TELEDENTISTRY

Evidence-based Use of Teledentistry in Oral Health Services

In dentistry, there is a brand-new practice field called “teledentistry.” With this new concept of practice, patients can quickly and effectively connect with oral health practitioners to receive advice and information on their oral health or dental problems.

The use of telemedicine with higher-quality technologies in the field of dentistry can provide more profit than ever to dental care. “Teledentistry” is an innovative method allowing the provision of oral healthcare services by connecting patients, dental practitioners, and various consultant specialists worldwide (1).

For the most beneficial decision to be made, this article aims at presenting an overview of teledentistry by reviewing the existing evidence-based literature on the use of teledentistry in oral health services. The most useful and reliable teledentistry interventions were gathered from the best available evidence(2). This article guides dentists on how they can utilize teledentistry in their practice.

What is Teledentistry?

Teledentistry is the use of electronic information, imaging and communication technologies, including interactive audio, video, data communications as well as store and forward technologies, to provide and support dental care delivery, diagnosis, consultation, treatment, transfer of dental information, and education as defined by the American Teledentistry Association (ADA) (3).

According to ADA’s comprehensive policy statement on teledentistry, it includes, but is not limited to, live video (synchronous), store and forward (asynchronous), remote patient monitoring (RPM), and mobile health (mHealth) (4). It is the combined usage of modern telecommunication with routine dental management procedures, aiming to deal with dental treatment needs like emergency conditions in an effective and timely manner (5). It can also manage dental problems despite geographical distances, especially in rural, border, and remote areas (5).

Several terms are used to address “teledentistry.” Teledentistry originally refers to the use of telemedicine in the field of dentistry. Telemedicine or the practice of healthcare services using technological communication is also variously termed “telecare,” “telehealth,” “eHealth,” “mobile health,” or “mHealth” (6, 7). In addition, teledentistry can also refer to mOralHealth as defined by WHO report of the global mOralHealth (8). Other terms for teledentistry include “digitalized oral healthcare services,” “digital dental consultation,” “digital oral health services,” and so on (9).

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Why using Teledentistry?

The main purposes of using digitalized dentistry can be categorized into five groups:

Table 1. Purposes of Teledentistry

Target	Purposes	Description
Patients	Consultation and referral	Teledentistry can support prompt dental consultation and proper referral to the routine oral health services for underserved populations in isolated areas, remote places, or areas affected by natural disasters or armed conflict (10). Teledentistry can be used in the early detection (8) or monitoring (10) of oral diseases, especially in a special situations like the COVID-19 pandemic (11).
	Tele-treatment	Using teledentistry to give treatment directly to patients has barely been reported. It may include drug prescriptions for emergency and non-emergency conditions, such as the drug prescription by periodontists with assistance of general dentists (12), and prescription of drugs to manage dental emergencies like pain and infection control for people at sea until they can receive clinical treatment (13).
	Oral health education and reinforcement of oral hygiene control	The use of online communication allows dentists to easily give oral health education and oral hygiene reinforcement to patients or a group of people. Reminders via text messages or apps can help maintain effective oral hygiene control by promoting patients' compliance (14).
Professionals	Inter-professional communication	Teledentistry can facilitate communication between oral health practitioners, for example, general dentists and specialists, to obtain a treatment recommendation, and family dentists coordinating with dental specialists to provide advanced services (9).
	Professional development	Using teledentistry in professional development includes accredited and unaccredited online learning through video-conferencing (15), online courses (16, 17), websites, or applications (10).

Requirements for Teledentistry

It is of foremost importance that oral health practitioners who use teledentistry meet existing standards of practice and the professional, legal, and ethical obligations to patients (18). Dentists must use their professional judgment to treat patients' oral health conditions, whilst bearing in mind the need for further in-person clinical examination or treatment appointments. Patients who receive teledentistry care also need to give official consent to collect patient information to oral health practitioners in the same way it is done in dental clinics (5, 18). Teledentistry requires digital equipment that can provide precise and accurate resources to deliver oral health services effectively (18).

Advantages of Teledentistry

FOR PATIENTS:

1) Patients can receive quick, useful, and easily accessible oral health services regardless of distance (6, 7, 19).
2) Dentists and specialized healthcare personnel can communicate for guidance and consultations (1, 7, 19).
3) Teledentistry helps increase communication duration, frequency, and quality between dentists and patients, e.g., the use of teledentistry in encouraging proper oral hygiene care and oral health education (20-22).
4) Cost-reduction is one of the well-known advantages of teledentistry as it can reduce travel expenses and other unnecessary expenses (1, 19).

FOR DENTAL HEALTH CARE PERSONNEL:

1) Need for dental workforce could be lowered since teledentistry helps manage a larger number of patients within a shorter time than that of conventional healthcare methods (1) and reduces unnecessary appointments (19).
2) Local dental healthcare personnel could also get guidance and could treat patients under close monitoring of respective specialists (5), resulting in effective oral diagnoses, thereby reducing the unnecessary patient referral(6).
3) It is applicable in all fields of dentistry, including prevention, treatment, research, and education (5, 23).
4) It can supplement and/or improve traditional teaching methods (15).
5) Tele-communication can assist in patient screening for medical, travel history, and urgency of treatments prior to clinical appointments to assess the risk of highly communicable diseases like COVID-19 (24).

Disadvantages of Teledentistry

1) It cannot substitute some oral health services, especially dental treatment for both emergency and non-emergency conditions. Definite diagnoses sometimes cannot be made without supplementary examinations that require special equipment in dental offices, like x-ray machines and electric pulp testing devices.
2) It depends largely on the quality of technologies available such as internet speed (16), quality of intra-oral cameras or photographs, and so on. (25).
3) One of the major concerns is the privacy and security of patient information(5).
4) Technical errors might give rise to misdiagnosis or inaccuracy in treatment decisions (17).
5) No specific legislation or medico-legal regulation for professional misconduct and the utilization of health insurance currently exists (16, 17).
6) It might not be applicable in places lacking trained individuals like dentists, hygienists, or IT technicians (6, 16).
7) It may require special training on how to deal with advanced communication technology (15, 26).

Evidence-based Use of Teledentistry in Oral Health Services

With the increasing use of technology in oral health services, oral health practitioners must be able to select and adopt teledentistry interventions into their practice wisely. Teledentistry is known to be highly accepted by patients and dentists (26). No explanation is needed on how technology can help overcome distances and costs of transportation; however, the quality of oral health services through the assistance of teledentistry still needs to be assured. Teledentistry interventions with high-level evidence (randomized and non-randomized controlled trials) in the past ten years, focusing on interventions to improve patient care, were collected and described in this factsheet. Studies aimed at professional development were excluded.

Table 2. Included Studies According to Usage of Teledentistry

Uses of Teledentistry	Number of Studies
Oral health education and reinforcement of oral hygiene control	23 (14, 20, 21, 27-49)
Professional communication	1 (50)
Consultation and referral	0
Tele-treatment	0
Professional development	Not considered in our review

According to our review of 28 controlled trials (27 randomized and one non-randomized controlled trials), the most common use of teledentistry interventions is oral health education and reinforcement of oral hygiene control measures (Table 2). There was only one non-randomized controlled trial that tested the clinical effectiveness of professional communication through teledentistry in diagnosis of temporomandibular disorders (50). There is no evidence concerning the usability of tele-treatment in dentistry to date.

Therefore, providing treatment through teledentistry should be done with caution. For consultation and referral, no studies were found. That might be because most studies addressing diagnostic accuracies of teledentistry methods are on a cross-sectional basis (7). Nevertheless, previous systematic reviews have reported that teledentistry methods were comparable to other clinical assessments in the detection of caries (23), oral lesions (7), and oral screening (especially in schools, rural or remote areas, and long-term care facilities)(6).

Table 3. Examples of Teledentistry Interventions

Examples of Teledentistry Interventions	Types of Teledentistry Application	References
Tailored applications for behavioral reinforcement or OHE*	Asynchronous*	(30, 33, 34, 39-43, 45, 46, 51)
In-office OHI *followed by telephone calls, text messages, or videos	Asynchronous	(20, 28, 29, 31-35, 37, 38, 44)
In-office OHI with the use of intra-oral camera during consultation followed by reinforcing text messages	Asynchronous	(38)
Sending digital radiographs with open and closed mouth, with information collected through questionnaires for diagnosis of TMD* using intranet emails	Asynchronous	(50)
Social media applications to receive video tutorials and share self-photographs with the group	Asynchronous, Synchronous*	(14)
In-office OHE and leaflets about care for oral health and fixed appliances followed by sending email reminders to watch a video	Asynchronous	(27)
Watching a presentation about oral hygiene care with or without following reinforcing text message reminders	Asynchronous	(21, 36)
Postoperative physiotherapy in hospitalized oral cancer patients, followed by mouth opening exercise reinforced via telephone calls after discharge	Asynchronous	(48)

* **Abbreviations:** OHE, oral health education; OHI, oral hygiene instructions.

* **Asynchronous;** information stored and forwarded, **Synchronous;** live, real-time encounter; two-way interaction

Table 3 highlights examples of teledentistry interventions that proved to be better or comparable to in-person practice or provided impressive results when combined with in-person practice. From our results, there was convincing evidence in favor of the use of teledentistry in oral health education and reinforcement of individual's preventive behavior, such as tooth brushing, flossing, and wearing retainers. Reminders sent via text message or mobile applications can significantly improve patients' oral hygiene, both with or without prior in-office oral hygiene instructions, especially in orthodontic patients. Previous reviews also reported that sending reinforcing messages could significantly improve patient's plaque control and gingival bleeding(22).

Nevertheless, while using teledentistry, caution has to be given in showing the actual video recording to the patient, especially in the oral surgery field, as it could give rise to untoward effects such as increased patient anxiety (47).

The usage of teledentistry has been tested mainly in high-income countries. Among the total 28 controlled trials that we have found, 17 studies are from high-income countries; there are six and five studies from upper-middle and lower-middle-income countries. Even though teledentistry was created to reduce cost and to reach remote areas, we found that teledentistry has not been utilized or studied enough in low-income countries that may substantially benefit from it.

Since teledentistry has enormous benefits, it should be integrated into several levels of oral health services - interpersonal, organizational, and national levels. It grants profitable societal benefits to underserved populations. Moreover, its timesaving and cost-reducing benefits are noteworthy. A big challenge for teledentistry, designed to overcome distance, is limited or non-existent internet access or technical support in remote areas. Using these technologies may also seem confusing to many people. Since communication is the basis of teledentistry, consideration of evidence and quality assurance in teledentistry services, e.g., data transferring methods, connection speed, and data management, should be done to ensure effective communication.

Eventually, teledentistry can provide access to oral health services to those who cannot or are unlikely to come to the dentist, give oral health education to patients, and connect oral health practitioners together to improve services. With various advantages for dentists and patients, teledentistry is a promising tool to be used in the dental field.

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Appendix. Summary of the current randomized controlled and non-randomized controlled trials (n = 28)

No.	Authors/ Year of Publication (Country)	Study Population (Number of Subjects)	Teledentistry Intervention(s) (Level of Interventions) (52)	Comparison Group	Main Outcomes	Study designs	Study setting	Summary of results (*, †, ‡, §, ¶)
1	Salazar-Fernandez et al., 2012 (Spain) (50)	patients with TMDs, 1-5 years (n=1052)	digital TMJ and panoramic radiographic consultation using intranet emails (individual level)	TMDs conventional consultation system at the hospitals	clinical effectiveness, cost of consultation, levels of patient satisfaction	NRCT	dental schools or universities /clinics or hospitals	†
2	Jejurikar et al., 2014 (India) (20)	patients with full fixed appliances in both arches, 13-19 years (n=50)	OHI followed by text message reminders once a week for 4 months (individual level)	OHI only	plaque index (PI), white spots lesion (WSL)	RCT	dental schools or universities	‡
3	Bowen et al., 2015 (USA) (21)	patients with fixed maxillary edgewise appliances, 10-18 years (n=50)	an audiovisual presentation about oral hygiene care followed by text messages 2-3 times a week for 4 weeks and one text message per week for the following 8 weeks (individual level)	an audiovisual presentation about oral hygiene care only	plaque value assessed by planimetry-based assessment (Digimizer software)	RCT	clinics or hospitals	‡

4	Al-Silwadi et al., 2015 (United Kingdom) (27)	patients scheduled to receive fixed appliance orthodontic treatment, ≥13 years (n=60)	verbal oral health education and leaflets about care of oral health and fixed appliances followed by sending email reminders to watch a video delivering the same information (individual level)	verbal oral health education and leaflets about care of oral health and fixed appliances	knowledge about care for dentitions and appliances	RCT	dental schools or universities	‡
5	Abdaljawwad, 2016 (Iraq) (28)	patients with fixed orthodontic appliances, 17-23 years (n=34)	OHI followed by text messages twice a week for 4 weeks and once a week for the following 8 weeks. (individual level)	OHI only	bleeding index (BI), modified gingival index (MGI), plaque index (PI)	RCT	clinics or hospitals	‡
6	Cozzani et al., 2016 (Italy) (29)	patients with fixed orthodontic appliances, mean age: 13.5 ± 1.7 years (n=84)	1.OHI followed by reinforcing text messages or 2. OHI followed by telephone calls after 5–7 hours of initial bonding (individual level)	OHI only	oral hygiene index with modified Silness and Loe index, plaque index (PI)	RCT	clinics or hospitals	‡
7	Zotti et al., 2016 (Italy) (14)	patients with full fixed appliances in both arches, mean age: control group 13.6 years, study group 14.1 years (n=80)	OHI with the use of WhatsApp chat room to receive video tutorials and sharing self-photographs as a part of "Brush Game" (individual level)	OHI only	plaque index (PI), gingival index (GI), white spots (WS), presence of caries	RCT	clinics or hospitals	‡
8	Iskander, M., et al., 2016 (USA) (30)	adults who accompanied a child to the dental appointment, majority age group: 36–45 years (n=89)	oral health education through the 'Dental Trauma mobile healthcare' application (permanent tooth avulsion scenario) (individual level)	oral health education through 'Save Your Tooth' poster (primary tooth injury scenario)	knowledge about permanent tooth avulsion	RCT	clinics or hospitals	*
9	Li et al., 2016 (China) (31)	patients newly received fixed appliance and single-phase orthodontic treatment, 12-21 years (n=224)	subscription to a WeChat account that delivered 2 behavioral reminders a week and 2-3 educational messages a week throughout treatment periods (individual level)	received the same orthodontic strategy and pretreatment education as in the WeChat group	treatment duration, failure to attend appointments, late attendance of appointments, bracket bond failure, orthodontic PI, and modified gingivitis index	RCT	clinics or hospitals	*
10	Jadhav et al., 2016 (India) (32)	subjects from two different social work colleges, 18-20 years (n=400)	OHI and oral health education followed by oral health educational text messages 2 times a week for 3 months (individual level)	OHI and oral health education only	oral hygiene index and gingival index (GI)	NRCT	Other	‡

11	Iqbal et al., 2017 (Pakistan) (33)	patients with full-fixed orthodontic appliances, 15-25 years (n=100)	OHI followed by text message reminders once a week for 60 days (individual level)	OHI only	bleeding index (BI), modified gingival index (MGI), and plaque index (PI)	RCT	dental schools or universities	‡
12	Alkadhi et al., 2017 (Saudi Arabia) (34)	patients with fixed orthodontic appliances, ≥12 years (n=44)	a mobile application for video oral health instructions and active reminder 3 times a day for 1 month (individual level)	OHI during visits	Plaque and Gingival indices (PI and GI)	RCT	dental schools or universities	*
13	Kumar et al., 2018 (India) (35)	patients with fixed orthodontic appliances, 13-19 years (n=60)	OHI followed by text message reminders once a week for 3 months (individual level)	OHI only	plaque indices (PIs) along with WSL status	RCT	clinics or hospitals	‡
14	Williams et al., 2018 (USA) (36)	participants with mild to moderate periodontitis, 21-80 years (n=60)	watching a presentation of oral hygiene instructions, brushing and flossing on PC (individual level)	OHI with visual aids	plaque score (PS) and bleeding index (BI)	RCT	clinics or hospitals	†
15	Marchetti et al., 2018 (Brazil) (37)	technical high school students, aged 14-19 years (n=263)	1. verbal oral health education followed by reinforcement messages sent by a mobile app for 30 days 2. oral health education videos followed by reinforcement messages sent by a mobile app for 30 days 3. oral health education videos only (individual level)	verbal oral health education only	knowledge score (KS), simplified oral hygiene index (OHI-S), gingival bleeding index (GBI)	RCT	schools	‡ All methods were not different in the improvement of oral health status. Video guidance together with the app can improve long-term KS better than other methods.
16	Araújo et al., 2019 (Portugal) (38)	patients with > 20 teeth, and bleeding on marginal probing index over 0.5, mean age: 38.40 ± 12.49 years, (n=142)	1. Using intraoral camera (IOC), explanations and discussion about oral hygiene status 2. Weekly text message (TM) for 1st 4months 3. Both explanations using IOC and weekly TM (individual level)	OHI only	bleeding on marginal probing (BOMP), dental hygiene, and behavior change	RCT	clinics or hospitals	‡ The supplementary use of an in-office intra-oral camera in oral health education can improve the effectiveness of text messaging in oral hygiene control.
17	Zotti et al., 2019 (Italy) (39)	patients from 3 private dental practices, 4-7 years with one of their parents (n=100)	OHI with the use of oral health educational apps (2 types according to age) (individual level)	OHI only	plaque index (PI), caries presence, localization of carious lesions	RCT	clinics or hospitals	‡

18	Alkilzy et al., 2019 (Germany) (40)	children with almost complete deciduous dentitions, mean age: 5.1 ± 0.6 years (n=49)	OHI with additional toothbrush mobile application (individual level)	OHI only	plaque and papillary bleeding indices (QHI, PBI)	RCT	clinics or hospitals	‡
19	Wang et al., 2019 (Taiwan) (48)	patients admitted at a general hospital for curative oral cancer surgery, 30–82 years (n=60)	12-week intervention program (warm compress, masticatory muscle massage, and jaw exercises) 3times a day and additional telephone support following hospital discharge (individual level)	12-week intervention program alone	maximum interincisal opening (MIO)	RCT	clinics or hospitals	‡
20	Takeuchi-Sato et al., 2020 (Japan) (49)	patients with TMDs, mean age: 30.7 ± 8.7 years, (n=30)	Cognitive Behavioral Therapy (CBT) with an email-based recording and reminding system and with sticky note reminders (individual level)	simple verbal instructions to avoid daytime non-functional tooth contact (n-FTC)	pain-free unassisted mouth opening	RCT	dental schools or universities	*
21	Deleuse et al., 2020 (Belgium) (41)	patients with full-fixed orthodontic appliances, 12-18 years (n=38)	an interactive oscillating/rotating electric toothbrush connected to a brushing aid app (individual level)	an oscillating/ rotating electric toothbrush alone	plaque index (PI), gingival index (GI), white spot lesion (WSL)	RCT	dental schools or universities	¶ Using the app with electronic toothbrushes was not different from using electronic toothbrushes alone in promoting oral hygiene.
22	Scheerman et al., 2020 (Iran) (42)	high school students, 12–17 years, with and without their mothers (n=791)	1. the use of a Telegram channel called "Dental Health" to receive oral health education via text messages and videos by patients 2. the use of the Telegram channel by mothers to receive oral health education and instructions to coach and monitor their child's oral hygiene. (individual level)	no intervention	psychosocial variables, toothbrushing behavior, Visual Plaque Index, and Community Periodontal Index	RCT	schools	¶ Teledentistry was effective to deliver oral health education among high-school students, especially with the involvement of their mothers
23	Scheerman et al., 2020 (Netherlands) (43)	patients with fixed orthodontic appliances, mean age: study group 13.2±1.01 years, control group13.5±0.97 years (n=121)	using the "WhiteTeeth" mobile application for reinforcement of plaque control daily for 12 weeks (individual level)	OHI and oral health education during dental visits	plaque index and bleeding on marginal probing index (BOMP)	RCT	clinics or hospitals	‡

24	Vpk et al., 2020 (India) (44)	patients with cerebral palsy, 4-12 years (n=53)	OHI followed by video-based oral health education (individual level)	OHI only	oral hygiene status, including simplified oral hygiene index (OHI-S), plaque index (PI), and gingival index (GI)	RCT	clinics or hospitals	‡
25	Shida et al., 2020 (Japan) (45)	participants coming to Kyoto University, ≥18 years, mean age: control group 25.0 years, study group 26.0 years (n=112)	OHI via videos followed by using a real-time visualized brushing instruction device (GUMPLAY) linked to a mobile application for 4 weeks (individual level)	OHI via videos followed by brushing with the same device without connection to an application	plaque control record (PCR) score	RCT	clinics or hospitals	†
26	Marchetti et al., 2020 (Brazil) (51)	high school students, 14-19 years (n=291)	1) In-office oral health education followed by using an app 'Oral Health' to send a message and a video every day for 30 days 2) Oral health education via a video and followed by using the app 3) Oral health education via a video without app (individual level)	In-office oral health education alone	simplified oral hygiene index (OHI-S) and gingival bleeding index (GBI)	RCT	schools	*
27	Al-Moghrabi et al., 2020 (UK) (46)	participants planned for removable thermoplastic retainer (TPR), 12–21 years (n=84)	My Retainers' mobile application that reminds to wear orthodontic retainers (individual level)	retainer wear chart reminder	stability, plaque levels, bleeding on probing and probing depth, levels of patient experiences and knowledge related to retainers	RCT	dental schools or universities	†
28	Omezli et al., 2020 (Turkey) (47)	patients scheduled for lower third molar surgery, mean age: study group 22.93 ± 5.83 years, control group 23.12 ± 4.99 years (n=113)	video showing third molar surgery (individual level)	verbal information about third molar surgery	anxiety and pain scale	RCT	clinics or hospitals	§

* Teledentistry is more favorable than the conventional method; † Teledentistry is not different from the conventional method; ‡ Teledentistry along with conventional methods is more effective than conventional ones alone; § Teledentistry is less favorable than the conventional method; ¶ Others

RCT - randomized controlled trial, NRCT – non-randomized controlled trial

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