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Telledentistry; In the Time of Conflict in Palestine

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Abstract

Oral health matters. Teledentistry is defined as the collective use of technology to address oral health issues at a distance. The practice teledentistry could possibly be ideal for underprivileged population in remote places where access to oral health services is limited. Teledentistry specifies oral health care assistance through consultation, diagnosis, prevention, treatment using audio, video and data communication. The use of Information and Communication Technologies (ICT) for the exchange of data and information in dentistry, providing health services in situations where it is necessary to overcome geographical, temporal, social and cultural barriers is called teledentistry. Teledentistry can thus eliminate the disparities in oral health care between urban and rural communities. This articlereviews the role of teledentistry in different fields of dentistry and Palestine.

Keywords: *Teledentistry, Telemedicine, E-health, Information and communication technology, Oral health.*

Introduction

Tele is a Greek word meaning “Distance” and Mederi is latin word meaning “to heal”. The World Health Organization (WHO) defines telemedicine as the use of telecommunications and virtual technologies to provide healthcare outside of traditional healthcare facilities.By providing healthcare services from a distance it lessen the need for contact between the patient and the healthcare provider. Remove geographical barriers by bridging gaps in the unequal distribution of the healthcare facilities. It provides Care for more people, especially those who live in remote areas. **[1]**

Teledentistry is a relatively new field that combines telecommunication, technology and dental care. Due to the enormous growth of technological capabilities, teledentistry possesses the potential to fundamentally change the current practice and the face of the dental care. The term “teledentistry” was used in 1997, when Cook defined it as “the practice of using video-conferencing technologies to diagnose and to provide advice about the treatment over a distance” **[1]**. “Tele” is a Greek word meaning “distance” and “mederi” is a Latin word meaning “to heal.”

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Teledentistry is a developing area of dentistry that integrates electronic health records, telecommunications technology, digital imaging, and the Internet to link dental providers and their patients**.[2]** The use of teledentistry presents as an emerging web-based intervention system, distance learning framework, and a vehicle to decrease the phenomenon of professional isolation common to rural and underserved areas**[3-4]**.Teledentistry has high usability and significance for dentists, clinicians, patients, hospital managers and health care decision/ policy makers in state governments and central government. **[1-5]**

Teledentistry provides tremendous potential in improve access and delivery of oral health care, improving cost effectivenessand facilitating fast and efficient diagnosis and treatment planning with teleconsultation. Teledentistry could also bridge the gap between demand and supply by providing dental care in rural areas, where there is a shortage of specialists and comprehensive sophisticated health care. **[1-5]**

Telemedicine is being used today in academic medical centers, community hospitals, managed – care companies, rural hospitals and is also being used to link health care providers in developed countries to the hospital in developing countries. **[1-6]**

Various step sand needs are required to implement teledentistry successfully. Dentists should meet the existing standards of practice and both ethical and legal obligations **[7]**. They should take informedconsenttocollectpatientinformationand should bear in mind the later need for in-person treatment or clinical examination appointments **[7, 8].** Teledentistry requires fast Internet and modern electronic and digital equipment to deliver healthcare services accurately [**7, 9]**. There are two forms of teledentistry: Real-time consultation, which is the immediate transfer of information, and "store and forward," where data is stored and forwarded later as needed [10]. The storeand-forward teledentistry is the system widely used and consisting of a computer with a hard drive memory, digital and intraoral camera, RAM, speedy processor, and Internet connection. In some situations, there may be a need for a fax machine, printer, and scanner. Live video conferencing is enabled through the standalone IP/ISDN video conferencing or PCI codec board installation into the system. **[1- 9]**

Theconcept of teledentistry is the use of telecommunication and information technology, electronic medical records, video and digital images to facilitate the delivery of dental care to distant or isolated people or for consultations and staffing between specialists. [**14**] The type of interaction provided by teledentistry classifies it as synchronous or asynchronous. In asynchronous teledentistry, the information can be recorded for later analysis, as in an email. In synchronous teledentistry, the interaction is in real-time (eg, a videoconference). [**21**]

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Teledentistry is used in generalist and speciality practices, e.g., orthodontics, endodontics, oral surgery, periodontics and dental public health. The greatest value of teledentistry is the potential to reduce healthcare inequalities, providing greater access to specialists and timely oral care. [**11**] Teledentistry has the potential to identify high-risk populations, facilitate patients' referrals to a dental consultant and support locally-based treatment, thus reducing waiting lists and unnecessary travel and loss of productivity. [**15,16,20**]

This articlereviews the role of teledentistry in different fields of dentistry and Palestine.

History of Teledentistry;

Telemedicine began in 1924, with the concept of a physician seeing his patient over the radio using a television screen **[11]** . The initial 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 **[12].** The birthplace of teledentistry as a subspecialist fi eld of telemedicine can be linked to a 1994 military project of the United States Army Total Dental Access Project aiming to improve patient care, dental education, and effectuation of the communication between dentists and dental laboratories **[3 ,11 – 13]**. Teledentistry was put into practice by the U.S. Army by doing consultations on persons located more than 100 miles apart **[11]**. Since that time, various public health facilities, remote rural clinics, and organizations have practiced teledentistry with various degrees of success. The variation in the levels of acceptance and use of dental EHRs throughout the profession has been determined by the mode of communication preferred, type of software and hardware used, and the type of internet connection.

Advantages of Using Teledentistry;

Teledentistry provides a unique way to help overcome the barriers or geography and travel time to deliver long-distance clinical training, continuing education, and hands-on training for the dentist/dental hygienist at remote clinics [**11, 15**] .

Its application is of utmost importance and great value in rural and urban underserved areas where there is unavailability of specialist consultation which reduces the costs of service and improves quality of care [**12– 14**]. The results of telehealth usage increase inter-professional communications which will improve dentistry's integration into the larger health care delivery system [**13]** . Second opinions, pre- authorizations and other insurance requirements will be met almost instantaneously online, with the use of real images of dental problems, thereby making traditional dental care more efficient [**14, 15**]. In addition, it will facilitate the greater use of nondentist providers (such as dental hygienists or mid-level providers) and improve early

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diagnosis and treatment of oral disease [**15**] . For dental and dental hygiene schools, interactive video-conferencing allows for the evaluation of patient information (with or without the patient's presence), which allows for the interaction and feedback between the educator and the students [**14**]. Telehealth can serve as a tool to compliment and expand the capacity of school child care centers to meet the children's dental care needs by using technology to connect to the health providers at another location [**14**]. For dental facilities, there is long term cost effectiveness due to savings generated from not purchasing equipment and materials to develop traditional dental radiographs. Although Telehealth is being used nationally and internationally by educational institutions and public health facilities, still many legal, fi nancial, and ethical concerns exis.

Disadvantages of Using Teledentistry;

Telehealth allows the dental hygienist to initiate treatment based upon their assessment of a patient's need without a dentist on site; however, supervision levels vary from state to state and this affects the services a dental hygienist may perform in rural and remote settings using teledentisty equipment **[3**] . Accountability, licensure, jurisdiction, liability, privacy, consents, and malpractice are crucial aspects to consider when attempting to establish the foundations of a telehealth practice [**11,13**] . The most signifi cant barrier to a nationwide teledentistry practice is the traditional system of state-by-state licensing. There is no law to clarify the role of the teledoctor and their liability [**11**]. The cost of the telecommunication equipment has also been a matter of concern and presently, the cost for virtual teledental consultations has not been reimbursed by insurance companies [**3 ,12**]. Ethically, patients must be made aware that their medical and dental information will be transmitted electronically and the possibility exists that the information will be intercepted, despite maximum efforts to maintain security and confi dentiality [**11 ,13**]. In addition, some doctors may use the internet to set up and seek direct patient contact, thus becoming cyberdentists. [**11, 13**] using telehealth technology. Other challenges include: the time and cost it takes for practitioners and staff to get acclimated to using the telehealth system. In underserved communities (below the poverty line) located in rural or urban areas, the lack of infrastructure and patient literacy remain major obstacles.

Equipment:

A few years ago, teledentistry involved calling an expert on the telephone for advice. Now it involves consulting experts using the Internet. It involves the local dentist digitizing and electronically transmitting drawings, diagrams, photographs, and X-rays to a specialist.**[5]**

To develop the teledentistry-assisted, affiliated practice dental hygiene workforce model and add teledentistry skills to its curriculum two each of the following equipment is required: Open

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Dental office management software; Tiger View Professional digital imaging management software; Acclaim Intraoral Digital Cameras; Scan-X Duo digital x-ray film scanners; Nomad Portable Handheld X-ray radiographic systems; Dell laptop computers; and Dell projectors. All of the equipment chosen integrates seamlessly and has proven to besuccessful in both local and remote applications of teledentistry-assisted, affiliated practice dental hygiene.

Interactive video-conferencing may be conducted via POTS (plain old telephone service), satellite, ISDN, Internet or Intranet. Nowadays social media like facebook and whats-app are being used for teledentistry. It allows dentist to seek opinion of experts and peers for difficult procedures. Also pictures are posted of treatment already done by the dentist. [**6-7**]

Various steps and needs are required to implement teledentistry successfully. Dentists should meet the existing standards of practice and both ethical and legal obligations [**7**]. They should take informed consent to collect patient information and should bear in mind the later need for in-person treatment or clinical examination appointments [**7, 8**]. Teledentistry requires fast Internet andmodern electronic and digital equipment to deliver healthcare services accurately [**7, 9**]. There are two forms of teledentistry: Real-time consultation, which is the immediate transfer of information, and "store and forward," where data is stored and forwarded later as needed [**10**]. The storeand- forward teledentistry is the system widely used and consisting of a computer with a hard drive memory, digital and intraoral camera, RAM, speedy processor, and Internet connection. In some situations, there may be a need for a fax machine, printer, and scanner. Live video conferencing is enabled through the standalone IP/ISDN video conferencing or PCI codec board installation into the system. [**5-10**]

Legal Considerations in Teledentistry;

We all live in digital era where sending an E-mail or a text message to a colleague as teledentistry referral might become a matter of legal scrutiny and can have immense ramifications for the dentists. Any practitioner offering an opinion over the internet, either to a colleague or a layperson, through E-mail or formal consultation should ensure that they write a disclaimer mentioning that all of the consultation is done over teledentistry and should also ensure that they take a digital written and duly signed informed consent from the patient to prevent themselves from being sued for malpractice by courts. There are also issues about the confidentiality of medical and dental information. Therefore, an informed consent should be taken from the patient and the patient should be made aware about the inherent risk of improper diagnosis or treatment due to the failure of technology.

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Furthermore, since the dentist does not treat the patient physically, the patients might (or claim to) suffer from a teledentistry referral and such consultant may be liable under negligent supervision thus, it is imperative for them to obtain a digital written and duly signed informed

consent from the patient to prevent themselves from getting trapped for under malfunction. The Office for Civil Rights will not enforce penalizations for Health Insurance Portability and Accountability Act noncompliance against oral health providers that oblige patients in good faith through teledentistry during the COVID-19 public health emergency. However, health -care professionals should give a disclaimer before proceeding with virtual consultation

to inform patients that third-party applications possibly present may breach in privacy, and all obtainable privacy modes as well as encryption should be allowed while using such technology and applications.[**29- 32**]

CURRENT EVIDENCE FOR TELEDENTISTRY;

1.Oral medicine and radiology;

Teledentistry plays a vital role in this specialty by enabling the transmission of images of oral and mucosal lesions viaelectronicmailforspecializedconsultation,discussions, sharing ideas and providing provisional diagnosis for the patient.[**33**] Oral lesions can be shared with the aid of photographs and subsequent clinical data can be stored as a textual file for correlation. Diagnosis can be enhanced by using a complete electronic patient history comprising of past medical records, drug history and family history (if any). Digital radiology is equivalent to traditional films for many diagnostic and therapeutic tasks and is considered an essential part of oral diagnosis. In addition, it also serves the advantage of diminished radiation exposure for both patients and dental personnel. Intraoral/Extraoral radiographs of a patient can also be sent to a specialist through different means of applications for further opinion and consultation, also termed as teleradiology.9 A previous study compared the radiological interpretation of periapical lesions when analyzed by a conventional means or teledentistry and the results revealed no significant differences between these two methods.[**34**]

Bradley M et al.[**36**] successfully proved the use of teledentistry in oral medicine in a community dental service in Belfast, N. Ireland, using a prototype teledentistry system.[**30**] Torres-Pereira C et al. suggested that distant diagnosis is an effective alternative in the diagnosis of oral lesions using transmission of digital images by email.[31] Summerfelt FF reported a teledentistry-assisted, affiliated practice dental hygiene model developed by the Northern Arizona University Dental Hygiene Department, that allowed dental hygienists to provide oral healthcare to underserved populations by digitally linking up with a distant oral health team.[**38**]

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2.Pedodontics;

The method of teledentistry is as an excellent alternative for children afraid of visiting the dentist. This has led in a reduction in their fear and anxiety compared to clinical examination in real-time. Teledentistry in pedodontics can be utilized for diagnosing caries in young school children and also help in screening of early childhood caries in preschool children.[**39**] This will ultimately help to improve overall health of children.

Kopycka-Kedzierawski DT and Billings RJ showed that teledentistry is as good as visual/tactile examinations for dental caries screening in young children.[**50**] KopyckaKedzierawski DT et al. suggested that teledentistry offers a potentially efficient means of screening highrisk preschool children for signs of early childhood caries.[**41]** They successfully demonstrated a teledentistry project established in inner-city child-care centers in Rochester, NY.[**42**] Amavel R et al. stated that remote diagnosis of children dental problems based on noninvasive photographs constitute a valid resource.[**43**] Kopycka-Kedzierawski DT et al. demonstrated that the intraoral camera is a feasible and potentially costeffective alternative to a visual oral examination for caries screening, especially early childhood caries, in preschool children attending childcare centers.[**44**]

3.Orthodontics and dentofacial orthopaedics;

Teledentistry can help to provide interceptive orthodontic treatment supervised by specialized orthodontist for decreasing the severity of malocclusion for disadvantaged children who cannot afford orthodontic treatment.[**45**] It can also help to identify the children with oral habits like tongue thrusting, mouth breathing, nail biting, lip biting etc. With the help of telecommunication, children as well as their parents can be made aware of the future adverse effects of these habits. Minor emergencies such as.rubber ligature displacement, irritation due toan orthodontic appliance which usually warrants visits can be solved by using telecommunication. teleconsultants may also participate from a distance in the creation of a plan and program of orthodontic management. In a previous study, it was noticed that the clinician's agreement for screening orthodontic referrals on the basis of clinical photographs was comparable to those reported for clinical decision making.[**15,46**]

Berndt et al,[**47**] assessed the feasibility of a general dental practitioner providing interceptive orthodontic services to disadvantaged children with real-time supervision from an orthodontist using teledentistry. 30 Pre-treatment and posttreatment orthodontic study models of children treated by a general dentist using teledentistry and 96 children treated by orthodontic residents directly supervised by orthodontic faculty were scored with the peer assessment rating index. The results commend no significant differences between the groups before treatment or after

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interceptive orthodontic treatment. The study concluded that interceptive orthodontic treatments provided by sufficiently prepared general dentists and supervised remotely by orthodontic specialists through teledentistry were a viable approach in reducing the severity of malocclusions in disadvantaged children when referral to an orthodontist was not feasible. Stephans et al,[**51**] in their review on orthodontic referrals via Teledent Southwest concluded that the project enabled dentists to offer a better service for their patients and use specialist services more appropriately. Mandall et al,[**47**] evaluated General Dental Practitioner's (GDPs) opinion about a teledentistry system to screen new patient orthodontic referrals. 200 GDPs were approached from Stockport, Oldham, Bury, Rochdale, and Bolton in Greater Manchester, and High Peak in Derbyshire. A total of 71% of GDPs thought teledentistry for orthodontic referrals would be a good idea. More than half of GDPs agreed or strongly agreed that there would be implications on their surgery time, expense, and equipment safety. The authors summarized that GDPs generally supported a teledentistry system for new patient orthodontic referrals. The use of teledentistry makes it accessible for dental practitioners in remote locations to seek consultation from an orthodontist. These consultations will play big role in diagnosis, planning of treatment, and application of preventive and interceptive orthodontic practices.[**47-51**]

4.Periodontics;

Teledentistry plays a vital role in the field of periodontics by sharing of images of the periodontium, thus detecting and diagnosing periodontal pathologies. The periodontist can then go through the pictures and radiographs to decide on a suitable treatment plan thus improving oral and overall healthcare of the patient as well as the society. Teledentistry could also be an effective audio-visual aid for the purpose of delivering oral hygiene instructions to patients, including brushing and flossing techniques, use of interdental cleaning aids, plaque control methods, etc. A previous web-based teledentistry consultation system showed that patient referrals to oral surgery,prosthodontics, and periodontics had thehighest consults. A total offifteen patients were subjected to periodontal surgery and their sutures were removed at a faraway place a week later under the telesupervision of the periodontist.

Rocca et al,[**54**] described the evolution of a teledentistry system within the U S department of defense. Total dental access (TDA) was a teledentistry project within the Department of Defence that enabled referring dentists from the US Armed Forces to consult with specialists on the status of a patient. TDA concentrated on three areas of dentistry: continuing education, patient care, and dentist-laboratory communications. One of the intent of this project was to increase patient access to quality dental care. The other intent was to establish a cost effective telemedicine system.

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In the first study of teledentistry at Fort Gordon, Georgia, a dental image management system in conjunction with an intraoral camera was used to capture colour images of a patient's mouth. These images were then broadcast over a 9600 baud modem from the dental clinic in Fort McPherson, Georgia to Fort Gordon, a farness of 120 miles. 15 periodontal patients were referred to Fort Gordon for surgery. 1 week after their surgery, each patient reported to Fort McPherson for suture removal and intraoral imaging. Color still images were obtained at the time of suture removal, of the surgical sites and these images were transmitted to Fort Gordon for examination by the periodontist who performed the surgery. The results showed that 14 of the 15 patients saved the return trip to Fort Gordon. The patients consonantly felt that they had received better care than they normally received and were especially pleased at the elimination of the long trip to Fort Gordon. The dentists were also convenient in their ability to make proper decisions and diagnoses using the equipment. In the web-based teledentistry systems, the referring dentist entered into a secure server using a Web browser. He chooses a specialty (orthodontics, periodontics, prosthodontics, oral and maxillofacial surgery, oral medicine, endodontic, oral pathology, or paediatric dentistry). He then directs the patient demographics, complaint, radiographs and images, to the specialist of patient‟s choice. The data then sent to the database and an electronic mail notifies the specialist of the pending consult, which he will route via the Internet. The specialist analyse the consult and writes his diagnosis and treatment. The ended consult is now stored on the database server. The referring dentist gets an email indicating that his consult has been answered. The results showed that the data collected on the Web-based teledentistry referrals showed an average of 40 consults per month. The referrals to oral surgery had the maximum number of consults, then the prosthodontics and periodontics. Benefits of a Web-based teledentistry consultation system were very minimum cost, expandable to a wide range of locations, more detailed information for data analysis..[**54-57**]

5.Oral and maxillofacial surgery´;

Use of new technologies in dental surgery provided better diagnosis, situational analysis, and planning of appropriate treatment solutions. Technologic development has been at its 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. One of the first cases was scientifically presented by the Karl Landsteiner Institute for Biotelematics, Vienna , consisting of a specially devised telenavigation server and telenavigation clients**.[58]**

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Generally, the procedure of teleimplantologic consultation is as follows: at the site of surgical dental implantation, it is first necessary to obtain CBCT image and 3D computerized jaw reconstruction. DICOM files are then transferred to the main server for storage, enabling multiple downloading of the files for review or intervention planning. Dentists, distant teleconsultants, then download the files, perform the requested actions such as software planning of the position, size, and shape of dental implants. If necessary, based on the digital placement scheme, a template for the implantation process is made, leading surgical drill in the jaw area, and navigation markers are positioned, enabling intraoperative navigation of surgical instruments during surgery itself. At the end, teleconsultants post the amended files to the server, and operators are then ready to begin the process of dental implantation**.[58-61]**

Duka et al.,[**62**] conducted a study to investigate practical usability of telemedicine approaches in everyday management of oral surgery patients in terms of reliability of established diagnosis and indications for oral surgery treatment of the third molars. They summarized that the diagnostic assessment of the clinical diagnosis of impacted or semi impacted third molars assisted by the telemedicine approach was equal to the real-time assessment of clinical diagnosis. Herce et al., [**63**] in a pilot study on the management of impacted third molars using telemedine described the preliminary results of a store-and-forward telemedicine system aimed at the presurgical management of impacted third molar pathology. It was a longitudinal, multicenter, descriptive, evaluative pilot study managed at the Oral and Maxillofacial Surgery Unit of Virgen Macarena University Hospital (Seville, Spain) and four primary care areas located between 15 and 95 km from the hospital. The results showed that over a time period of 12 months, 97 patients were joined in the study, from different 102 tele-consultations received and evaluated within the same period. Patients endured through telemedicine were included on the surgical wait list on within a mean interval of 3.33 days since the last visit to the primary care dentist, with only 1 visit to the hospital that was on the day of surgery. The average waiting interval of patients endured through the conventional referral system was 28 days with at least 2 visits to the hospital before the final interference. On-the surgery day, cancellation rate of the series was 7.8%, because eight patients did not have surgery on the scheduled day. The abolishing rate in the sample of patients managed through the conventional system was 8.85%. The authors summarized that the practice of telemedicine was accurate, effective, and avoided unnecessary visits to the hospital and shortened waiting intervals. The introduction of smartphones has made the practice of telemedicine and teledentistry more feasible. Aziz and Ziccardi [**64**]described telemedicine using smartphones for oral and maxillofacial surgery communication, consultation, and treatment planning. The authors summarized that the use of Smartphone telemedicine was an efficient and effective way for remote specialist consultation and recommended its consideration by the oral

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and maxillofacial surgeon. According to maxillofacial surgeon, smartphone offered clear and fast access to electronically mailed digital images and allowed the oral/maxillofacial surgeon free mobility, not clogged by the constraints of a desktop personal computer. This in turn owed for improved efficiency of the specialty consultation and improved triaging, ultimately providing enhanced care to the maxillofacial patient. The literary works supports teledentistry could be effectively used in offering specialist services in oral surgery to the patients in far locations. [**65-66**]

6.Telemedicine in endodontics;

Any faults in differential diagnosis and prognosis of treatment of periapical lesions can be the source of subsequent complications, problems, additional waste of time and money, sometimes being the cause of complete revisions of prosthetic restorations based on poorly treated teeth. Periapical lesions constitute a large portion of dental pathology and their treatment is commonly performed by dentists who are not specialists in endodontics.

Modern telemedical systems are an ideal solution for seeking and obtaining timely expert help in that regard. Zivkovic et al.[**67**] have practically demonstrated that with the use of teledentistry methods based on Internet, diagnosis of periapical lesions can be adequately assessed; based on that, a necessary plan can be devised for a proper endodontic or oral surgical management of these lesions. Teledentistry based on Internet as a medium for distant communication enables its use worldwide, wherever the world wide web is present as a wire or wireless connection, reducing the costs of management and increasing the availability of urgent help to all patients .[**67**]

Brullmann *et al* , [**68**]in their study on the remote recognition of root canal orifices tested the 50 images of endodontically accessed teeth acquired with an intraoral camera.The images were saved on a laptop computer and were presented to 20 observers who marked the visible canal orifices using software which stored the canal locations in standard files.**[59,60]** The decided positions were verified on histological slices. In 87% of the cases, the canal locations were marked correctly. The results of the study showed that the remote recognition of root canals by experienced dentists could help younger colleagues in the detection of root canal orifices. Baker *et al*,**[59]** compared the interpretation of conventional radiographs transmitted by a video teleconferencing system to conventional view box interpretation for both artificial and *in vivo* periapical bone lesions.30 Results of the study showed no statistical difference between the ability of the evaluator to identify periapical bone lesions using conventional radiographs on a viewbox and his ability to interpret the same images transmitted on a monitor screen. The

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application of teledentistry in conservative dentistry and endodontics is proven in many different studies.**[59,60]**

7.Prosthodontics;

In prosthodontics, teledentistry facilitates the remote evaluation of edentulous ridges, supporting tissues, and abutment teeth through diagnostic casts, clinical photographs, and radiographs. With this information, specialists can guide the on-site general dentist and dental technologist in designing and fabricating appropriate prostheses, enhancing access to expert care without requiring the patient to travel [**68**]. A recent study by Lakshmikantha et al., [**69]**explored the implementation of teledentistry to improve prosthodontic care access in remote regions of Fiji. Through semi-structured interviews with dentists and a pilot teledentistry platform that included video consultations, digital impression-taking, and remote monitoring, the study identified both challenges and opportunities in delivering care. While infrastructure limitations and internet connectivity posed notable hurdles, the platform was well-received by users and facilitated better communication and treatment planning. These findings suggest that with adequate support and collaborative efforts, teledentistry can significantly enhance prosthodontic service delivery in underserved and geographically isolated settings [**70**].

Ignatius et al,[**71**] conducted a study to investigate the use of videoconferencing for diagnosis and treatment planning for patients requiring prosthetic or oral rehabilitation procedures. The consultations bust in between a specialist dental treatment unit in a central hospital and general dental practitioners in seven regional health centres. Videoconferencing was run using standard commercial units via an IP network, at bandwidths of 762 kbit/s to Mbit/s. In total, 24 patients and 25 professionals (18 dentists, 2 dental hygienists, and 5 nurses) took part. There were no technical issues. A diagnosis or treatment plan could be made in 24 out of 27 tele-consultations. All participating dentists were contented with the consultation process and indicated that the technology used was of sufficient quality for clinical issues. A patient satisfaction questionnaire indicated that patients were also satisfied. The authors endow that the video consultation in dentistry has potential to increase the total number of dental specialist services in sparsely populated regions, such as those in Finland.[**71**]

8.Role in Public Health Dentistry;

Teledentistry offers a distinctive approach to provide remote clinical training, continuing education, and practical instruction to dentists and dental hygienists working in distant clinics. It also supports educating patients on self-care practices. By enabling preventive and diagnostic care remotely, it helps reduce the need for additional patient visits, saving both time and

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expenses. The technology requires minimal equipment, allowing real-time face-to-face communication between users. This method is also valuable for increasing dental hygiene students' understanding of public and community health concerns. Costa et al., studied the implementation of a teledentistry system in public dental health services in a South Brazilian city, focusing on teleconsultations in periodontics. Over seven months, 22% of general dentists conducted 68 teleconsultations prior to specialist referrals, which improved treatment decisions and referral prioritization. Key factors influencing implementation included political and administrative support, resource availability, system integration, and internet reliability. The study highlights that addressing these barriers is essential to optimize teledentistry adoption and enhance dental care delivery in public health systems [**72]**.

APPLICATION OF TELEDENTISTRY IN DENTAL EDUCATION;

Teledentistry has played an important role in dental education through the means of selfinstruction and video conferencing. The web based, self-instructional educational system contains information that has been used and stored in webserver by the user even prior to accesses the program.[**72**] The advantage of this system is that the user has authority to control the speed of the program and can review the learning material on numerous times on his or her own wishes.6 A study done by Johnson and Schleyer about Web-based dental continuing education and assessed the values on the basis of a set of well designed guidelines by using the Design of Educational Software.[**7,8**]A survey conducted by Spallek et al. among participants who undertook several web based dental Continuing Education(CE) courses revealed that lack of communication among individuals and with their peer groups could result in dissatisfaction. [**73**]

Interactive video-conferencing may be conducted via various modes of communication such as POTS(Plain old telephone service), Satellites, ISDN, Internet or Intranet. Interactive videosessions includes both a live video conferencing sessions with a proper camera set up where the information about patient personal details can be transmitted and other valuable points (such as past medical history, extra or intra oral radiographical examination) that can be delivered before or at the same time (for example, via fax) as the videoconference. The benefit of this type of interactive based education system is that the user can recieve feedback in short span of time.[**73-75**]

Limitations and Challenges of Teledentistry;

There are general elements that limit the use of teledentistry during pandemic outbreaks. The general elements include politics, technology, and education. Political features are controlled by authorities from governments or health organizations. The features related to policies that

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address implementation guidelines[**72- 76**]If primary health organizations like the World Health Organization (WHO) publish guidelines related to telemedicine, then national health organizations will follow the WHO guidelines. The national policies' impact on the use of teledentistry is considerable because it allows authorities to recommend the use of teledentistry to oral health care workers. Technological features describe the tools or means of connectivity by the health care practitioner and the patients. Connectivity means include internet connection and mobile network-based connection.[**73- 76**] The presence of a fast connection helps teledentistry achieve a continuous process. The hardware materials needed to be used as a tool in teledentistry include computers, cellphones, and tablets. The hardware's compatibility with software that supports teledentistry is considerable for its usage. Educational features are concerned with the acceptance of teledentistry in all aspects of society. Patient education and health care professional education regarding teledentistry is considerable for proper usage. A poor knowledge regarding the capabilities of teledentistry software may limit the functions that can be used by the oral health professional [**73- 76**].

Specific elements within the specialties of dentistry are also evident in limiting teledentistry such as the limitations of encompassing treatment and diagnostic procedures. Many treatment methods require clinical visits from patients.[**73- 80**]Teledentistry distances the patient from the oral health care professional. The absence of clinical presentation is a considerable limitation for teledentistry. Almost every specialty (e.g., surgery, endodontic, orthodontic, prosthodontic) requires treatment procedures to be done inside the dental clinic [**18,31, 77-80**]. Diagnostic procedures (e.g., percussion test, palpation, cold test) also requires clinical presence. The distant feature is the most substantial challenge of teledentistry [**77-80**].

ETHICAL AND LEGAL CONCERNS;

As it is with any information technology system, there are concerns about the safety of the data which is transmitted via the teledentistry data such as copyright and ownership issues. Similar to all online systems, these systems are also susceptible to hacking and data theft issues. The most prominent concern from the patient perspective is that of confidentiality of the data.[**27,28**] Patients should be informed about the chances of loss of data despite maximum efforts and should also be briefed about the chances of improper diagnosis or treatment failure due to technology errors or failure.[**28-30, 81**] The copyright and data ownership issues are primarily due to the lack of a proper legal framework regulating the teledentistry as well as telemedicine domains. There is an acute lack of regulations over matters such as privacy, security, remuneration, taxation, jurisdiction, definition and regulation of malpractice and issues associated with ecommerce.[**28,81,82**] The United States has made it mandatory from the year

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2000 that teledentistry practitioners must obtain full license to practice across state lines.[**28,30,31]** Literature about the legal issues concerning teledentistry is scarce and is non - comprehensive. [**81-83**]

Teledentistry in Palestine

The Palestinian-Israeli conflict is ethnopolitical in nature. It has a number of features that distinguish it from other conflicts of a similar type. The distinctive features of the conflict go beyond the contradictions at the level of regional politics. They touch on the deep nature of the Arab-Israeli/Palestinian-Israeli conflict. In addition to the political and economic component of the conflict, other factors such as culture, values of ethnic identity are of great importance. From the very beginning, the Arab-Israeli conflict in Palestine reflected more than just a struggle for the territory. It was a struggle for their history, myths, traditions, and religion, associated with this land by both peoples. The expanding borders of the Israeli state especially after the 1967 war are perceived by Palestinians not only as a confirmation of the seizure of their territories, but also as an assertion of differences and hostility between the two peoples. Due to the ethnic component, it is perceived by the parties not only as a conflict of interests but as a conflict of values. The concept and essence of ethnopolitical conflict and the complexity of its regulation reflect the main characteristics of the Palestinian-Israeli confrontation. These features make the Arab-Israeli conflict the most difficult to manage and to settle. The difficulties of resolution through political compromises create serious problems for the peace process. Despite the ongoing local and international peace efforts, the Jews, Arabs, and other residents of Israel and the Palestinian territories (i. e. the West Bank and Gaza) have endured decades of political, social, and physical upheaval with periodic eruptions of violence. .[**93-98**]

Teledentistry is a promising solution for improving oral healthcare in Palestine, particularly in rural and underserved areas with limited access to dental services. It uses telecommunications to enable remote consultations, diagnosis, and treatment planning, which can increase access and efficiency, although its implementation faces challenges like limited infrastructure and a need for better provider awareness and training. The current political situation, particularly in the Gaza Strip, has exacerbated existing challenges by severely obstructing healthcare access, making sustainable solutions like teledentistry even more critical.

Teledentistry in Palestine is a growing but challenged field, offering a lifeline for underserved rural areas and conflict-affected populations by connecting patients to care via video/chat, but it faces hurdles like poor infrastructure, low dentist awareness/acceptance, and the severe disruptions from recent conflicts, though humanitarian efforts and new apps are emerging to

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digitize records and expand access to basic care, focusing on sustainability beyond immediate crises. .[**1-6,12-18,98**]

The medical aid system in Palestine operates under tough conditions. Apart from the obvious health challenges, visiting patients with primary care is often equally challenging. Digitalization and telemedicine are supposed to be a partial answer. The Polish Centre for International Aid and a local partner are introducing a system that will improve aid in the West Bank.

The PCPM Foundation , The Polish Center For International Aid (**PCPM**) is non-governmental organization in Poland providing humanitarian and development assistance. has been helping Palestine in the West Bank for 10 years. The first projects focused on supporting agricultural cooperatives through training, retrofitting farmers, and helping them sell their products, but since 2021, the priority has been medicine. Unfortunately, access to a doctor is becoming more difficult every year. The villages most excluded from medical assistance are those that lie in Zone C of the West Bank – an area that is under full, i.e., administrative and military, Israeli control. .[**93-100**]

“Such villages cannot build permanent medical facilities. The health service relies on mobile clinics that travel to buildings designed to receive primary care patients,” says Ewa Jakutajć, the project coordinator.

Between July and December, the clinics provided more than 7,000 medical consultations. After the Hamas-Israel war, the clinics are working in increasingly difficult conditions and are forced to adapt their operations to the ever-changing situation.

“We live far from schools, hospitals, and medical facilities. Most people do not have transport, and we live high up in the mountains. Water is also hard to come by in our village. The clinic, which has been renovated, will be very helpful, especially for pregnant women. Previously, they had to go to hospitals that are very far away”, says the village chief of the Hebron district. .[**98-100**]

One example is the village of Skaka. Unfortunately, the Ministry of Health does not provide medical services. The Palestinian Medical Relief Society, supported by the PCPM, is only one of the largest organizations that can help .[**93-98**]

“Residents suffer from a lack of medical services and particular medicines. People have no way to get to hospitals, and this is made even more difficult by the many Israeli checkpoints. It is also harder for us doctors to reach the cut-off villages”, says doctor Ahmed from PMRS .[**98-100**]

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PMRS was founded in 1979 by a group of Palestinian doctors and health professionals seeking to supplement the decayed and inadequate health infrastructure caused by years of Israeli military occupation. In the years prior to the Intifada for Independence, PMRS made a significant contribution to the creation of a Palestinian national health infrastructure, replacing the fragmented health system inherited from years of Israeli occupation .[**98-100**]

PMRS now extends its services to over 1.5 million Palestinians in the West Bank and Gaza Strip, providing improved models of healthcare that are built on sound evidence based practice and specifically adapted to the Palestinian context. In focusing on a rights-based approach to its health services provision, PMRS has steadily developed its advocacy program and has become a leading Palestinian NGO able to implement participatory lobbying campaigns at national and governmental level to promote health as a human right for all Palestinians. PMRS is also an active member of the People's Health Movement, PNGO (The Palestinian NGO Network), the Health Nutrition cluster, the Emergency cluster, the Non Communicable Diseases thematic group and other National and transnational Health Groups in Palestine. .[88-**98**]

PMRS provides medical services focusing on children, men, and women. It tests diabetes and blood pressure, performs ultrasounds on pregnant women, and checks dermatological symptoms. .[91-**98**]

PMRS is present in the West Bank, in East Jerusalem and in Gaza as the same organization. Its headquarters are located in Ramallah and while it has branches all over Palestine. PMRS's programs are mainstreamed all over the country, in all the districts.[**90-98**] PMRS's management is structured around program directors on the one hand, who supervise the development and implementation of one program everywhere PMRS is present, and district managers on the other, who are responsible for the coordination of all activities under a project or program which are to be implemented in their district. For example, one of PMRS's major programs is the Women's Health Program. The program's strategy and goals for the year are developed at headquarter level involving all the relevant staff and set for all districts, including East Jerusalem and Gaza. The Women's Health Program coordinator is responsible for drafting the strategy and its dissemination, she supervises the collection of M&E data for the program and drafts the annual report on the program's activities .[**91-98**] District coordinators, by contrast, are responsible for keeping track of all the different projects and programs implemented in their districts, managing the staff in their district and ensuring the communication of information both horizontally between programs, as well as vertically, of potential challenges affecting the district to the higher management. District coordinators are also in charge of relaying potential specific needs of communities or beneficiaries in their district. .[**93-98**]

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Lastly, it is important to note that it is due to our commitment to collaborate that we are able to execute our goals effectively and as efficiently as we do. Due to our mobile health clinic network of 580 communities, and our work within the communities we have established great rapport, which provides an incredibly robust foundation when implementing new work and initiatives. .[**93-97**]

The project of the Polish Centre for International Aid is pioneering. There is no telemedicine system in Palestine. Thanks to the Foundation, this is set to change, but what is essential is that it will be widely available and free of charge. .[**91-95**]

In the first step, as early as March, telemedicine clinics will be operating in the Jenin and Hebron regions where, because of safety regions, it is the biggest challenge to reach the medicine facility. An app has been developed with Palestinian IT specialists. Patients will have the opportunity to consult a family doctor and a gynecologist. Through the app, it will be possible to connect by both video and chat. .[**93-98**]

Importantly, the PCPM is not just digitalized but creates a whole system that will help define and agree on a coherent process for carrying out tasks and procedures. This allows doctors to systematize their work, translating into more efficient and consistent work. Because with this, doctors as well as medics can be sure that repetitive operations are performed correctly. .[**93**]

Minimum standards have been developed that doctors must meet. In addition, two PCPM Medical Emergency Team experts have created a training program for GPs and gynecologists.[**93-98**]

“In November, an evaluator will operate in Palestine. He will conduct interviews and collect feedback from users of the telemedicine system.” Jakub Majcher says we will implement possible improvements and extend the telemedicine clinics to the entire West Bank through him .[93-**98**]

Ultimately, we plan to open telemedicine clinics in seven regions of the West Bank in 2026. This innovative solution will significantly affect the availability of medical assistance regardless of where patients live and the changing situation in Palestine,” says Ewa Jakutajć. **.[95-101**]

Through the mobile application, it will be possible to contact a doctor via chat and video. In addition to creating an entire telemedicine system, the PCPM will also help to digitalize medical records, which are currently entirely paper-based. Once the app is implemented, every doctor and patient will have access to the treatment history. .[**97-100**]

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Palestine (consisting of the Gaza Strip and the West Bank) has access to Telephone, Radio, Television, and Internet services; however, it significantly trails behind global standards in these sectors.[**98-101**]

CONCLUSION

Currently, teledentistry has not yet become an integral part of mainstream oral health care system. In the near future, teledentistry will be just another way to access an oral health care system, especially encouraging for remote populations who may have difficulty accessing the oral health care system due to distance, failure to travel, or lack of oral health care providers in their area. Future developement in technology will enable teledentistry to be used in many other ways, such as quality and safety assessment, clinical decision support, medication e-prescribing, consumer home use, and simulation training. Teledentistry provides new opportunities for dental education by providing the primary care professionals with an easy access to efficient consultation and by helping in conducting postgraduate education and continuing dental education programmes. In spite of some issues which need to be resolved, the potentiality of teledentistry is tremendous in developing countries, which needs to be searched. Palestine can work towards establishing a robust teledentistry infrastructure that improves access to dental care for all its citizens.

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