TELEDENTISTRY AND ADVANCEMENTS IN TRADITIONAL DENTAL CARE

ABSTRACT:

Health care affordability, accessibility, availability, and quality have long been a major concern for humanity. Telemedicine has emerged as a new promise for alleviating health care constraints. It is the use of tele-communications and information technology for consultations, education, and public awareness, with the goal of improving patient care and time management. Teledentistry is a form of telemedicine that is used in the field of dentistry. It is beneficial in improving services to underserved people, such as those in rural or less developed areas.The recent spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its associated coronavirus disease (COVID-19) has caused widespread public health concerns However, due to restrictions in movement, it was difficult for the patients to visit the clinics for routine check-ups. This was overcome by the advent of INTERNET OF DENTAL THINGS(IODT) which has a major impact on and have tremendously transformed teledentistry. Dental health app platforms using AI have made teledentistry more accessible and user-friendly. The advent of sensor and camera technologies has opened up new possibilities and breakthroughs. Furthermore, teledentistry can be a beneficial tool for peer education, consultations, and ensuring proper referral channelizing.

Key words: Teledentistry, Technology, Remote monitoring, Internet, Dental apps

1.0 INTRODUCTION:

The combination of internet combined with latest technological and multimedia gizmo have allowed their use in all applicable fields in human life and it was an inevitable event that health care services merged with internet and communications.[1,2] This brought a huge change in how health care has been rendered. This merger gave birth to telehealth services worldwide.[2,3] The **Agency for Healthcare Research and Quality** (AHRQ) states that,"Telehealth is the use of telecommunication technologies to deliver health-related services and information that support patient care, administrative activities, and health education" Dentistry in recent decade have seen unfurling changes in the field of telehealth which called itself teledentistry.[1,4]

The term ‘Teledentistry’ was first used by Cook 1997 who defined it as **the practice of using video-conferencing technologies to diagnose and provide advice about treatment over a distance**.[5,6,7,8]

It is a dynamic new limb added to telehealth care systems.[9,10] Though it is a much more challenging domain as oral care generally needs face-to-face intervention,still it has potential for remote monitoring, diagnosis, and emergency care till one can visit a dentist.[11]

Making appointment, proper use of dental health care products and post-treatment care in case of short-term practitioner visits are well incorporated in teledental care systems.[12,13,14]

Unfortunately, the Corona virus Disease-2019 (COVID-19) with its grim consequences, had worsened the overall health care along with a huge impact on the oral health care for the general population.Dental practices came to a serious halt due to the basic nature of the profession.[15,16,21]

The exchange of clinical information and images over remote distances for dental consultation and treatment planning was a possibility teledentistry offers key advantages in the dental management of patients without involving the risk of human-to-human transmission.[17,18]

To focus on teledentistry, there is a crucial need for dentists to venture into new virtual platforms, acquire proper education and training about the same,become ready to implement its use into normal practice and promote its use equally among fellow practitioners and patients. [19,20,21]

The telehealth platforms not only aids in consultations and treatment plans but also follow ups,health education, primary prevention as well as health promotion.[22,23,24]

Awareness of patients about teledentistry is an immediate requirement for implementing the services.Payment transparency should be followed among those who uses the platforms for consultation and treatment.[25,26]

2.0 METHODS IN TELEDENTISTRY:

The scope of Teledentistry includes making all types of medical facilities available at all times from anywhere on the planet via the internet, mobile phones, Short message services (SMS), or data centers, as well as the

secure exchange of online medical consultations, online health records, online drug prescription management, and pan-national patient data exchange.[19,20,27,28]

Teledentistry can be practiced through **4** methods: [4,29,30]

a) REAL TIME CONSULTATION OR LIVE VIDEO (SYNCHRONOUS):

Real-Time Consultation uses audio-visual aids between dental experts and their patients.

b) STORE AND FORWARD (ASYNCHRONOUS):

Storing and Sending (Asynchronous) radiographs, pictures, video, digital impressions, and photomicrographs are examples of documented health information that is communicated via a secure electronic communications system.

c) REMOTE PATIENT MONITORING (RPM):

Personal health and medical information is obtained from an individual from one site and communicated to a provider (often via a data processing service) in another location to be used in care related activities.

The latest addition to the methods of teledentistry is mobile health or m-health.

d) MOBILE HEALTH:

Mobile communication technologies, such as cell phones, tablets, or personal digital assistants, support health care and public health practise and education. Patients can use a smartphone app to access teledentistry, which could include apps that track patient brushing or other forms of home care.

3.0 TECHNOLOGY IN USE AND ADVANCEMENTS:

The need to oral health equity and equality along with the obligation of oral health care to flourish in every nook and corner of the world and the necessity to provide unhindered dental services in situations of severe pandemic, teledentistry has a lot of potential to become frequently used in terms of clinical care and public health delivery.[31,32,33]

Teledentistry system consists of a computer/laptop, an intraoral video camera, and a digital camera for the pictures. It also consists of a modem and an internet connection can just be availed with a simple smartphone or even through telephonic conversations. Recently teledental services employs innovative technologies, such as website monitoring applications, mobile phone apps and various wearable and implantable devices. [29,34,35]

3.1 TELEDENTAL WEBSITES :

Few of the teledental companies who have accessible websites which has a worldwide reach in teledental services are: [36,37,38,39,40]

- https://www.dentulu.com/ - a Los Angeles-based company that offers teledentistry consultations and other services in several languages and can send a dentist to a patient's home.

- https://www.mouthwatch.com/ (**TeleDent** is the teledental platform of Mouthwatch). It is a New Jersey company offering the secure and scalable TeleDent platform for real time and recorded communication between patients and providers, treatment planning, and virtual consultations

- https://teledental.com/ - comes with a microsoft, android and ios supported smartphone application

- https://www.theteledentists.com/ -is a Kansas City based company that allows users to have virtual consultations with dentists at any time of the day and can refer them to a local dentist

- https://www.toothpic.com/- is a New York City-based company that provides oral health education, allows them to get feedback from dentists on photos of their teeth and answers dental questions, all via a secure online platform

Few services in India:

- https://www.delhidental.com/teledentistry/- Dr. Kathuria's Dentistry is a dental setup that brings Teledentistry in Delhi, India

- https://www.dentistsforme.in/ - Colgate-Palmolive (India) Limited, has launched Colgate DentistsforMe - the first of its kind Teledentistry platform in June 2020.

- https://dentamitra.com/- based in Bengaluru offers a dental online site and application, which uses an artificial intelligence scanner to diagnose teeth problems through image processing. The website also enables users to search for dental clinics and doctors nearby, book appointments, and connect with doctors over video calls.

- http://www.dialdent.in/ - Gurgaon, Haryana based DialDent is a company dedicated to revolutionising preventive health care in India through it's services.

- https://edantseva.gov.in/- contains information about the National Oral Health Program (NOHP), detailed list of all the dental facility and colleges, Information, Education and Communication (IEC) material and a unique feature called the 'Symptom Checker', which provides information on symptoms of dental/oral health problems, ways to prevent these, the treatment modes along with nearest available dental facility (public and private sectors both).

3.2 FEW OF THE DENTAL APPS USING THE MODE OF TELEDENTISTRY: [41,42]

- **MY DENTIST**:

The app with its online website is an award winning comprehensive oral healthcare management and promotion platform in the United Kingdom.The service providers speak to patients on the phone first to offer help and advice and book in appointments if the dentist needs to meet patient face-to- face.The app remained active in the pandemic situation for the patient care.

- **DENTAL MANAGER** :

Each patient on this app has its own profile.The patient profile contains any information that is needed for consultation or treatment and any additional information/procedure is instantly displayed on the patient's dental chart. For each visit, user can choose the type of procedure with details about the cost of treatment, and the time of the visit.

- **DENTAL Rx:**

This software lets dentists write prescriptions and transmit them to the lab instantly, through an iPhone.

- **iROMEXIS**:

It is a full-featured 2 Dimensional (2D) and 3 Dimensional (3D) mobile photo viewer. All images created, including 3-D photographs, are displayed on an X-ray equipment. Images are one of the simple methods to make patient education and consulting more convenient.

Many of these sites provide their own intraoral camera softwares and screening tools along with spaces to upload data on complaints and radiographic images.[43]

3.3 ADVANCEMENTS:

The Internet of Dental Things (IoDT) [44,45] currently allows dentistry equipment to gather and exchange data with the use of software, sensors, embedded electronics, and networking connectivity, which may be shared in real-time with the dentist, thereby improving the preventive care process [44,46]. It proposes a 'smart' and new dental health-care strategy for preventing and treating dental caries, oral cancer, periodontal disease, and other dental problems. This has a lot of potential in terms of reaching out to people about their dental health. A dentist, for example, can assess an individual's oral hygiene using data obtained by the camera and sensors while brushing [47].

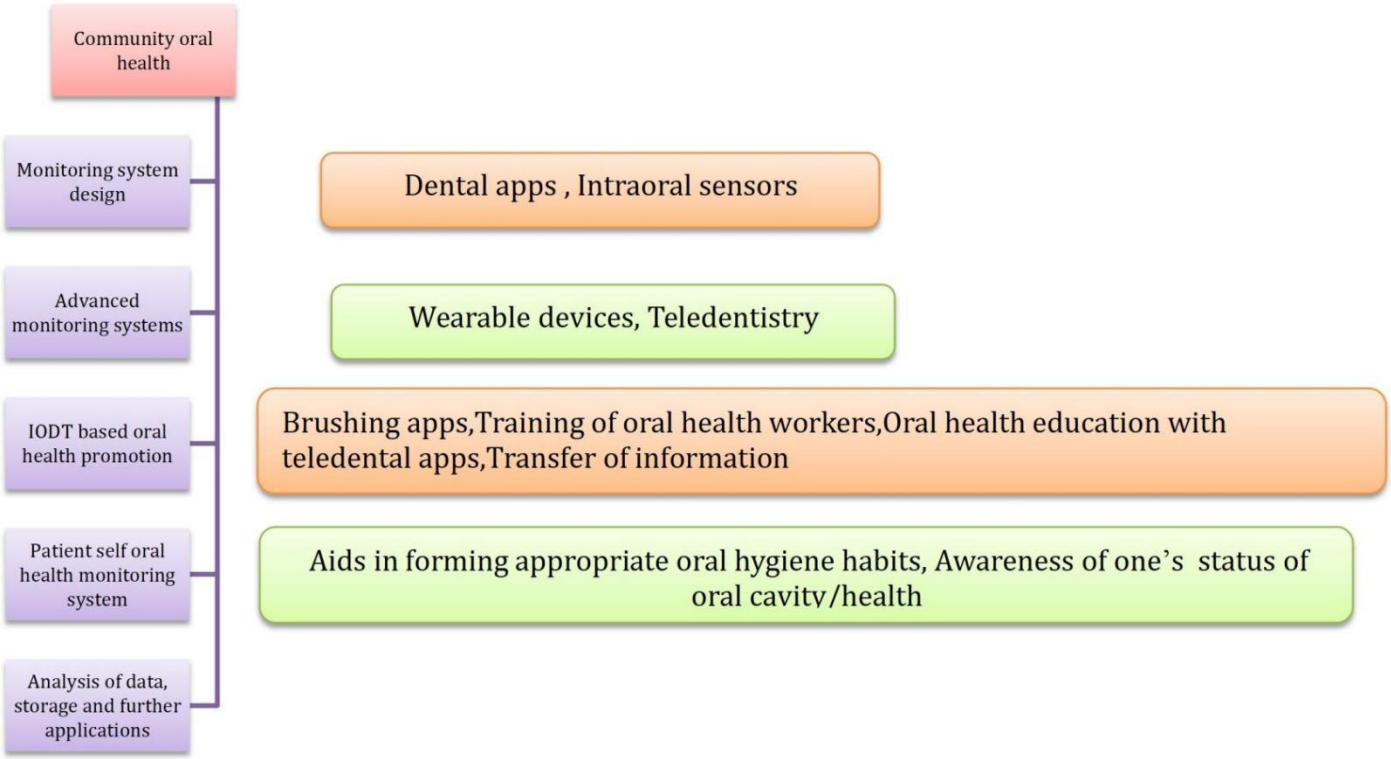

Figure 1: Chart describing contribution of teledentistry in Community Oral Health [48]

supportive equipments specifically aiding in remote oral health monitoring,could be used in collecting data and information from patients using teledental services [49]. Few are listed as follows:

3.3.1 Camera technology :

Camera technology will improve, allowing for smaller cameras and more detailed images. Endoscopes are already in use in doctor's offices. Dentists in remote areas will be able to make better judgments based on more precise data because to developments in camera technology. In rural areas using the intraoral camera could be performed by any type of health worker and not only requires a dentist. A dentist can judge the status of oral health using the images and provide with a diagnosis and treatment plan. Few camera technologies are even patient friendly and the images of one's oral cavity could be. [46,49,50]

3.3.2 5G Technology:

In comparison to existing mobile technologies, the 5G-based IOT ecosystem is a network of linked devices that use the 5G network and incorporate new technological capabilities that boost productivity. [46,48]

3.3.3 Biosensors:

Biosensors are a viable and cost-effective alternative in healthcare, whether it is for general or oral health and disease monitoring. This technique could be used in implantable appliances and other point-of-care devices to just provide continual monitoring. They function by converting a biochemical reaction into usable data by employing biological components. [46,58] A bioreceptor is connected to a transducer in this system, such as biologically produced or derived materials, or biomimetics. Sensor-based dental devices can be connected, to acquire precise data and timely notifications. [49,50,51]

3.3.4 Wearable and monitoring technologies:

The sensors would be placed near the mouth or mounted or implanted inside the oral cavity for to collect samples. The device then would produce data viewable on a user's smartphone or sent to the user's doctor through teledental services. Teeth implants, orthodontic

brackets,retainers,clear dentures/aligners, mouth-guards etc. can relay arrays of patient data on disease-specific biomarkers, diet, habits, masticatory forces etc.over the storage platforms like the 'Cloud', ready to be accessed by the dentist [52,53].

3.3.4.1 Tooth mounted chips:

The wireless sensors are designed to monitor health and dietary habits, relaying data about sugar, salt,water and alcohol intake recorded by the sensor layers and successfully transmitted to the receiver via the radio frequency signal. [46,48] Tiny IoT devices are placed in teeth because it is smaller in size (2X2mm) and can be easily bonded to tooth. In addition, placed device effectively transmits information via sensor due to the successful response to the received radio-frequency signal.[54] The placed Internet of Things (IoT) sensor collects the entire chemical, nutrient, and other information via different layers presented in IoT teeth mounted sensor. The bio responsive layer collects entire chemical information and nutrient data which is transmitted to receiver or health care provider via radio-frequency spectrum. Along with the nutrient information, salt, sugar and other water level contents also [55] .

3.3.4.2 Mouthguards:

Mouthguards using 'Cavitas sensors' [56] is integrated with a glucose sensor and a wireless measurement system to monitor salivary glucose. Due to the sensors embedded in the mouth guard, which detects the vibrations caused by grinding, they are being warned by alarms send via "Bluetooth' to their "Smart-phones. The device could identify the areas of teeth that are most affected by the clenching and grinding and help dentists devise effective treatment and restoration plans [52].

3.3.5 Dental 3d scanner :

In the domain of dentistry, a variety of imaging methods are used. Scanners at dental laboratories can also be used to create a 3D digital model from a precise model or impression of the [46,57] . It allows for automatic scanning of a patient's specific body part in less time and at a lower cost. Dental lab scanners are increasingly a component of the digital process in dental labs. For example, Near Infrared Technology is used in the **iTero Element Plus Series** imaging systems to create 3D models, intraoral scans, and aid in caries identification [49].

3.3.6 Virtual and Augmented Reality :

This help in creating a highly detailed virtual model of the human body including oral cavity to be specific, which can undoubtedly aid in precise diagnosis and treatment plan formulation. This can be used for in-person consultaion and off-site training [59,60].

3.3.7 Artificial intelligence (AI):

Artificial intelligence is a term that refers to a multitude of ways for making robots perform with human-like intelligence. It requires merging massive amounts of data with sophisticated algorithms to develop machines that can perform tasks on their own. In Teledentistry, AIs can help in patients trying to reach clinicians with their oral health problems can perform preliminary as well as advanced diagnoses and formulation of treatment plans [61,62].

3.3.8 A Conceptual IoDT Based Caries Prevention Model [48]:

This IoDT based caries prevention model could be easily applied at the community dental care level. This shows the comprehensive use of modern technological advancement specifically brought out by the Internet of Dental Things concept, to improve the purposes of teledentistry. There are few steps that follows. These can be applied to any other model concerning diagnosis as well as treatment of oral disorders through the use of teledentistry.

1. **Oral data collection stage**: In this first step, intraoral sensors are used to monitor different factors like pH of oral cavity, presence of biofilm, temperature of oral cavity etc. The generated data is collected continuously and interruptedly from patients.

2. **Data Transfer stage**: This collected oral care data gets transferred to the cloud server through mobile phones or tablet app.

3. **Analysis of data and storage**: IoDT application, Artificial Intelligence (AI) and teledentistry carries out the analysis of data and storage.

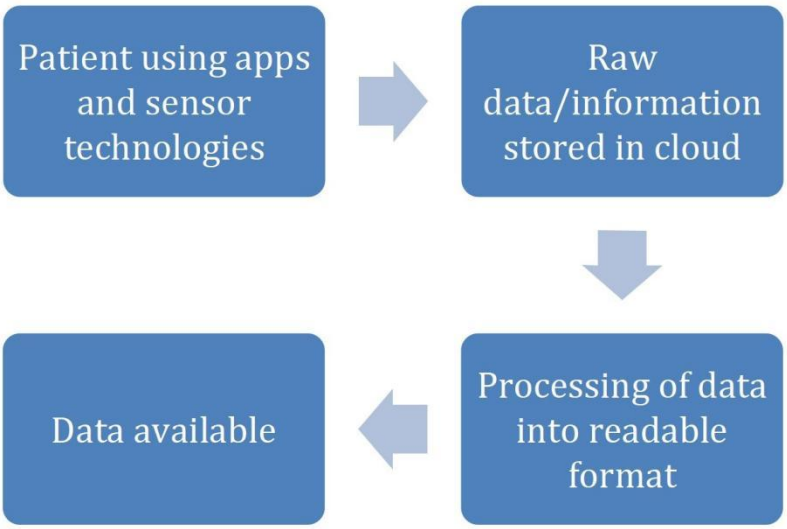

Figure 2: Showing interconnection between data collection through devices and softwares and its appropriate use in teledentistry.

Advantageous to teledentistry, these data stored in a centralised database can be used to determine oral health status and disease prevalence in customers based on age, sex, socioeconomic status, profession and other comparable demographics. This would help in monitoring as well as prevention of disease and understanding behavioural aspects of patients to use teledental services for treatment. Knowing the disease trends and other aspects of oral disease diagnosis and treatment, can help in a community level of oral health promotion and imparting health education with sound statistics and can help in bringing oral health equity in accessible and remote areas [63].

4.0 IMPACT IN TRADITIONAL PRACTICE:

Though face to face doctor-patient interactions is comfortable and best way to provide proper oral health care, nevertheless amalgamation of teledental practice with traditional methods or even to some extent entirely technology based oral care have high prospective of efficient and effective all round dental treatment.Various technological and network advancements in around the world as well as the country will soon enable dentists to establish teledental services as sole mode of providing dental care or as an add-on mode to traditional systems. Patient education and motivation is required to popularise the use of teledentistry.With more advancements in this field,

companies providing teledentistry services or technology related to sharing of health related data should invest aggressively in high security and proper mode of consent acquiring. The more safe and secure customers feel to share data and with ease of consultations,teledentistry can become a relatable mode of oral health care service platform.The self perception of practitioners vary from region to region around the globe. Applying teledentistry in dental practice was generally well perceived by dental practitioners.Gender differences in perceptions were linked to certain aspects of the efficiency and cost reduction of teledentistry and the most important concerns were about security and confidentiality.Targeted patient according to the residential areas (Tier1/Tier2/Tier 3) decides the level of internet penetration and thus there is more accesibility in Tier-1 to use teledental services.

5.0: PHARMACOLOGICAL SERVICES :

Clinicians on daily basis communicate about pharmaceutical products and services or prescribe drugs to those who require them over technological devices- a simple example of how telehealth services could be used for prescription of drugs and therapeutic measures. Online or on-call services to deliver medications at doorstep has been a huge relief during the pandemic times and to remote places or to the ailing. Online customer base are growing rapidly and primary motivation has been receiving proper and effective pharmacological consultations to curb the problem at hand or to get relief until the next appointment [64]. E- Drug prescription is an important part of teledentistry as it educe medication errors and monitor for drug interactions to help enhance health care quality and patient safety.

• Providers can electronically request prescription refills, making care more convenient.

For doctors, pharmacies, and patients, e-Prescribing is more convenient, less expensive, and safer.

6.0 CONCLUSION:

Teledentistry is a new and promising technique that uses modern telecommunication procedures to improve oral health care. It is a fast-growing branch of telehealth, a field that is already having a significant impact on the health-care business. Although it is not error-free and involves many medicolegal issues, in the testing times of COVID-19, teledentistry has proven to be extremely

beneficial for handling emergency situations as far as possible, without causing the patients to visit the dental clinic unless absolutely essential. Fortunately it is advancing in all inclusive areas and growing more popular in the dental industry, thanks to its many advantages for both dentists and patients. Teledentistry can help patients of all ages receive early intervention and preventive therapies. The most practical use of teledentistry is to move preventive and early intervention treatments out of the dental clinic and into the community. Teledentistry will be significantly improved by real-time data from Artificial Intelligence and other wearable devices, along with increased analytics powered by the electronic health record system network. The significant advancement would be increasing patient awareness and optimism about using teledental services, as well as dentists' rapid preparedness to deliver these services.

6.0 Role of the funding source:

Source of funding was not used for the study.

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