

# Teledentistry: A Need of the Era

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## ABSTRACT

Teledentistry, a quite new field, has a potential to change the dynamics of the dental care delivery system. Most of the dentists are in the dark about teledentistry, about its target and advantages and how to get immersed into it. Teledentistry is an upcoming field in dentistry that combines telecommunication technology, digital imaging, and the Internet to link health providers in rural or remote communities. It is an exciting field that has endless potential. Teledentistry improved quality of care; it increases patient access to dental treatment, and the cost effectiveness. Teledentistry is also helpful in long distance clinical training, screening and dentist-laboratory communication and continuing education, Teledentistry may provide a possible solution to many prevailing problems related to dental treatment provision, like people living in rural village areas and those who are not able to get regular dental care, and it can ensure the good oral health of the children in schools and child care centers. The future of Teledentistry will depend on the efforts of the health authorities as on the collective efforts of the dental professionals. This article illustrates as to how teledentistry can be an effective solution for dentists and their patients.

**KEYWORD:** Applications, Health care professionals, Smart phone

## INTRODUCTION

There are many barriers for the rural population to gain access to speciality dental treatment, such as poor or no public transportation, geographic remoteness and poverty, leading to a compromise on quality health treatment, resulting in complications.<sup>1</sup> Advances in dental care have validated that early diagnosis, early

intervention and preventive treatments can prevent or decrease the progress of most oral diseases, conditions that, when left untreated, can have deform, painful, and lasting negative health consequences.<sup>2</sup> Most important advances have been made by use of computers, telecommunication technology, digital diagnostic imaging services, devices and

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analysis software and follow-up. Technologic innovations in the field of dentistry have been extensive in recent years.

Dental care is being constantly transformed by the opportunities which are provided by technology and telecommunication. Dentistry, in a collateral combination with telecommunications technology and the Internet, has allowed a relatively new and exciting field that has endless potential called "Teledentistry."<sup>3</sup> Due to the enormous growth of technological capabilities, teledentistry possesses the capacity to fundamentally change the current practice and the face of the oral health care.<sup>4</sup> The term "Teledentistry" was first used in 1997, when Cook defined it as "the practice of using videoconferencing technologies to diagnose and provide advice about treatment over a distance."<sup>5</sup> It has the capability to improve access to oral healthcare, improve the delivery of oral healthcare treatment, and lower its costs. It also has the ability to eliminate the disparities in oral health care between rural and urban communities.

Many years ago how telephones impacted people, in the same way within next 10 or 20 years teledentistry will be a necessary of life. What was considered relatively distant future some twenty years ago today is the reality in dental clinics. Teledentistry as such is not so difficult, if we know how to turn on a television or how to make a phone call or how to fax a document, we can learn teledentistry.<sup>6</sup> A few years ago, teledentistry entangled calling an expert on the telephone for advice, whereas today it all there on the internet.

Teledentistry is implemented in some

developed countries and needs to be encouraged and implemented on a priority basis in India due to lack of specialist dental manpower and an extensive underserved population.<sup>7</sup> This paper reviews the history, form, scope, and applications of teledentistry. Thus an attempt to reinforce awareness on teledentistry among the dental practitioners is needed in developing countries.

## DEVELOPMENT AND HISTORY OF TELEDENTISTRY

Radiology was one of the earliest medical specialties to utilize tele-communication as early as 1959 when Albert Jutra used communication cable to transmit videotaped tele-fluoroscopy examinations between two hospitals in Montreal, five miles apart.<sup>8</sup>

The initial concept of teledentistry developed as part of the blueprint

for dental informatics, which combines computer and information science, engineering and technology in every areas of oral health, and which was drafted at a 1989 conference funded by the Westinghouse electronics system group in Baltimore.<sup>9</sup> The US Army's total dental access (TDA) project is seen as being at the frontier of teledentistry. Begun in 1994, this project initially used a traditional plain old telephone system (POTS) with to different communication methods: real-time and store-and-forward.<sup>3</sup> In 1995, Rocca et al conducted a pilot study in Haiti to connect a general dentist to a dental specialist in Washington DC, via a satellite system.

*Teledentistry is a combination of telecommunications and dentistry, involving the casting of clinical information and images over remote distances for dental consultation and treatment planning.<sup>5</sup>*

Two years later, integrated services digital network (ISDN) based teledentistry was tested in Germany, Belgium and Italy. Studies have also been conducted in Scotland, Japan, England and Taiwan to examine ISDN-based teledentistry.

In the 1990s the concept of 'teledentistry' was introduced. Cook, in 1997, defined this as "the practice of using video-conferencing technologies to diagnose and provide advice about treatment over a distance"<sup>2,6</sup> Since then, an aeon of teledentistry is expanding worldwide and teledentistry is gaining ground in developing countries.

## TELEDENTISTRY AND TYPES OF TELEDENTISTRY

Teledentistry uses telecommunications technology, electronic health records, digital imaging, and the Internet to provide teleconsultation with specialists, supervision of collaborative hygienists in remote areas, and education. Teleconsultation through teledentistry can take place in either of the following ways "Real - Time Consultation" and "Store and forward method." (Figure No.1 and 2)

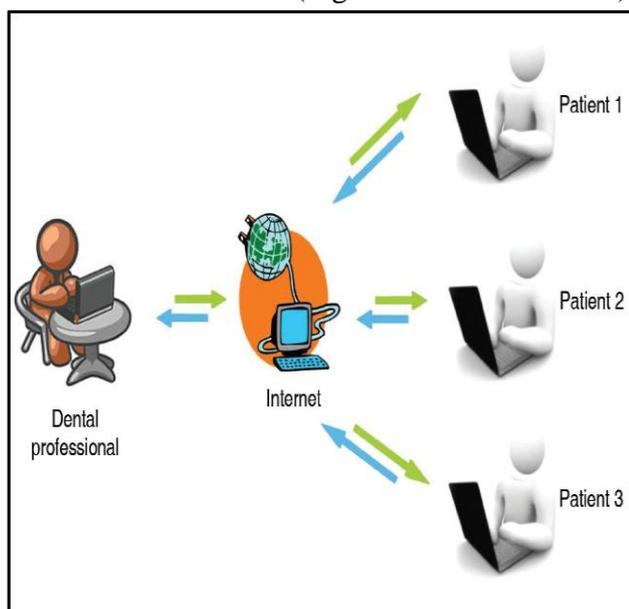


Figure No.1: Real-time consultation

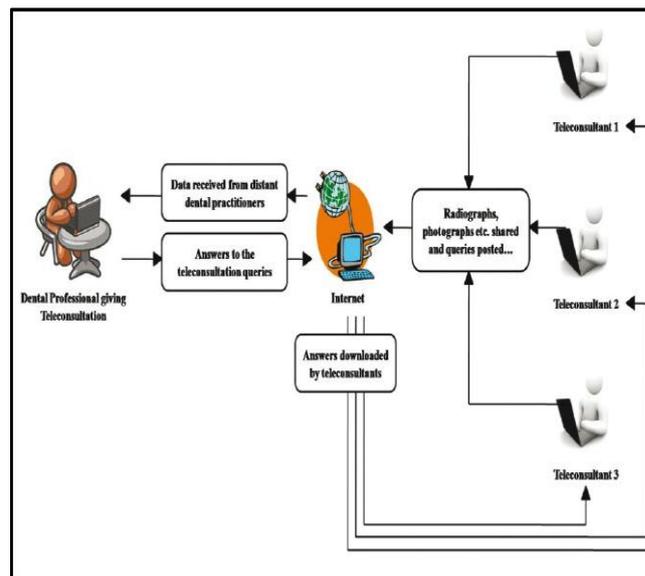


Figure No.2: Store-and-forward method

Real-time consultation involves a videoconference between dental professionals and their patients, at different locations, through which they may see, hear, and communicate with each other. Store-and-forward method involves the exchange of clinical information and static images collected and stored by the dental practitioner, who sends them for consultation and treatment planning. The patient is not present during the "consultation."<sup>10</sup> Dentists can share patient's information, radiographs, graphical representations of periodontium and hard tissues, therapies, tests, applied lab results, photographs, remarks, and other information transportable through multiple providers. A "Near-Real-Time" consultation has also been mentioned in the literature involving low resolution, low frame rate product that looks like apprehensive television.<sup>11</sup>

## TOOLS FOR EXCHANGE OF INFORMATION

POTS (plain old telephone system) is still used frequently in teledentistry because of its low maintenance and technical support costs.<sup>3</sup> This

method transfers the information real-time, whereas the store-and-forward method allows the data to be stored in a local database to be forwarded as needed. POTS works through the telephone company with low-speed and unreliable connection. Data exchange is also possible with the help of FAX machine.

ISDN (integrated services digital network) provides a higher speed, and information can travel in both directions simultaneously, which increases accessibility and reliability in teledentistry.<sup>3</sup> But building an international ISDN network is too expensive and impractical. The World Wide Web is popular tool for easy access of information, it has no equal.<sup>12,13</sup> An ISDN network, on the other hand, is connected from one point to another with no network sharing. Live interactive videoconferencing can also be conducted via satellite.<sup>8</sup>

## SCOPE OF TELEDENTISTRY

Teledentistry has the ability to improve access to oral health care, improve its delivery and reduces its costs. It also has the ability to eliminate the disparities in oral healthcare between rural and urban society. Teledentistry may turn out to be the inexpensive, as well as the fastest, way to bridge the rural-urban health divide and also can help to bring specialized healthcare to the remotest corners of the world.<sup>14</sup>

Interdisciplinary communications will improve dentistry's integration into the larger healthcare delivery system. The application of teledentistry for specialist consultations, diagnosis, treatment planning, co-ordination and continuity of care will provide aspects of decision support and facilitate a sharing of the contextual knowledge of the patient among dentists.<sup>15</sup> Teledentistry will also bring an opportunity to supplement traditional teaching methods in dental education

by providing new opportunities for dental students and dental surgeons.<sup>16</sup>

## TELEDENTISTRY AND ITS APPLICATION IN RURAL AREAS

In rural areas, there is a shortage of specialists and the lack of comprehensive and sophisticated health care. Through teledentistry we can increase the accessibility of the specialists to the rural and underserved communities for their dental needs, besides decreasing the time with the specialty consultations.<sup>17</sup>

## ROLE IN POSTGRADUATE DENTAL EDUCATION AND PRIVATE PRACTICE

Teledentistry can serve as a good tool for postgraduate students and for providing continuing updates for the dentists. In interactive video-conferencing, the patient information is checked first, which allows for the interaction and feedback between the educator and the students. The patient cases can be reviewed comprehensively and at the students' own pace. This boosts the students' enthusiasm and provides new learning opportunities for the dentists.

## ROLE IN SCHOOLS AND PAEDIATRIC CARE CENTERS

It is the need of the hour to develop models for schools and children care centres in our country to utilize teledentistry to increase the access to dental care for toddlers and teenagers. Schools and child care centres play a vital role in

ensuring the optimum oral health of the children through:

- Screening for dental problems before they become emergencies.<sup>18</sup>
- Helping children in managing their chronic illnesses.
- Connecting children and their families health and social services and
- Providing urgent consulting for oral healthcare.

Teledentistry can serve as a tool to symphonized and expand the capacity of school and paediatric care centres to meet the children's oral care needs by using technology to connect to the health providers at another location.

## CURRENT CONCEPTS ON THE APPLICATION OF TELEDENTISTRY

### APPLICATION IN ORAL MEDICINE AND RADIO-DIAGNOSIS:

Bradley *et al*, in a study on the application of teledentistry in oral medicine and radio-diagnosis in a community dental treatment, Northern Ireland, proved how teledentistry can be used successfully to offer consultations.<sup>19</sup> Patients with oral diseases from areas of Northern Ireland were referred by dentists to a small number of specialist services: cardinally, the Regional Oral Medicine Consultant at the School of Dentistry, Belfast. A prototype of teledentistry system was set up in 2005 as a part of a service improvement scheme by Community Dental Service of the Home first Legacy Trust in partnership with the Oral Medicine Department at the School of Dentistry. Teledentistry has reduced waiting periods and saved resources by offering these

services at local levels with specialist consultation. Pereira *et al*, assessed the feasibility of distant diagnosis of oral diseases, using transmission of images through email.<sup>20</sup> The study involved 25 cases of oral lesions over a period of one year at a primary care public health clinic in Parana in Brazil. The authors summarized that the primary care clinics may benefit from the use of email and digital cameras for tele-health in remote areas where oral medicine specialists are unavailable. Summerfelt *et al*, described an innovative oral health workforce model on teledentistry for dental hygienists.<sup>21</sup> The 2010 U.S. Patient Protection and Affordable Care Act (PPACA) called for training midlevel dental health care providers to work with underserved society. Legislation was passed in Arizona in 2004 allowing qualified dental hygienists to enter into an affiliated practice relationship with dentists to provide dental care services for underserved populations. In response, the Northern Arizona University Dental Hygiene Department developed a teledentistry-assisted practice that placed a dental hygienist in the role of the midlevel practitioner as part of a digitally linked oral health care team. The author summarized that teledentistry-assisted affiliated practice dental hygiene was one midlevel practice model that could answer the call of the PPACA to provide comprehensive preventive oral health care and diagnostic services for the growing population of underserved patients in both urban and remote areas. The midlevel practitioner can participate as a digitally linked member of a complete oral health care team with the help of teledentistry methodology that could be adapted to any mode used for the emerging midlevel oral health clinician. Initial training efforts proved that teaching the data collection technologies to dental hygiene students was easily and successfully achieved: students, with only 6 h of training, showed their capability to set up,

manage distant patient service facilities, and transfer digital diagnostic data from the distant locations that were statistically as diagnostically efficacious as diagnostic data obtained from an onsite dental hygiene clinical laboratory. The usefulness of teledentistry in offering specialist services to underserved population in remote areas can be clearly demonstrated with these studied along with many others.<sup>22,23</sup>

#### *APPLICATION IN ORAL AND MAXILLO-FACIAL SURGERY:*

Duka *et al.*, 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.<sup>24</sup> 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.<sup>25</sup> Herce *et al.*, in a pilot study on the management of impacted third molars using telemedicine 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 described telemedicine using smartphones for oral and maxillofacial surgery communication, consultation, and treatment planning.<sup>26</sup> 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 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.<sup>27,28</sup>

#### *APPLICATION IN CONSERVATIVE DENTISTRY AND ENDODONTICS:*

Brullmann *et al* ,in their study on the remote recognition of root canal orifices tested the 50 images of endodontically accessed teeth acquired with an intraoral camera.<sup>29</sup> 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. 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*, 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.<sup>30</sup> 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 application of teledentistry in conservative dentistry and endodontics is proven in many different studies.<sup>31</sup>

#### APPLICATION IN ORTHODONTICS

Berndt *et al*, assessed the feasibility of a general dental practitioner providing interceptive orthodontic services to disadvantaged children with real-time supervision from an orthodontist using teledentistry.<sup>18</sup> 30 Pre-treatment and post-treatment 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 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*, 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.<sup>32</sup> Mandall *et al*, evaluated General Dental Practitioner's (GDPs) opinion about a teledentistry system to screen new patient orthodontic referrals.<sup>33</sup> 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.<sup>34</sup>

#### APPLICATION IN PROSTHODONTICS

Ignatius *et al*, conducted a study to investigate the use of videoconferencing for diagnosis and treatment planning for patients requiring prosthetic or oral rehabilitation procedures.<sup>35</sup> 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.

### APPLICATION IN PERIODONTICS

Rocca *et al*, described the evolution of a teledentistry system within the U S department of defense.<sup>12</sup> 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.

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.

### ROLE IN PEDIATRIC DENTISTRY

Kedzierawski and Billings assessed dental caries prevalence and dental care utilization in preschool children enrolled in urban childcare centres in comparative efficient study.<sup>36</sup> Caries prevalence was decided in a cohort of children

12-60 months of age. Capable children were randomized into two groups: group one received a traditional visual/tactile oral examination and group two received a teledentistry examination. The authors summarized that teledentistry was as good as visual/tactile examinations for dental caries screening in young children and offered a potentially efficient means of screening high-risk preschool children for signs of early childhood caries. The study showed that the use of intraoral camera was a feasible and potentially cost-effective alternative to a visual oral examination for caries evaluation, especially early childhood caries, in preschool children who visits childcare centers. Another study by Kedzierawski *et al*, assessed caries prevalence by means of teledentistry in 12- to 60-month old children enrolled in Early Head Start inner-city child care centres.<sup>37</sup> Images of the primary dentition were collected by trained tele-health assistants using on intraoral camera. Images were stored into a Web-based storage and retrieval program. They were send to a secure, remote-site computer, and accessed by a calibrated paediatric dentist. The results of the study showed that almost half of the preschoolers enrolled in the study were affected by dental caries, only a few children had very often visited a dentist; and teledentistry offered a potentially efficient means of screening high-risk preschool children for signs of early childhood caries. These studies along with others demonstrate the usefulness of teledentistry in assessing the prevalence of dental caries and other disorders among children where a pediatric dentist's consultation may be obtained in a cost-effective manner.<sup>38</sup>

## STRENGTH

In rural areas, where there is a less number of specialists, the deficit of comprehensive and sophisticated health care is a problem.

Teledentistry can widen care to remote patient populations at a reasonable cost as well as ease the problem of a shortage of specialized dental consultants and professional isolation in rural village areas.<sup>39</sup>

Teledentistry teaches general dentists when to refer a patient and how to treat more complicated cases, which can change their practice style and give them more choices in treating patients. Global communication with colleagues is instantly available through a simple click of the mouse.

Teledentistry can be a very good tool for teaching Postgraduate students and even for providing continuing education for dentists. Teledentistry significantly elevates health care knowledge and computer skills. Interactive videoconferencing is more effective than web-based self- instruction. An advantage of the online CDE is that it obviates traveling to and from continuing education lectures. Often dentists do not have the extra time necessary to access CDE courses due to family and job responsibilities. In fact, When considering all of the costs that a professional has to consider for a CE course (travel, lodging, food, and time away from work), online CDE has many benefits as compared to traditional CDE.<sup>8,40</sup>

In most developing countries like India, a most of the population lives in rural areas, where healthcare facilities are not enough. Teledentistry can have a meaningful contribution in bridging the gap between the demand and the supply.<sup>41</sup> The various issues in healthcare delivery system such as inadequate health infrastructure and clinical services, lack of qualified doctors, the almost non-availability of specialist care, the late discovery of the comestible, the deferment in the delivery of the treatment due to the greater time which is required for the transport of the patients to

urban healthcare facilities and the provision of healthcare by inexperienced primary healthcare service providers may be addressed with telemedicine and teledentistry.<sup>42</sup>

## LIMITATIONS

Although teledentistry looks promising for dental consultation and dental education. Users need to understand its limitations and certain critical factors. Legal issues exist, including licensure, malpractice, privacy, Security and ethics. One of the advantages of teledentistry is its ability to increase access to dental care, but users must be careful when providing consultations a cross country lines. If technical problems occur during data transmission that cause a misdiagnosis or medical error, issues of responsibility and malpractice need to be considered. In addition, privacy and security are important issues in cyberspace. If patient's data are lost or stolen during the process of transmission, the entire project may need to be discontinued, especially once the Health Insurance Portability and Accountability Act becomes law.

## 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 development 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.

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