

Article

Teledentistry Through Web Apps And IODT - Reforming Dental Care In The Covid-19 Era

Dr. Kunal Jha¹, Dr. Yagnaseni Mandal^{2*}, Dr. Avinash J.³, Dr. Gunjan Kumar⁴, Dr. Vinay S.⁵, Dr. Arpita Singh⁶

¹ Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha 751024, India; kunaljha101@gmail.com;

² Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha 751024, India; yagyaseni001@gmail.com;

³ Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha 751024, India; aviandash@gmail.com;

⁴ Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha 751024, India; drgk1014@gmail.com;

⁵ Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha 751024, India; reachvnys@gmail.com;

⁶ Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha 751024, India; arpitapathi@gmail.com;

* Corresponding author: yagyaseni001@gmail.com;



Citation: K.Jha, Y.Mandal, Avinash J., G.Kumar, Vinay S., A.Singh, Teledentistry Through Web Apps And IODT - Reforming Dental Care In The Covid-19 Era. *Iota*, 2021, ISSN 2774-4353, Vol.01, 03. <https://doi.org/10.31763/iota.v1i3.485>

Academic Editor : P.D.P.Adi

Received : 26 July 2021

Accepted : 26 August 2021

Published : 13 September 2021

Publisher's Note: ASCEE stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by authors. Licensee ASCEE, Indonesia. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

Abstract: Health care affordability, accessibility, availability, and quality have long been a major concern for humanity. It uses telecommunications and information technology for consultations, education, and public Awareness to improve 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. The advancements overcame this in technology, like introducing the INTERNET OF DENTAL THINGS (IODT), which has a major impact on and has 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.

Keywords: Dental care, Remote monitoring, COVID-19, Internet of Things, Biosensing techniques, Teledentistry.

1. Introduction

The internet, combined with the latest technology and multimedia gizmo, has allowed their use in all applicable fields in human life. It was an inevitable event that health care services merged with the 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 the 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 in 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 telehealthcare systems.[9,10] Though it is a much more challenging domain as oral care generally needs face-to-face intervention, it still has the potential for remote monitoring, diagnosis, and emergency care until one can visit a

dentist.[11] making an 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 COVID-19, with its grim consequences, had worsened the overall health care along with a huge impact on 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 and follow-ups, health education, primary prevention, and 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 use the platforms for consultation and treatment.[25,26]

2. 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, 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], Furthermore, Teledentistry can be practiced through 4 methods: [4,29,30]

1. *Real-Time Consultation or Live Video (Synchronous):*

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

2. *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.

3. *Remote Patient Monitoring (RPM):*

Personal health and medical information are obtained from an individual from one site and communicated to a provider (often via a data processing service) in another location for care-related activities. And The latest addition to the methods of Teledentistry is mobile health or m-health.

4. *Mobile Health:*

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

3. Technology in use and Advancements

The need for 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 a severe pandemic, Teledentistry has a lot of potentials 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 that can be available with a simple smartphone or even through telephonic conversations. Recently teledental services employ 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, Mo.-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 to Delhi, India.
- <https://www.dentistsforme.in/> - Colgate-Palmolive (India) Limited 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 revolutionizing preventive health care in India through its services.
- <https://edantseva.gov.in/> - contains information about the National Oral Health Program (NOHP), a detailed list of all the dental facilities 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*:

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

- *DENTAL MANAGER* :

Each patient on this app has their 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, the 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 2D and 3D mobile photo viewer. All images created, including 3-D photographs, are displayed on 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 software and screening tools along with spaces to upload data on complaints and radiographic images.[41]

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]. Figure 1 is a chart describing the contribution of Teledentistry in Community Oral Health [48].

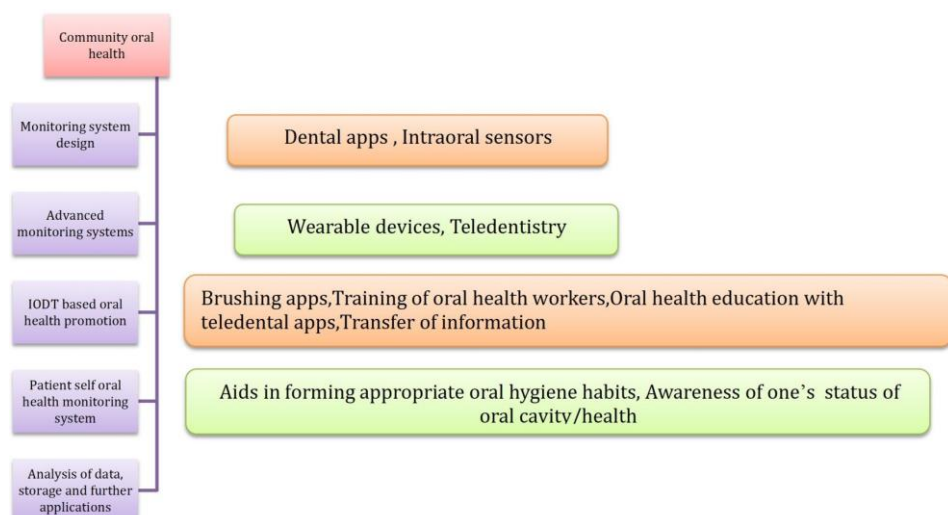


Figure 1. A chart describing the contribution of Teledentistry in Community Oral Health [48]

It proposes a 'smart' and new dental healthcare strategy for preventing and treating dental caries, oral cancer, periodontal disease, and other dental problems. This has a lot of potential in 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].

Supportive equipment specifically aiding in remote oral health monitoring could collect 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 make better judgments based on more precise data because of developments in camera technology. In rural areas, any health worker could perform the intraoral camera and not only require a dentist. A dentist can judge oral health status using the images and provide a diagnosis and treatment plan. Few camera technologies are even patient-friendly, and one's oral cavity images could be. [46,49,50]

3.3.2 5G. Technology

Compared 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 for general or oral health and disease monitoring. This technique could be used in implantable appliances and other point-of-care devices just to 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 to collect samples. The device then would produce data viewable on a user's smartphone or send it to the user's doctor through teledental services. Teeth implants, orthodontic brackets, retainers, clear dentures/aligners, mouthguards, 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 they are smaller (2X2mm) and can be easily bonded to the tooth. In addition, the placed device effectively transmits information via a sensor due to the successful response to the received radio-frequency signal.[54] The placed IoT sensor collects the entire chemical, nutrient, and other information via different layers presented in IoT teeth-mounted sensor. The bioresponsive layer collects entire chemical information and nutrient data transmitted to the receiver or health care provider via the radio-frequency spectrum, along with the nutrient information, salt, sugar, and other water level contents [55].

3.3.4.2 Mouthguards

Mouthguards using "Cavitas sensors" [56] are 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 sent via "Bluetooth" to their "Smartphones." 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 3Dimensional 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 3-dimensional models of intraoral scans and aid in caries identification [49].

3.3.6 Virtual and Augmented Reality

This helps in creating a highly detailed virtual model of the human body, including the oral cavity, to be specific, which can undoubtedly aid in precise diagnosis and treatment plan formulation. This can be used for in-person consultation 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 independently. In Teledentistry, AIs can help patients trying to reach clinicians with their oral health problems perform preliminary and advanced diagnoses and formulate 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 a few steps that follow. 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 the oral cavity, presence of biofilm, the temperature of the oral cavity, etc. The generated data is collected continuously and interruptedly from patients.
2. Data Transfer stage: This collected oral care data is transferred to the cloud server through mobile phones or tablet apps.
3. Analysis of data and storage: IoDT application, Artificial Intelligence (AI), and teledentistry carry out the analysis of data and storage.

Furthermore, Figure 2 is an Interconnection between data collection through devices and software and its appropriate use in Teledentistry. Advantageous to Teledentistry, these data stored in a centralized 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 monitor and prevent disease and understand the behavioral 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 to be inaccessible and remote areas [63].

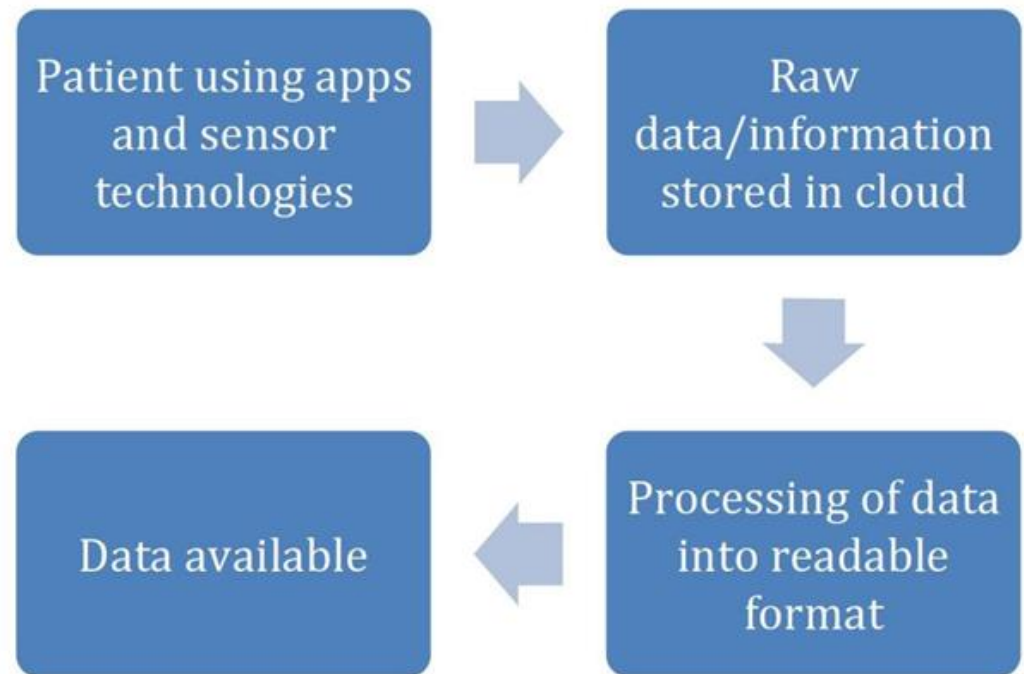


Figure 2. Interconnection between data collection through devices and software and its appropriate use in Teledentistry.

4. Impact in Traditional Practice

Though face-to-face doctor-patient interactions are the comfortable and best way to provide proper oral health care, an amalgamation of teledental practice with traditional methods or even to some extent entirely technology-based oral care have a high perspective of efficient and effective all-round dental treatment. Various technological and network advancements worldwide and the country will soon enable dentists to establish teledental services as the sole mode of providing dental care or as an add-on mode to traditional systems. Patient education and motivation are required to popularise the use of Teledentistry. With more advancements in this field, companies providing teledentistry services or technology related to health-related data sharing 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 oral health care service platform model. The self-perception of practitioners varies 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 Teledentistry's efficiency and cost reduction, and the most important concerns were about security and confidentiality. According to the residential areas (Tier1/Tier2/Tier3), Targeted patients decide the level of internet penetration, and thus, there is more accessibility in Tier-1 to use teledental services.

5. Conclusions

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 already having a significant impact on the healthcare business. Although it is not error-free and involves many medicolegal issues, in the testing times of COVID-19, Teledentistry has proven to be highly beneficial to handling emergencies as far as possible, without causing the patients to visit the dental clinic unless 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 and dentists' rapid preparedness to deliver these services.

Author Contributions: Conceptualization; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], methodology; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], software; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], validation; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S] formal analysis; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], investigation; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], data curation; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S] writing—original draft preparation; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], writing—review and editing; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], visualization; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], supervision; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S] project administration; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], funding acquisition; [K.J],[Y.M],[A.J],[G.K],[V.S],[A.S], have read and agreed to the published version of the manuscript.

Acknowledgments: The authors would like to thank the Kalinga Institute of Dental Sciences, India, and the research team members. Therefore, this research can be completed properly.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Accessed from: <https://www.ahrq.gov/cpi/about/otherwebsites/healthit.ahrq.gov/index.html>; Accessed on February 09th, 2021
2. Accessed from: <https://www.cms.gov/Medicare/Medicare-General-Information/Telehealth/index>; Accessed on: February 9th, 2021
3. Shirzadfar H and Lotfi F. The evolution and transformation of Telemedicine. *Int J Biosen Bioelectron*. 2017; 3(4):303–6.
4. Vij A, Sharma R, Jawa U. A New Hope - Teledentistry. *(IJSR)* 2021,10(3):174 - 80
5. Clark G. Teledentistry: What is it Now, and What Will it be Tomorrow? *J Calif Dent Assoc*. 2000; 28: 121-7.
6. Bumb, Swapnil. Teledentistry: It's All About Access To Care. *TMU J Dent*. 2014;1:64-6.
7. Chhabra N, Chhabra A, Jain RL, Kaur H, Bansal S. Role Of Teledentistry In Dental Education: Need Of The Era . *Journal of Clinical and Diagnostic Research*. 2011;5(7): 1486- 8
8. Gupta M, Datta S. Teledentistry: An Integrated Approach in Dental Education. *Indian J Dent Educ*. 2019;12(2):51-7.

9. Nesbitt TS, Katz-Bell J.' History of Telehealth. In Understanding Telehealth.' Rheuban K, Krupinski EA.McGraw-Hill; <https://accessmedicine.mhmedical.com/content.aspx?bookid=2217§ionid=187794385>.
10. Ryu, Seewon.Telemedicine: Opportunities and Developments in the Member States: Report on the Second Global Survey on eHealth. 2009 (Global Observatory for eHealth Series, Volume 2).Healthcare Informatics Research vol.2012; 18(2): 153–155.
11. Accessed from: https://www.who.int/goe/publications/goe_telemedicine_2010.pdf; Accessed on: Feb 09,2021
12. Accessed from:<https://www.aap.org/en-us/professional-resources/practice-transformation/telehealth/Pages/What-is-Telehealth.aspx>; Accessed on: February 9th,2021.
13. Accessed from: <https://www.medicaleconomics.com/>; Accessed on: February 10th, 2021
14. Koonin LM, Hoots B, Tsang CA and L Zanie.Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic – United States. Morb Mortal Wkly Rep 2020;69:1595–9
15. Abbas B, Wajahat M, Saleem Z, Imran E, Sajjad M, Khurshid Z. Role of Teledentistry in COVID-19 Pandemic: A Nationwide Comparative Analysis among Dental Professionals. Eur J Dent. 2020 Dec;14(S 01):116-22.
16. George PP, Edathotty TT, Gopikrishnan S, Prasanth PS, Mathew S, Ameen AAM.Knowledge, Awareness, and attitude among practicing orthodontists on Teledentistry during COVID pandemic in Kerala: A cross-sectional survey. J Pharm Bioallied Sci. 2021;13(Suppl 1):846-50.
17. Haider MM, Allana A, Allana RR. Barriers to Optimizing Teledentistry During COVID-19 Pandemic. Asia Pacific Journal of Public Health. 2020;32(8):523-524.
18. Bhochhibhoya A, SHRESTHA R.Teledentistry: A Novel Tool to Combat COVID- 19.International Healthcare Research Journal 2020;4(4):77-80
19. Kharbanda O, Priya H., Balachandran R., and Khurana C. Current Scenario of Teledentistry in Public Healthcare in India. Journal of the International Society for Telemedicine and EHealth.2019;(7):1-8.
20. Alvandi M. Telemedicine and its Role in Revolutionizing Healthcare Delivery'. The American Journal of Accountable Care.2017;5(1):e1-5
21. Agarwal N, Jain P, Pathak R and Gupta R.Telemedicine in India: A tool for transforming health care in the era of COVID-19 pandemic. J Educ Health Promot.2020;28(9):190-2.
22. Accessed from: https://www.who.int/goe/publications/goe_telemedicine_2010.pdf; Accessed on: Feb 09,2021
23. Almathami H, Win TK, Gjorgievska EV.Barriers and Facilitators That Influence Telemedicine-Based, Real-Time, Online Consultation at Patients' Homes: Systematic Literature Review.J Med Internet Res.2020;22:e16407
24. Jumreornvong O, Yang E, Race J, Appel J. Telemedicine and Medical Education in the Age of COVID-19. Acad Med. 2020; 95(12):1838-43.
25. Rahman N, Nathwani S, Kandiah T. Teledentistry from a patient perspective during the coronavirus pandemic. Br Dent J. 2020 Aug 14:1–4.
26. Al-Khalifa KS, AlSheikh R. Teledentistry awareness among dental professionals in Saudi Arabia. PLoS One. 2020;15(10):e0240825.
27. Mirhashemi S, Rasouli HR and Mirhashemi AH. The necessity of Telemedicine. Trauma Mon. 2015; 20(4):e25616.
28. da Costa CB, Peralta FDS, Ferreira de Mello ALS. How Has Teledentistry Been Applied in Public Dental Health Services? An Integrative Review. Telemed J E Health. 2020;26(7):945-954.
29. Jampani ND, Nutalapati R, Dontula BS and Boyapati R.Applications of Teledentistry: A literature review and update. J Int Soc Prev Community Dent. 2011;1(2):37-44
30. Accessed from: https://www.ada.org/~media/ADA/Publications/Files/CDT_D9995D9996-GuideTo_v1_2017Jul17.pdf; Accessed on: April 20th, 2021
31. Alauddin MS, Baharuddin AS, Mohd Ghazali MI. The Modern and Digital Transformation of Oral Health Care: A Mini-Review. Healthcare (Basel). 2021 January 25th;9(2):118.

32. Passi et al . Teledentistry - A new era, evolution, and advancement in dentistry. International Journal of Current Research,9(12):63256-63.
33. Estai, M., Kanagasingam, Y., Mehdizadeh, M. et al. Teledentistry as a novel pathway to improve dental health in school children: a research protocol for a randomized controlled trial.BMC Oral Health.2020;20(11):1-9
34. Tella AJ, Olanloye OM, Ibiyemi O. Potential Of Teledentistry In The Delivery Of Oral Health Services In Developing Countries. Annals of Ibadan postgraduate medicine.2019;17(2): 115-23.
35. Accessed from: <https://www.americanteledentistry.org/facts-about-teledentistry/>; Accessed on: Feb 18,2021.
36. Accessed from: <https://www.dentulu.com/>; Accessed on: July 10th, 2021
37. Accessed from: <https://teledental.com/>; Accessed on: July 10th, 2021
38. <https://www.onlinedoctor.com/best-teledentistry-companies/#TeleDentists>;Accessed on: July 10th, 2021
39. <https://yourstory.com/2021/03/world-oral-health-day-5-dental-tech-startups/amp>; Accessed on: July 10th, 2021
40. Accessed from: <https://www.republicworld.com/india-news/general-news/e-dantseva-is-the-first-ever-digital-platform-dr-harsh-varadhan.html>; Accessed on: July 10th, 2021
41. Accessed from: <https://www.dentistryiq.com/dentistry/prosthodontics-and-labratory/article/16361781/the-best-mobile-dental-apps>; Accessed on: April 14th,2021
42. Accessed from:<https://www.medscape.com/features/slideshow/dentalapps#3>; Accessed on: April 14th, 2021
43. Tiffany B, Blasi P, Catz SL, and McClure JB. Mobile Apps for Oral Health Promotion: Content Review and Heuristic Usability Analysis. JMIR Mhealth Uhealth. 2018;6(9):e11432.
44. Salagare, S., Prasad, R. An Overview of Internet of Dental Things: New Frontier in Advanced Dentistry. Wireless Pers Commun.2020;110:1345–71.
45. Liu, L., Xu, J., Huan, Y., Zou, Z., Yeh, S., & Zheng, L. A Smart Dental Health-IoT Platform Based on Intelligent Hardware, Deep Learning, and Mobile Terminal. IEEE Journal of Biomedical and Health Informatics.2020;24:898-906.
46. Javaid M, Haleem A, Singh RP, Suman R. Dentistry 4.0 technologies applications for dentistry during COVID-19 pandemic.Sustainable Operations and Computers.2021;2: 87–96.
47. Takuma Yoshitani, Masa Ogata, and Koji Yatani. 2016. LumiO: a plaque-aware toothbrush. In Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '16). Association for Computing Machinery, New York, NY, USA, 605–615. DOI:<https://doi.org/10.1145/2971648.2971704>
48. Salagare S, Prasad R. Internet of Dental Things (IoDT), Intraoral Wireless Sensors, and Teledentistry: A Novel Model for Prevention of Dental Caries. Research Square; June 07th, 2021. DOI: 10.21203/rs.3.rs-487495/v1.
49. Access from: https://cloud.info.itero.com/iTero-Plus-Pub?utm_source=Launch-Ad&utm_medium=banner&utm_campaign=Dental-Economics; Accessed on: August 08th, 2021
50. Pentapati KC, Siddiq H. Clinical applications of an intraoral camera to increase patient compliance - current perspectives. Clin Cosmet Investig Dent. 2019;11:267-78.
51. Kishen A, John MS, Lim CS, Asundi A. A fiber optic biosensor (FOBS) to monitor mutans streptococci in human saliva. Biosens Bioelectron. 2003;18(11):1371-8.
52. Kinjo R, Wada T, Churei H, Ohmi T, Hayashi K, Yagishita K, Uo M, Ueno T. Development of a Wearable Mouth Guard Device for Monitoring Teeth Clenching during Exercise. Sensors. 2021; 21(4):1503
53. Irving M, Stewart R, Spallek H, Blinkhorn A. Using Teledentistry in clinical practice as an enabler to improve access to clinical care: A qualitative systematic review. Journal of Telemedicine and Telecare. 2018;24(3):129-46.
54. Vellappally S, Kheraif A, Anil S, Wahba A . IoT medical tooth mounted sensor for monitoring teeth and food level using bacterial optimization along with adaptive deep learning neural network.Measurement.2019;135: 672-7
55. Accessed from: https://www.adea.org/GoDental/Dental_Blogs/Words_From_Your_Peers/The_Future_of_Dental_Technology_and_Innovation.aspx; Accessed on: August 9th,2021

56. Arakawa, Takahiro et al. Mouthguard biosensor with a telemetry system for monitoring of saliva glucose: A novel cavitas sensor. *Biosensors & bioelectronics*. 2016;84:106-11
57. Son K, Lee KB. Effect of Tooth Types on the Accuracy of Dental 3D Scanners: An In Vitro Study. *Materials (Basel)*. 2020;13(7):1744
58. Zhang Y, Chen R, Xu L, Ning Y, Xie S, Zhang GJ. Silicon nanowire biosensor for highly sensitive and multiplexed detection of oral squamous cell carcinoma biomarkers in saliva. *Anal Sci*. 2015;31(2):73-8.
59. Haleem A, Javaid M, Khan IH. Virtual reality (VR) applications in dentistry: An innovative technology to embrace. *Indian J Dent Res*. 2020;31:666-7
60. Kwon HB, Park YS, Han JS. Augmented reality in dentistry: a current perspective. *Acta Odontol Scand*. 2018;76(7):497-503.
61. Tandon D, Rajawat J. Present and future of artificial intelligence in dentistry. *J Oral Biol Craniofac Res*. 2020;10(4):391-6.
62. Accessed from: <https://ai-teledentistry.com/#:~:text=AI%20Teledentistry%20offers%20dentists%20an,more%20securely%20with%20their%20peers>; Accessed on: Aug 09, 2021
63. Bhargava A, Sabbarwal B, Jaggi A, Chand S, Tandon S. Teledentistry: A literature review of evolution and ethicolegal aspects. *J Global Oral Health* 2019;2(2):128-3