, as a rule by email

7.10 Application in orthodontics

Orthodontic practice on daily basis clinically needs assistance of specialist using today's processed i.e. computer technology. Minor emergencies in orthodontic field like rubber ligature displacement, discomfort due to appliance or irritation in cheek or soft tissue injury can be easily assessed and patient along with parents can be reassured and without the need for their visits to the clinic. *Berndt et al*, assessed the feasibility of a; general dental practitioner providing interceptive orthodontic services to disadvantaged children with real time supervision from orthodontist using teledentistry [39]. Online teledentistry trial has assessed that inappropriate orthodontic referrals to consultants are reduced and provided general dental practitioners with quick access to advice that would enable them to tackle a wider range of cases themselves [40]. Other trials done to test validity of a teledentistry system for screening orthodontic referrals. Patients were alluded through a "store and forward" teledentistry link and were later evaluated clinically, to assess whether the same decision to accept the referral was made. It was seen that clinician agreement for screening and accepting orthodontic referrals based on clinical photographs was comparable to that detailed for clinical decision making. [41] Few studies showed the impact of teledentistry advice on outcome of orthodontic treatment provided by general dental practitioners demonstrated that "TeleDent SW" enabled them to offer a superior service for their patients and use specialist services more appropriately. [42]

8. Teledentistry in Covid times [43]

Teledentistry can be a suitable option to increase access of healthcare services to patients and save resources during the COVID-19 pandemic. In light of social distancing and lockdown measures, healthcare providers should consider adapting patient pathways and using telehealth as a method of consultation in the recovery planning of services. A Survey conducted showed patients positive perspective towards teledentistry in all five domains: patient satisfaction, ease of use, the effectiveness including increasing access to clinical services, reliability of the teledentistry system and usefulness for patients.

9. Benefits of Teledentistry

- Reduced cost of service and improved quality of care. [4]
- Reduction in peer isolation and increased specialist support as well as education.[27]
- General dentists will send multimedia patient records to dental specialists, often enabling the specialist to make a diagnosis and develop a treatment plan without having to see the patient in person.[26]
- Improvement in diagnostic services
- Improved integration of Dentistry into the larger health care delivery system.[12]
- Improvement in communication with the Insurance industry with respect to requirements.[12]
- Improvement in communication with dental technicians.

10. Limitations of Teledentistry

- There is necessity for appropriate training, pressure for an instant response, message-misunderstanding, privacy concerns and possibility to overlook/ neglect messages. [16]
- Practitioners choosing to include teledentistry as part of their practices ought to educate themselves as to the legal, technological, and ethical issues that are a part of this new practice medium.[4]
- Another important concern is cost of equipment required for teledentistry. Dental practice set-ups must have intra-oral cameras, digital cameras and computers with Internet access, which automatically cater to teledental solutions. As innovation has advanced, changes in the size, features, and costs of various technological components have decreased the cost of teledental consultations. [45]

11. Future Aspects of Teledentistry

Teledentistry is a rapidly forming subset of telehealth, a field that already has considerable impact on the health care industry. Day by day, the use of this new field is attracting dentists across the globe and bringing the fraternity closer as well as improving the quality of the services rendered. The advances in telecommunication have rightly enabled the dental care to promise many exciting changes during the next few years [13]. The future might also see distant telemedical control of robotized instruments in situations with long-term unavailability of dental care, e.g., during space flights, on transoceanic ships, and in various rural areas. Medical staff involved should be should be trained and must have adequate computer knowledge & skills with teaching experience [44]. Dental practitioners must have license to practise, ensure the security of their systems and data that they transmit. Data encryption, password protection and user access logs can help in deterring most of the people and in protecting patient confidentiality [4]. Teledentistry can work wonders in emergency dental conditions, posttraumatic and postoperative controls, postprosthetic patient surveillance etc. Nanotechnologies, stem cell research and control of bioinductive and bioregenerative materials can be extensively studied through telemedicine

and teledentistry. Also it can be used in methods is to support the processes of collection, triage, sorting, counting, and analysis of raw electronic data for the purpose of induction in the systems of artificial intelligence. So far we have achieved a lot with teledentistry but still a thousand miles to live a safe and better life

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