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Effect of Teledentistry and Outcome for Dental Professionals at Saudi Arabia: A Systematic scoping Review

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ABSTRACT

Introduction: Dental care is a crucial aspect not only for oral health but also for overall individual health. Teledentistry (TD) offers data acquisition based on computational application and informatics to ease dental practice, education, and research.

Aims: The current study aims to assess the impact of TD and its outcome on dental professionals in Saudi Arabia.

Materials and Methods: A detailed scientific literature search was made using the most relevant scientific studies from 2000 onwards to achieve the objective. Multiple databases, including PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), and Scielo databases, were explored for Teledentistry and its impact on dental professionals.

Results: A total of 176 articles from different databases and screened for relevancy. Duplicate studies (16) were excluded in preliminary screening. Further, 151 studies were excluded considering predefined inclusion and exclusion criteria. A total of 9 studies with 1008 dental patients with active dental problems and 435 dental professionals for a questionnaire-based survey among Dental professionals were selected for the systematic review. Two criteria were selected to assess the impact and outcome of TD on the dental professional; one patient outcome and second dental professional competency in TD as part of dental practice. Here, among selected studies, both patients and dental professionals were satisfied with TD for a dental practice in diagnosis and treatment.

Conclusions: TD had shown a promising impact on dental professionals in offering dental care practice and service. New modern cutting-edge technological innovation will further improve and enhance the promising effect of TD on dental professional.

Key words Teledentistry, PRISMA, Randomized clinical trials, Dental, Informatics, Teleconsultation

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INTRODUCTION

Oral health, precisely dental health, is crucial for the overall health of an individual [1]. Several studies have demonstrated that oral infection, mainly dental, as periodontitis, may lead to systemic diseases, including cardiovascular, inflammatory, and metabolic illnesses. An uncontrolled bacterial dental infection may lead to dental plague resulting in bacteraemia that may further trigger several systemic diseases [2]. Increased dental diseases also raised the frequency/number of dental consultations, diagnosis, and treatment [3]. The role of a dental professional is not limited to only dental diagnosis and treatment but also provides an effective consultation about dental health/oral health. In this regard, a cross-talking in real-time or using virtual platforms between patients and dental professionals is essential. In a conventional approach, a real-time dental consultation requires frequent visits often get difficult in remote areas and more precisely in conditions such as the COVID19 pandemic era [4]. Real-time consultation with a dental professional is a difficult task for patients from remote locations. In Teledentistry (TD), a combination of telecommunications and dentistry to exchange dental clinical information for diagnostic and treatment purposes is carried out via virtual mode. TD involves a set of virtual dental services using teleconsultation, videoconferencing, and data sharing. A decade back, teleconsultation was started for health awareness, initially translated as telemedicine to enhance dental practice. TD allows the use of advanced computational technology and informatics for electronic health records, electronic referral systems, digitizing images, teleconsultation, and tele-diagnosis [5]. The breakthrough was made in connection with modern cutting-edge computational (high-end processors, imaging tools, data sharing tools, and software's) and information technology (4G/5G networking) based platforms to fulfil multiple objectives, including access to remotely located patients, storage and share of dental diagnostics, and better utilization of time and resources [6].

Nowadays, TD emerged as a major tool in clinical dental sciences as part of telemedicine to improve clinical practice, education, diagnosis, treatment, and research [7]. Using robust computational application platforms and informatics, virtual/remote access of data is possible. It is evident that TD is applicable in various clinical dental areas, including endodontics, orthodontics, oral surgery, and pediatric dentistry.

TD offered several benefits while improving dental practice to the dental physician and patients [8,9]. The analytic and surgical tools clubbed with advanced software provide ease in TD access and practice in recent times. TD is a growing area that also provides an advantage in storing dental practice data for further uses. TD offers a cost-effective approach to dental practice in real-time consultation [10]. Studies have shown that tele-dentistry's effectiveness is similar to real-time patient's consultation for diagnosis and treatment. Dental professionals are seeking further developments in TD for a more effective and robust dental practice. TD has become much significant during the COVID19 era, and several studies have shown effective dental practice without any high-risk intervention [4]. During the COVID19 pandemic time era, there is tremendous development and success in TD in offering teleconsultation, tele-diagnosis, and oral care services delivery.

TD is a part of telemedicine that remains available for several decades, precisely part of dental education. However, teledentistry's clinical implication becomes visible in the last few years with improved information technology and telecommunication [11]. The development of handy hardware with enabled more user-friendly software interface offered ease for real-time use to the dental professional. The use of robust information technology, such as 4G networking in sharing data, was also a key concern.

Still, the large-scale use of TD remains a concern worldwide. It depends on several factors, including the preference of technology over conventional methods, accessibility of data, and patient's compliance with TD [12]. In this study, we aimed to explore the impact of TD and its outcome on dental professionals in Saudi Arabia. The more significant concern was how effective TD can be in a given geographic area and finding ease in using technology for dental practice by dental professionals. Additionally, we assessed the impact of TD on dental professionals.

More concern is given on patient compliance with TD and its clinical outcome that provides a measure for the effectiveness and impact of technology. Here, we analyzed several studies and outcomes of TD, considering clinical outcome and dental professional competency in using technology. Based on the outcome, how TD does has changed (if any) method/s of the dental practice, and how large impact was based in given studies. Therefore, we aimed to analyse the preference of TD in solving dental issues/ complications by dental professionals in different geographical areas over conventional methods. We also emphases how computational applications and information technology have changed the dental practice as part of TD in context with effectiveness and preference for both patients and dental professionals.

MATERIALS AND METHODS

This systematic review was performed in compliance with the PRISMA statement. The search of most relevant scientific articles during 2000-2020 for systematic review was made in among different biological databases, including PubMed/ Medline, Cochrane Central Register of Controlled Trials (CENTRAL), and Scielo databases.

We narrowed down our search on TD during 2000-2020 as the development and practice of TD are best suited in a given time frame. We narrow down our search for specific studies, including randomized clinical trials (RTCs), meta-analysis, pilot studies, observational studies, questionnaire studies, and expert opinion.

The detail of the studies was retrieved using several specific searches but specific to our theme. Here, in the selection of study, our search also emphasizes patients' feedback; about TD, accessibility, compliance, and outcome. Full-length studies were searched in the given theme, and data was retrieved.

Search strategy

Here, we included TD studies associated with randomized clinical trials (RTCs), meta-analysis, pilot studies, observational studies, questionnaire study, and expert opinion.

For the search of most relevant studies, different keywords were used. Here, we have used "Teledentistry," "dental teleinformatics", "dental telecommunication", "dental telehealth", "dental professional and teleinformatics". We have used individual and combination of keywords in search of most relevant studies in Teledentistry. Further, search keywords, including randomized clinical trials (RCTs), meta-analysis, and human studies, were used for study design, protocol, and a number of participants. Full-length studies fulfilling inclusion and exclusion criteria were selected for the systematic review.

Inclusion/exclusion criteria

All the inclusion and exclusion criteria applied to the systematic review are summarized in Table 1. We strictly included studies that fulfil inclusion and exclusion criteria for systematic review, primarily RCTs, meta-analysis, pilot studies, observational studies, questionnaire study, and expert opinions.

Table 1: Criteria followed in the present systematic review.

Inclusion and Exclusion Criteria	
Inclusion Criteria	
Outline	RCTs, meta-analysis, pilot studies and expert opinion-based studies that utilize TD to improve dental practice.
Patients	Patients opting TD to improve dental complications.
Intervention	TD based dental practice' Teleconsultation, diagnosis, treatment and education.
Language	English only
Exclusion Criteria	
Outline	Studies with poorly explained and/or incomprehensible methodology on TD in dental practice; diagnosis, treatment, and education
Publication Method	Abstract only
Status of study	Duplicate

Further, the relevant studies published in English and studies with available full text were included in the systematic review. Those studies do not comply with our predefined inclusion/exclusion criteria were excluded. Further, studies published in non-English language and studies with poorly explained and or incomprehensible research methodology were excluded. The risk of bias assessment was carried out using attrition and performance bias.

The studies were excluded considering different criteria, including one that does not comply with TD prerequisites, i.e., consultation via virtual means to diagnose and treat dental problems. Secondly, those studies do not provide detailed information, either clinical outcome or dental professional willingness.

Further, we stick to those studies where data sharing for imaging, diagnosis, and treatment was carried out. TD for follow-up was also considered here in the selection of studies.

For this systematic review to analyze the impact of TD and its outcome on dental professional, studies were also selected based on one active dental problem and competency of the dental professional in opting TD for dental service.

RESULTS

We collected 176 original articles using multiple keywords searches among various databases. Out of

these, only nine articles were found suitable for the analysis based on predefined inclusion and exclusion criteria. During the screening, 16 studies were reported as duplicate and were excluded. Further, 114 studies were excluded based on a lack of desired scientific information. Further, due to a lack of relevancy and complete scientific information, 37 additional studies were excluded. The systematic review was carried out utilizing scientific information available in 9 selected studies (1440 participants with 1008 dental patients and 435 dental professionals for survey-based analysis). Here Figure 1 represents the study design based on the PRISMA Flow Diagram.

Two key parameters were assigned here to determine TD's efficacy and its impact on the dental professional; patient's outcome and dental professional competency in TD for the dental practice. As shown in Table 2, in most of the studies, participant outcome was evaluated based on consultation time, ease in diagnosis, treatment, and duration of treatment TD was preferred over conventional methods.

Table 2: Summarizes impact of TD in dental practice using two major parameters; one patient outcome and second dental professional willingness and competency.

Study	Sample size	Dental Diagnosis	Analysis/ Consultation/ Time/Tele monitoring	Clinical Reference (Accuracy)	Assessment based on TD
Steinmeier et al. [13]	10	Gingivitis and periodontitis (All age group)	3.17 min ± 1.48 min	98% filled teeth 97% crown teeth 96% Implants	Effective in diagnosis of dental complications. However, periodontal condition was not accessed with the same accuracy
Giudice et al. [14]	57	Dental abscess and neoplastic lesion (Adults)	Consultation was based on photograph 481 photos	Based on adherence monitoring (AM) reports improvement in dental abscess and neoplastic lesion	Teleconsultation improved both dental professional and patient compliance with technology
Hasna et al. [15]	155	Dental Examination (Adults)	5.16 ± 3.6 min	Based on Questionnaire 66.8% (44 respondents) were satisfied with TD	There was no significant diffidence in treatment time, treatment option, and first consultation, but

					overall 70% of enrolled participants were satisfied with TD
Kopycka-Kedzierawski, et al. [19]	291	Dental caries; Diagnosis and treatment; Children	2.19 min	In 12 months follow up 35% of children (after first TD consultation) reported fewer cases of dental carried	TD-based oral examination for dental caries in children is effective over the traditional approach.
Yuen [16]	8	Oral Hygiene and health and Dental assessment	Video conferencing for 11 weeks of weekly 30 minutes	Based on LSGI scores, 17.6% were Clinically significant (American Dental Association)	TD based approach seems effective in the case of physically impaired patients with oral and dental complications.
Al-Khalifa et al. [17]	287	Survey for TD preference over the conventional method	Questionnaire-based survey among Dental professional	65% of dental professionals were familiar with TD	Several parameters were included to access TD based dental practice during COVID 19 pandemic. More than 90% of dental professionals acknowledge pre-diagnosis (during COVID19)
Kopycka-Kedzierawski et al. [20]	234	Dental caries; Diagnosis and treatment; Children	1.56	28% of children showed dental caries diagnosed via TD	Dental professional and children showed compliance with TD in the diagnosis of dental health
Estai et al. [6]	250	Dental caries diagnosis and dental health	Photograph based 9 months follow up study	Real-time experience with dental decay and caries in children	Dental professionals find a real-time experience to analyze the proportion of dental decay in children
Almazrooa et al. [18]	148	Survey in dental professional for TD in dental practice	Questionnaire-based survey among Dental professional	More than 50% of dental professional have experience of TD in clinical practice	large percentage (83%) were confident with TD in clinical dental practice

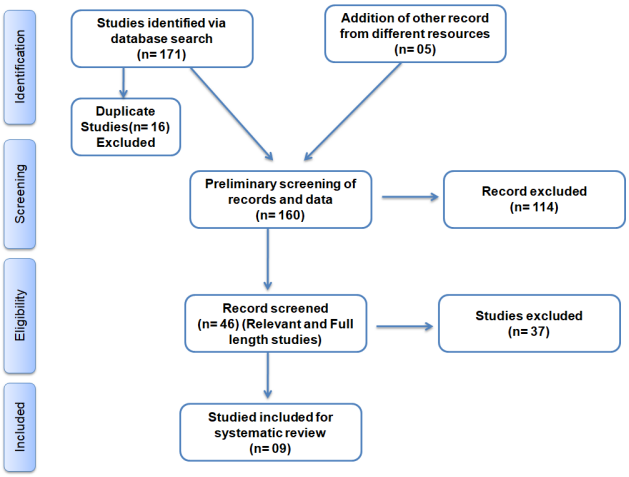

Figure 1: PRISMA flow diagram: Figure depicts the work layout for the present study.

Further, considering survey involving dental professional for TD relevancy in dental practice and ease in clinical implications, it was reported among the selected studies that more than 70% of dental professional agreed and satisfied with TD based dental practice. Here, in this systematic review, out of 9 eligible studies, 7 were inclined with patients and clinical outcomes. At the same time, 2 were a questionnaire-based survey among Dental professionals to evaluate whether dental professionals were accustomed to TD. Here, 1008 active dental patients and 435 dental professionals for questionnaire-based survey analysis showed the impact of TD in dental service. TD's efficacy among active 1008 dental patients was analyzed based on clinical outcomes and reported that more than 70% were satisfied.

Further, based on survey analysis among dental professionals, it was reported that more than 65% were skilled to opt TD in offering dental service. Among the selected studies, the dental patients (1008) opting TD to find solutions for their dental problems include oral hygiene, dental caries, gingivitis, and periodontitis. In TD, two major approaches opted were one time-bound consultation and second consultation based on imaging. The clinical efficacy and TD accuracy reported much higher (90%) in time-bound consultation over imaging-based TD.

Baseline characteristics

As shown in Table 2, TD was the preferred option in both patients and dental professionals. Considering the patients' outcome, most of the studies showed greater compliance with TD based dental treatment, including diagnosis.

It is essential to note that during the COVID-19 pandemic.TD-based consultation, diagnosis, and treatment were significant over conventional methods. On the contrary, the survey considering a dental professional for their willingness, competency, and accessibility as part of their dental practice was satisfactory.

DISCUSSION

TD offers dental care delivery in virtual mode using modern cutting-edge computational applications and informatics. In the last decade, TD has changed the clinical dental practice and improved quality medication in dental science. The impact of TD on dental care can be analyzed by evaluating patients and dental professional experience. The present systematic review included 9 studies that met the predefined inclusion criteria to access the impact of TD on dental professionals. The study observed that 70% of active dental patients were satisfied with TD-based dental services. On the contrary, many dental professionals who participated in a questioner-based survey were not only familiar but also competent to use TD as part of dental practice. Hence, considering the criteria, clinical outcome and competency, TD positively impacted dental professional working efficiency. A previous systematic review carried out by Estai et al. (2018) demonstrated the effectiveness and benefits of TD; however, the study failed to provide insight into the impact on dental professional working efficiency [8]. In the present systematic review, we added valuable information on the working efficiency of TD on dental practice and its effects on dental professionals based on clinical outcome and competency.

There is tremendous growth in TD-based dental practice in the last couple of years. Steinmeier et al. 2020 demonstrated that it is more applicable in case of diagnosis over treatment [13]. In the study with 10 participants for gingivitis and periodontitis diagnosis, overall accuracy of TD-based diagnosis was reported 97%. It was demonstrated that a teleconsultation for less than 5 minutes (3.17+1.48 min) is usefulin diagnosing dental complications with high-end accuracy. Furthermore, Giudice et al., 2020 found a different approach for diagnosis of dental complications and its treatment via TD based [14]. Using real-time imaging among participants seeking teleconsultation not only enhances for improvement of dental abscess and neoplastic lesion treatment but also establishes a database for reference use. Hasna et al., 2020 carried out a pilot study using a standard questionnaire for the satisfaction of patients undergone TD based on dental assessment [15]. The study reports 66.8% of participants were satisfied with the TD based approach. However, there was no significant difference in treatment time and treatment options. In TD, cost factor is visible but not relevant as virtual means of dental service is limited to a small percentage of dental patient's population. It has been studied that TD can also be useful in ensuring oral health and dental assessment. Yuen, 2013 evaluated via videoconferencing in impaired patients and reported that TD is an effective way to adhere to standard oral hygiene [16].

TD's positive impact on dental professionals can also be accessed as rise in cases of TD-based dental service during 2019-2020. During the COVID19 pandemic era, TD becomes more significant in offering remote and effective means of dental care. Al-Khalifa et al., 2020, surveyed to evaluate dental professional competency during COVID 19 pandemic time for the clinical dental practice [17]. It was reported more than 90% of dental professionals were aware of crucial protocols to handle dental practice in COVID cases. The study also has shown that more than 65% of dental professional was practically/clinically competent in TD in offering dental care [18]. In a similar pattern, Almazrooa et al., 2020 surveyed to ensure the effective use of TD of dental care. Here, it was reported more than 50% dental professional participated in the survey were confident and used TD as part of dental practice. Kopycka-Kedzierawski and Billings, 2013 investigated TD's impact in children's dental complications and effective solutions [19,20]. A total of 541 playschool children have participated in the study and assessment was made for the frequency and extent of dental caries. It was reported, TD provides ease in the early evaluation of dental complications, mainly dental caries in children.

In the present study, active dental patients were from different age groups with an increased percentage of TD based dental service. In a recent study, Estai et al., 2020 also has evaluated the prevalence of dental carried in children [6]. In a nine-month follow-up study, it reported that TD offered ease in diagnosis and management of dental caries in children with higher compliance. A similar pattern was reported in different geographical regions, including Saudi Arabia, Australia, European countries, and the United States. The effectiveness of TD in providing dental care was analyzed considering one clinical outcome and dental professional competency. The clinical outcome can be access based on patient feedback for dental treatment via virtual means over physical presence. Further, the expertise of dental professional in using virtual platforms for dental service is equally important in enhancing clinical outcomes.

Study limitations

Despite the large number of scientific articles in TD, the clinical (standard) data set were limited. In TD, as part of the dental practice, there is a lack of uniformity in the assessment, diagnosis, and treatment of dental complications. Also, we do not have control studies for comparative analysis of TD efficacy for the dental practice.

CONCLUSION

The use of remote technology in medicine is an emerging area, and TD is a classic example. Indeed, TD offered several advantages in delivering dental care to distant places; however, it is crucial to note how far such services are available. Considering the world population and socioeconomic state, alarge percentage of the community needs such services. Considering this systematic review, the impact of TD on a dental professional can be analyzed based on the following criteria:

- Dental professional equipped with TD based platform
- Availability of resources with patients
- Availably of Expertise dental professional

The growing research evidence suggests an increase in TD-based dental practice and dental care service in Saudi Arabia. In the last one year during COVID-19 pandemic, TD-based dental consultation and other services were more significant. Certainly, TD has improved dental care practice, and it will be further enhanced based on technological improvement. Several other parameters, such as data storage and data sharing can improve TD-based dental care and positively impact dental professionals in Saudi Arabia.

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