Situational panorama of Teledentistry in the world: an integrative review

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ABSTRACT

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. The objective of this integrative review was to analyze the overall situational panorama of Teledentistry. Scientific articles published in the last 10 years have been selected, in full, both in Portuguese and in English. The search for the journals was carried out in the Scientific Electronic Library Online databases, Latin American and Caribbean Health Sciences in Literature and PubMed, by means of combining the following descriptors: "Telemedicine", "Dentistry", "Distance, Education", in Portuguese and English. A total of 340 articles were found, of which 14 were included for final evaluation, with PubMed being the most prevalent database (71.4%). Most studies (85.7%) were included in level IV evidence. Studies reporting the use of this technology have been identified to minimize geographical barriers and to provide adequate assistance to the most vulnerable populations and others on reports from professionals, dentistry students and patients regarding the use of Teledentistry. It was concluded that Teledentistry is a global reality, but still needs to disseminate its experiences to the scientific community, for its consolidation as an educational and healthcare tool.

Descriptors: Information Technology. Telemedicine. Dental Informatics. Dentistry. Education, Distance.

1 INTRODUCTION

The era of technology has brought about changes at a frenetic pace, allowing the emergence of new alternatives with respect to educational resources, which bring among their characteristics the flexibilization in the delivery of educational contents[1], such as Teledentistry.

Teledentistry as a new interaction and communication tool was recently described, with scope and meaning until then not well defined and without consolidated consensus. It emerges from Telemedicine, being defined as the use of Information and Communication Technologies (ICT) for the exchange of data and health information and to provide health services in situations where there is a need to overcome geographical, temporal, social and cultural barriers[2]. In this scenario, in 2002, the *National Health System* reported a concern about the dental assistance of patients living in remote and isolated regions, declaring that Teledentistry is a support alternative for dentists who worked in these regions[3], presenting itself as a more accessible way to provide services to the population[4].

In Brazil, Telehealth Brazil Networks in Primary Care is an alternative to improve the quality of care, the expansion of the scope of actions offered by teams and the increase of the clinical capacity, including dentistry services. This is a component of the requalification program of the Basic Health Units (UBS), whose objective is to increase the resolution of Primary Care, promoting its integration with the Health Care Network as a whole, through the development of actions to support care health and permanent education for the Primary Care teams[5].

As a field of knowledge that is part of Telehealth, Teledentistry is constantly evolving, with emphasis on interactive tele-education, tele-assistance and the production of multicentric researches[1,6]. Teleassistance generates a tele-education component. The professional qualifies his/her action as a dental surgeon (DS), adding new knowledge in an immediate manner, focused on the topic of the doubt/question sent, allowing the DS to rely on remote help for a second opinion on a complex case or doubts that he/she may have, also known as second formative opinion[7]. Tele-education can also collaborate with the health professional in his/her professional training[8], in addition to training as a resident/specialist, through semi-distance courses with remote support or even telepresence, according to the possibility offered by the specialty. Such qualification options allow the DS new ways of training, with lower cost, adding value and quality with continuous improvement of clinical decision making[9].

Thus, the breadth of science offers space for study, discussion, and exchange of information to build an adequate and effective path for the qualification of the DS professional. Such action may reflect positively on the quality of oral health care, allowing a better planning and treatment outcome, as well as contributing to multi/interprofessional knowledge. The specific knowledge of Teledentistry can also qualify the formation/action of the team as a whole, integrating a quality service, with respect to geographic and temporal distances[10,11].

Teledentistry presents a great variability in its fields of application and documented experiences. These experiences can be grouped into two main branches: Teleassistance and Tele-education[12]. Thus, the purpose of this integrative review was to analyze the

situational panorama of Teledentistry in the world.

2 METHODS

It is an integrative literature review, a research method often used in evidence-based practice, whose aim is to gather and synthesize previous results, in order to elaborate a comprehensive explanation of a specific phenomenon. Thus, the conclusions are established through the critical evaluation of different methodological approaches[13].

This integrative review was composed of five stages: a) elaboration of the guiding question, based on the gap regarding the situation of Teledentistry in the world; b) definition of databases and establishment of criteria for inclusion and exclusion of studies/sampling or search in the literature; c) data collection; critical analysis of included studies, followed by the classification of study evidence; d) discussion of the results and, finally, e) presentation of the review/synthesis of the knowledge[13].

Only scientific articles published in full, both in English and Portuguese, in the last 10 years (period 2007 to 2017) were included to compose this integrative review and that involved the various actors and scenarios included in Teledentistry. Those who were not consistent with the subject of this study and which were repeated were excluded.

The search of the journals that composed this work was carried out in the databases *Scientific Electronic Library Online* (SciELO), Latin American and Caribbean Health Sciences in Literature (LILACS) and PubMed, by means of the combination by the *boolean* operator "AND" of the following descriptors, in Portuguese and in English: "Telemedicina/Telemedicine", "Odontologia/Dentistry", "Educação à Distância/Distance Education".

After the searches, the titles and summaries of the articles found were read and those that did not fit the proposed theme were excluded. The searches performed, as well as the articles found, were handled by a single operator, and the free Mendeley *software* was used to manage the articles that composed this review.

The quality of the studies was evaluated according to the classification of the level of evidence (LE)[14], as follows: level I - evidence obtained from the meta-analysis results of controlled clinical trials and with randomization; level II - evidence obtained in an experimental design study; level III - evidence obtained from quasi-experimental research; level IV - evidences obtained from descriptive studies or with a qualitative methodological approach; level V - evidence obtained from case reports or experience reports; level VI - evidence based on expert opinions or on the basis of standards or legislation.

This study took into consideration the ethical aspects of the research, respecting the authorship of the ideas, concepts and definitions present in the articles included in this review.

3 RESULTS

By means of the combinations of the pre-established descriptors, 340 publications were identified, being 28 in the SciELO database, 115 in LILACS and 197 in PubMed. After using the pre-defined criteria in the methodology of this study, 14 articles were selected to compose the sample. Table 1 expresses, from the search strategies, the bases consulted, the number of references found and that were selected.

Of the articles selected, 85.7% had English as the language of publication. Most of the studies (35.7%) were published in 2011.

The United States was the most prevalent country of affiliation of the main author of the articles (35.7%) and the PubMed database prevailed (71.4%) over the rest.

Table 2 expresses some initial analysis data of selected articles, such as author(s)/year of publication, country of affiliation of the main author, the title of the article and the database where it was found.

Data that include the author(s)/year of publication, study objectives, besides the evidence of the studies, according to the research design, are described in table 3.

Most of the studies classified regarding the evidence at level IV (85.7%), have characterized evidence of descriptive studies (non-experimental), as they were the reports about the experiences on the use Teledentistry of observational nature, where they described, from observations and descriptive analyzes, the before and after of the experiences with the implementation of Telehealth services[15].

Table 1. Search strategies, consulted databases, number of references found and selected

Search strategies	Consulted databases	References found	References selected
Telemedicina/Telemedicine [Words] and Odontologia/ Dentistry [Words]	SciELO	03	02
	LILACS	07	00
	PubMed	58	09
Telemedicina/Telemedicine [Words] and Educação a Distância/Distance, Education [Words]	SciELO	25	01
	LILACS	80	01
	PubMed	72	00
Odontologia/Dentistry [Words] and Educação a Distância/Distance, Education [Words]	SciELO	00	00
	LILACS	23	00
	PubMed	64	01
Telemedicina/Telemedicine [Words] and Odontologia/Dentistry [Words] and Educação a distância/Distance, Education [Words]	SciELO	00	00
	LILACS	05	00
	PubMed	03	00
TOTAL		**340**	**14**

Table 2. Characterization of selected studies

Author/Year	Country of affiliation of the main author	Title of the article	Databases
Silva *et al*., 2011	Brazil	Bauru School of Dentistry Tele-Health League: an educational strategy applied to research, teaching and extension among applications in telehealth	SciELO
Jampani *et al*., 2011	India	Applications of teledentistry: A literature review and update	PubMed
Summerfelt, 2011	United States	Teledentistry-Assisted, Affiliated Practice for Dental Hygienists: An Innovative Oral Health Workforce Model	PubMed
Keeppanasserril *et al.*, 2011	India	The effectiveness of Tele-guided Interceptive Prosthodontic treatment in rural India: A comparative pilot study	PubMed
Costa *et al.*, 2011	Brazil	Teleortodontia: ferramenta de auxílio à prática clínica e à educação continuada	SciELO
Glassman *et al*., 2012	United States	The Virtual Dental Home: Implications for Policy and Strategy	PubMed
Skelton-Macedo *et al*., 2012	Brazil	Teleodontologia: valores agregados para o clínico/especialista	LILACS
Hilsen, Jones, 2013	United States	Comparing potential early caries assessment methods for teledentistry	PubMed
Torres-Pereira *et al*., 2013	Brazil	Teledentistry: Distant Diagnosis of Oral Disease Using E-Mails	PubMed
Dunbar *et al*., 2014	United Kingdom	The Influence of Using Digital Diagnostic Information on Orthodontic Treatment Planning – A Pilot Study	PubMed
Kunin *et al*., 2014	United States	Comparing Face-to-Face, Synchronous, and Asynchronous Learning: Postgraduate Dental Resident Preferences	PubMed
Fortuin, Naidoo, 2015	South Africa	Opportunities for Teledentistry in South Africa	SciELO
Boringi *et al.*, 2015	India	Knowledge and Awareness of Teledentistry among Dental Professionals – A Cross-Sectional Study	PubMed
Tesfalul *et al*., 2016	United States	Evaluating the potential impact of a mobile telemedicine system on the coordination of specialty care for patients with complicated oral lesions in Botswana	PubMed

Table 3. Author(s), year of publication, objectives and level of evidence of the selected studies

Author, Year	Objectives of the studies	Level of Evidence
Silva *et al.*, 2011	To present the characteristics of Tele-Health League of the FOB-USP, as well as the development of its projects.	Level IV
Jampani *et al.*, 2011	To review the origin, rationality, scope, basis and requirements for Teledentistry, together with the current evidence that exists in the literature, besides the ethical and legal issues related to the practice of Teledentistry and the future of this alternative and innovative method of dental care.	Level IV
Summerfelt, 2011	To provide information about the Patient Protection and Affordable Care Act, identifies the equipment used in the Teledentistry model of the Northern Arizona University.	Level IV
Keeppanasserril *et al.*, 2011	To find out if newly trained dentists, under the remote guidance of specialists, can manufacture dentures that are functional and improve the quality of life-related to oral health.	Level III
Costa *et al.*, 2011	To investigate, through non-systematic literature review – which among the available technologies are able to be used in the development of Teledentistry services, as tools to aid clinical practice and continuing education.	Level IV
Glassman *et al.*, 2012	Describe how the Virtual Dental Home happens.	Level IV
Skelton-Macedo *et al.*, 2012	To portray, for the general practitioner/specialist, the aggregated values of Teledentistry.	Level IV
Hilsen, Jones, 2013	To evaluate and compare the visible and near-infrared detection methods for the identification of early non-cavitated *ex vivo* occlusal demineralization	Level III
Torres-Pereira *et al.*, 2013	To evaluate the applicability of telediagnosis in oral medicine through the transmission of digital clinical images by e-mail.	Level IV
Dunbar *et al.*, 2014	To evaluate whether orthodontic treatment planning is reproducible when performed using digital records compared to clinical examinations or using standardized records.	Level IV
Kunin *et al.*, 2014	To evaluate whether the new asynchronous format satisfied the educational needs of residents compared to the traditional (face to face) and synchronous (distance learning) formats.	Level IV
Fortuin, Naidoo, 2015	Report on the opportunities of the Teledentistry in South Africa.	Level IV
Boringi *et al.*, 2015	To know the knowledge and awareness of Teledentistry among dental professionals of a Faculty of Dentistry in India.	Level IV
Tesfalul *et al.*, 2016	To explore the potential impact of an oral mobile system of Telemedicine on the oral health specialty system of reference in Botswana.	Level IV

In one study the origin, rationale, scope, basis and requirements for Teledentistry were reviewed; ethical and legal issues related to the practice of Teledentistry and the future of this alternative and innovative method of dental care. In it, it was found that, in view of all the technological developments occurring in the field of this technology, professionals can eventually connect to virtual dental clinics and an entirely new era of Dentistry can be created[16].

This new era of Dentistry can already be observed in the course of Dentistry of the University of São Paulo (USP). The Teledentistry service of the Faculty of Dentistry of Bauru of the USP (TLFOB-USP), in four years of activity, obtained a high satisfaction rate and increased in the number of vacancies, greater commitment of the professors of the University and the association with others Brazilian leagues. The members of the TLFOB-USP, along with participating teachers, developed projects in Telehealth, Tele-Aid and Tele-education, resulting in the involvement of the University and the community[17].

The use of Teledentistry to minimize geographic barriers and provide adequate assistance to the most vulnerable populations has been reported in some of the publications selected by this review[18,19,20], highlighting the potential of Teledentistry to make access to the more accessible population.

In one study, it was observed that the practice of dental hygiene assisted by Teledentistry described in the paper, presented a model of mid-level practice that can provide comprehensive preventive oral health care and diagnostic services to the growing population of underserved patients in urban areas and remote areas[18]. In South Africa, one study found that Teledentistry is a potentially more affordable solution for performing dental services in most rural areas of South Africa[19]. In the United States, a growing demand for the model of the virtual dental home was observed, being recognized and communicated among those interested in access to dental care and oral health for vulnerable and neglected populations[20].

In another work, it has been observed that, newly graduated generalist dentists, when supervised remotely, they can provide *overdentures* (total prosthesis supported in implants) of satisfactory quality to the rural population. This strategy has the potential to improve access to care and raise the level of dentistry available to the rural population, when referral to specialists is not feasible[21].

A review of the literature that has evaluated the use of the broadband *internet*, mobile telephony, digital photography and websites, found that the use of technologies already accessible in the market can enable Teledentistry services in Brazil, as tools to aid clinical practice and continuing education[22]. The planning, diagnosis and consultation through Teledentistry and the use of this technology by students are also alternatives that can be of great value. In this sense, some authors have approached in their studies the clinical diagnosis and the accuracy of consultations by the Teledentistry service[23,24].

In one work, the visible and near-infrared detection methods were evaluated and compared for the identification of precocious non-cavitated occlusal demineralization in a model of tooth extracted *ex vivo*[23]. The authors noted that, although *Midwest Caries ID™* (MID) and Cross-polarization Optical Coherence Tomography (CP-OCT) were useful in detecting the presence of demineralization, it was not possible to adequately assess the depth of demineralization. Thus, the MID and CP-OCT did not have markedly higher diagnostic values from the evaluation of the simple visual photographic examination (CAM) for use in Teledentistry.

In another study, it was found that the use

of information technology can increase the accuracy of oral medication consultations, being increased, with the participation of two remote specialists, the possibility of correct diagnosis[24].

A study conducted in the United Kingdom aimed to evaluate whether orthodontic treatment planning is reproducible when performed using digital records compared to clinical examinations or use of standard records, as well as the opinion of the patients about face-to-face consultations and potential use of Teledentistry. It was found that the reproducibility of the planning of the intra-observer treatment was influenced by a change in the format of diagnostic information for half the observers; the agreement of treatment planning between observers was influenced by diagnostic information and that no individual was dissatisfied with the conventional consultation system[25].

A study in the United States with postgraduate students in Dentistry showed that such students preferred the presence and asynchronous formats in relation to the synchronous format in terms of the effectiveness and clarity of the presentations. Thus, the asynchronous format may be a more effective way of teaching in a postgraduate course[26]. Such result emphasizes the efficacy of distance learning, as published in literature[27]. In India, a study found that the majority of dentists did not have adequate knowledge and awareness about Teledentistry[28].

The most recent study selected in the composition of this integrative review explored the potential impact of a mobile oral telemedicine system on the oral health specialty. The authors suggest that Teledentistry can optimize the use of diagnostic hypotheses and specialist skills in remote regions where dentists are scarce[29].

4 DISCUSSION

The amount of articles selected, despite the large number of articles found after the combinations of the defined descriptors, can be explained by not including the gray literature in the article search, besides the term "Teledentistry" is not a descriptor registered in the Health Sciences Descriptors (DeCS)[30]. Also, in the databases in which the searches for this review were made, many magazines in the area of education are not indexed, where many articles on the subject Teledentistry may be published, with a higher indexation of health magazines.

Many studies and publications on the advancement of Information and Communication Technologies (ICT) come from developed countries, such as the United States, because in addition to advanced technology, human resources trained and qualified for an adequate and successful Telehealth service are necessary[10].

The first two articles listed for this review deal with Teledentistry as a new era in Dentistry. This can be explained by the constant evolution of Teledentistry services, in particular with regard to Teleassistance and Tele-education[6]. As an example of a successful experience of Teledentistry, there is the Teledentistry Center of the Dentistry School of the University of São Paulo, which is linked to the Telehealth Program Brazil, that since 2007 meets the demands of college and community through Tele-education and Teleassistance, respectively[31].

Some articles of this integrative review have addressed the use of Teledentistry in Teleassistence, offering greater access to dental care services, minimizing, thus, the geographical barriers between professionals and communities[18-22]. This is because many dental surgeons are concentrated in large centers, with an unequal distribution of these professionals, considering the different Brazilian regions. This factor may contribute to the difficulty of access

by the Brazilian population to oral health services[32].

Other studies selected to compose this review deal with Teledentistry as a tool of Tele-education[22-29], and can be used in professional training from graduation to post-graduation. Thus, Teledentistry can be considered an excellent way to integrate technologies and education, corroborating with work already published in the literature[08].

In a published study, the authors stated that there are many creative ways of adding technology to everyday life, with Teledentistry offering the general practitioner/specialist innovative ways to add value to daily practice[7].

5 CONCLUSION

The studies selected for this integrative review show that Teledentistry is a global reality, being an important tool for the assistance of dental care, especially to the most vulnerable populations and continuing training of the dental surgeon.

More studies are needed to be carried out showing the effectiveness of this technology. In addition, the results of experiments using this technology need to be widespread and disseminated to the scientific community in general, including in health databases. This will enable the expansion and consolidation of these services in the world, filling the remaining gaps as to its evidence, allowing a greater basis for its expansion and consolidation.

RESUMO

Panorama situacional da Teleodontologia no mundo: uma revisão integrativa

O uso das Tecnologias de Informação e Comunicação (TIC) para a troca de dados e informações em Odontologia, provendo serviços de saúde em situações em que seja necessário transpor barreiras geográficas, temporais, sociais e culturais é chamado de Teleodontologia. O objetivo dessa revisão integrativa foi analisar o panorama situacional global da Teleodontologia. Foram selecionados artigos científicos publicados nos últimos 10 anos, na íntegra, tanto em português quanto em inglês. A busca dos periódicos foi realizada nas bases de dados Scientific Eletronic Library Online, Literatura Latino-americana e do Caribe em Ciências da Saúde e PubMed, por meio da combinação dos seguintes descritores "Telemedicine", "Dentistry", "Distance, Education", nas línguas portuguesa e inglesa. Foram encontrados 340 artigos, sendo 14 incluídos para avaliação final, sendo o PubMed a base de dados que mais prevaleceu (71,4%). A maioria dos estudos (85,7%) foi incluída no nível IV de evidência. Foram identificados estudos informando sobre o uso dessa tecnologia para minimizar as barreiras geográficas e fornecer uma assistência adequada às populações mais vulneráveis e outros sobre relatos de profissionais, estudantes de Odontologia e pacientes quanto ao uso da Teleodontologia. Concluiu-se que a Teleodontologia é uma realidade global, mas ainda necessita de disseminação de suas experiências na comunidade científica, para sua consolidação como uma ferramenta educativa e de assistência à saúde.

Descritores: Tecnologia de Informação. Telemedicina. Informática Odontológica. Odontologia. Educação a Distância.

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