

Applications of teledentistry in dental practice: a systematic review¹

Aplicaciones de la teleodontología en la práctica odontológica: revisión sistemática¹

NATALIA FORTICH MESA², VIVI HOYOS HOYOS³

- 1 This project was financed by Special Cooperation Agreement (Convenio Especial de Cooperación) No. 212-2019, resulting from a COLCIENCIAS call for submissions.
- 2 DDS. MSc in Clinical Epidemiology. Professor, Corporación Universitaria Rafael Núñez. Cartagena (Colombia). ORCID: 0000-0003-2929-0278
- 3 DDS. Corporación Universitaria Rafael Núñez. Cartagena (Colombia). ORCID: 0000-0002-3085-7772

Abstract

Introduction: access to dental services in rural and remote areas is a problem still to be solved; for this purpose, a new alternative known as teledentistry has emerged. Through the application of information and communications technologies (ICTs), teledentistry promotes prevention, diagnosis, and treatment. This study aimed to determine the impact of teledentistry applications on clinical practice in different specialties based on the current evidence in the literature. **Methods:** two reviewers conducted a literature search in PubMed, EMBASE, EBSCO, ScienceDirect and LILACS databases until August 2019, to identify studies published in English, Spanish and Portuguese. Studies containing interventions applied to teledentistry, published in the last six years and available in full text were included. Bias risk was assessed through validated criteria according to each study type. **Results:** the search strategy retrieved 1028 articles, 24 of which were selected for evaluation. Twenty-three articles were cross-sectional studies and only one study was quasi-experimental. Seventeen studies (70.8%) considered teledentistry as an alternative to diagnosing and treating oral diseases in rural areas and health centers through mobile devices and clinical photographs. Most studies had moderate to high bias risk. **Conclusion:** while there is evidence on the use of teledentistry in the various fields of dentistry, it is important to keep in mind that since this is a novel tool that seeks to support access to health services in remote areas, the obtained results are preliminary, and further research with quality publications is necessary to evaluate the effectiveness of this tool.

Keywords:

teledentistry,
health promotion,
diagnosis, oral
health, distance
education

Resumen

Introducción: el acceso a los servicios odontológicos en zonas rurales y remotas es una problemática que aún no está resuelta, por lo que se ha introducido la teleodontología, a través de la aplicación de tecnologías de la información y la comunicación (TICs) por medio de la prevención, diagnóstico y tratamiento. El objetivo del presente estudio consistió en determinar el impacto de las aplicaciones de la teleodontología desde las diferentes especialidades a partir de la evidencia. **Métodos:** dos revisores realizaron una búsqueda en las bases de datos PubMed, EMBASE, EBSCO, ScienceDirect y LILACS para identificar estudios publicados en inglés, español y portugués. Se incluyeron estudios que contenían intervenciones en teleodontología, publicados en los últimos seis años y en texto completo. La calidad de los artículos se evaluó teniendo en cuenta el diseño del estudio. **Resultados:** se identificaron 1028 artículos, y se incluyeron 24 artículos para su evaluación. Veintitrés de estos artículos eran estudios transversales y un solo estudio fue de intervención. Diecisiete estudios (70,8%) presentaron la teleodontología como una alternativa para diagnósticos y tratamientos de enfermedades bucales en zonas rurales mediante dispositivos móviles, consultas y fotografías. La mayoría de los estudios presentaban un riesgo de sesgo de moderado a alto. **Conclusión:** pese a que existe evidencia sobre el uso de la teleodontología en los diferentes campos de la odontología, es importante tener en cuenta que, dado que esta es una herramienta novedosa que busca apoyar el acceso a los servicios de salud en zonas remotas, se hace necesario realizar una nueva búsqueda de evidencia con mejor calidad en la publicación.

Palabras claves:

teleodontología,
promoción
de la salud,
diagnóstico, salud
oral, educación a
distancia

Submitted: November 28/2019 – Accepted: April 14/2020



How to quote this article: Fortich-Mesa N, Hoyos-Hoyos V. Applications of teledentistry in dental practice: a systematic review. Rev Fac Odontol Univ Antioq. 2020; 32(1): 77-88. DOI: <http://dx.doi.org/10.17533/udea.rfo.v32n1a8>

INTRODUCTION

Telemedicine refers to the provision of medical care with Information and Communication Technologies (ICTs) to conduct diagnostics, consider treatments, prevent diseases, and strengthen the network of professionals and research activities in rural and hard-to-reach communities.^{1,2} Similarly, in dentistry, an innovative method called teledentistry has been developed, providing clinical care through electronic dental records and remote ICTs as an opportunity to raise awareness, promote education and provide patients with professional services.³⁻⁶

This concept was first implemented in dentistry in 1997 by Cook,⁴ who used video conferencing for diagnosis and remote treatment consultations, and managed to exchange clinical information and images.⁷ Currently, this alternative is still in development as a promising tool to identify the presence of injuries and perform teleconsultation in school programs, rural areas, and areas with limited access through different devices such as smartphones, portable x-rays, social networks, and in various specialties such as endodontics, oral surgery, periodontics, and public health, proving to be more efficient and with high demand in the provision of health services, thus reducing inequality in dental clinical care.^{8,9}

Globally, research projects like the ones conducted by Kale S, Kakodkar P, Shetiya SH¹⁰ in India assessed mothers' abilities for health education regarding the diagnosis of tooth decay, using smartphone photographs, which were sent through a social network. Each child's diagnosis was requested, with significant changes for mothers, who made improvements in the diagnosis of their children's dental condition.

In Latin America, specifically in Brazil, Fonseca et al¹¹ evaluated the correct diagnosis of the presence of oral lesions and diagnoses conducted remotely through digital images obtained with a cell phone, showing improved efficiency and higher demands in the provision of health services and a decrease in inequalities in dental clinical care.^{12,13} In Colombia, the concept of telehealth was implemented through Law 1419 of 2010, as a means of supporting the General System of Social Security in Health (Sistema General de Seguridad Social en Salud, SGSSS), in order to support health service providers in terms of equity in care, improved access to health services, and quality of life in vulnerable areas.¹⁴

However, the implementation and applicability of telehealth to date is still inconclusive because the development and application of these remote methods are recent, and therefore teledentistry is still unknown to many professionals, preventing the population from receiving the benefits of these practices. Therefore, a systematic review of the literature was conducted to determine the impact of teledentistry applications in various specialties in clinical practice based on available scientific evidence.

METHODS

A systematic search of the literature was conducted to describe and summarize the information available on the applications of teledentistry, following the PRISMA-P guidelines (2015).¹⁵

Eligibility Criteria

Eligible studies were independently selected by two reviewers who used titles and

abstracts, including descriptive analysis, cross-sectional studies and/or interventions in relation to teledentistry, published in the period 2013 to August 2019, available in full text in English, Spanish or Portuguese. Other study types, such as literature reviews, systematic reviews, or documents submitted as editorials or books were excluded.

Search Strategy

Eighteen bibliographic searches were carried out using the PubMed, EMBASE, EBSCO, ScienceDirect and LILACS databases from 2013 to August 2019. These searches were carried out through the combination of the following keywords: “teledentistry AND education distance”; “teledentistry AND health promotion”; “teledentistry AND oral health”; “teledentistry AND NOT telemedicine”; “teledentistry OR telehealth AND health promotion AND oral health”; “telehealth AND telemedicine AND teledentistry”; “teledentistry AND oral health”; “tele-

medicine AND teledentistry”; “telemedicine AND oral health”; “teledentistry AND health promotion OR oral health”; “teleodontología AND educación a distancia”; “teleodontología AND salud oral”. The search strategy was adapted for each database.

Selection of studies and data extraction

For the selection of studies, two authors examined the publications' titles independently and in duplicate based on the eligibility criteria; then the abstracts were accessed, deciding which articles to include. In the second evaluation stage, the articles were obtained in full text and evaluated by the two authors, who agreed by consensus on the final inclusion.

The selected articles were broken down in an evidence table (Table 1). The first reviewer extracted each full text, while the second reviewer independently verified the extracted data and resolved the discrepancies generated at this stage.

Table 1. Characteristics of included studies

First author	Year	Country	Context	Population involved	Research design	Outcome (Area to evaluate)	Tool used
AlKlayb ¹⁸	2017	Saudi Arabia	Doesn't report	Mothers	D	Oral health	Mobile app (iTeethey™)
Bhatt ¹⁹	2018	India	Rural area	Adults	C	Oral cancer / Cervical cancer	Interview
Birur ²⁰	2019	India	Industrial zone	Adults	A	Oral cancer	Mobile app
Boringi ²¹	2015	India	University	Dental professionals and students	D	Knowledge and beliefs	Questionnaire
Daniel ²²	2017	United States	Schools	Children	D	Tooth decay	Photographs
Almeida ²³	2017	Brazil	University	Children and adults	DT	Dentoalveolar trauma	Photographs
Estai ²⁴	2017	Australia	Rural area	Dentists, dental students, dental therapists, nurses	D	Tooth decay	Questionnaire
Estai ²⁵	2016	Australia	Doesn't report	Adults	DT	Oral diseases	Mobile app
Estai ²⁶	2016	Australia	Dental clinic	Children and adults	DT	Tooth decay	Mobile app
Giradeau ²⁷	2017	France	Prison	Prisoners	DT	Oral health	Camera (Soprocure®)
Haron ²⁸	2017	Malaysia	Doesn't report	Adults	DT	Oral cancer	Mobile device
Jung ²⁹	2018	South Korea	University	Adults	DT	Tooth decay	Digital Fluorescence (QLF-D)

First author	Year	Country	Context	Population involved	Research design	Outcome (Area to evaluate)	Tool used
Kohara ³⁰	2018	Brazil	University	Teeth extracted, Children	DT	Tooth decay	Mobile device
Martin ³¹	2016	United States	Doesn't report	Dental Professionals	D	Telehealth	Questionnaire
McFarland ³²	2017	United States	Rural area	Students in dentistry, oral health, and other health professions	D	Teledentistry	Questionnaire
McLaren ³³	2016	New York	Rural area	Children	D	Teledentistry	Teledentistry consultation
McLaren ³⁴	2016	New York	University	Children	D	Dental treatments	Teledentistry consultation
Morosini ³⁵	2014	Brazil	Prison	Adolescents	DT	Tooth decay	Photographs
Paixao ³⁶	2018	Brazil	Health centres	Teleconsulting	D	Teledentistry	Database
Puhorit ³⁷	2017	India	Rural area	Children	DT	Tooth decay	Camcorder
Roxo ³⁸	2017	Australia	Distance education	Dentists, nurses, dietitians	A	Oral cancer	Virtual course
Skandarajah ³⁹	2017	India	Health centre	Adults	PB	Oral cancer	Mobile microscope
Van Hilsen ⁴⁰	2013	United States	Doesn't report	Teeth extracted	QE	Tooth decay	Midwest Caries IDTM (MID), Visual Photo Examination (CAM), Cross-polarization Optical Coherence Tomography (CP-OCT).
Vinayagamorthy ⁴¹	2019	India	Rural area	Adults	O	Oral cancer	Mobile App (WhatsApp)

D: Descriptive; DT: Diagnostic Test; A: Analytical; CE: Quasi-experimental; O: Observational; C: Qualitative

Source: by the authors

The selected aspects for each article are classified by first author, country, context, study sample, study design, outcome, and tool used for the application of teledentistry.

Bias risk in individual studies

Bias risk was assessed according to each study type, verifying cross-sectional studies through a checklist by the Agency for Healthcare Research and Quality (AHRQ)¹⁶ and randomized clinical trials through the list of items for publication of the Cochrane Collaboration Tool.¹⁷

RESULTS

The search strategy identified 1028 articles, of which 24 were included in this systematic review (Figure 1). There were 23 cross-

sectional studies and 1 intervention study. Each study is detailed in Table 1.

Most studies were conducted in the United States and India, as well as in countries in South America, Asia, and Oceania. As for population type, the rural area was predominant. In terms of the intervened population, eight studies were performed in adults, four in children, two in children and adults, and one in adolescents. Other studies were in students, dental professionals, and other health-related professions; there were in vitro studies (teeth removed), and studies conducted in prisoners and teleconsultation. Concerning the area to evaluate, eight studies indicated tooth decay as the main outcome, followed by oral cancer with six studies. Finally, in determining the tool used for each study, an application or a mobile device was used in eight studies.

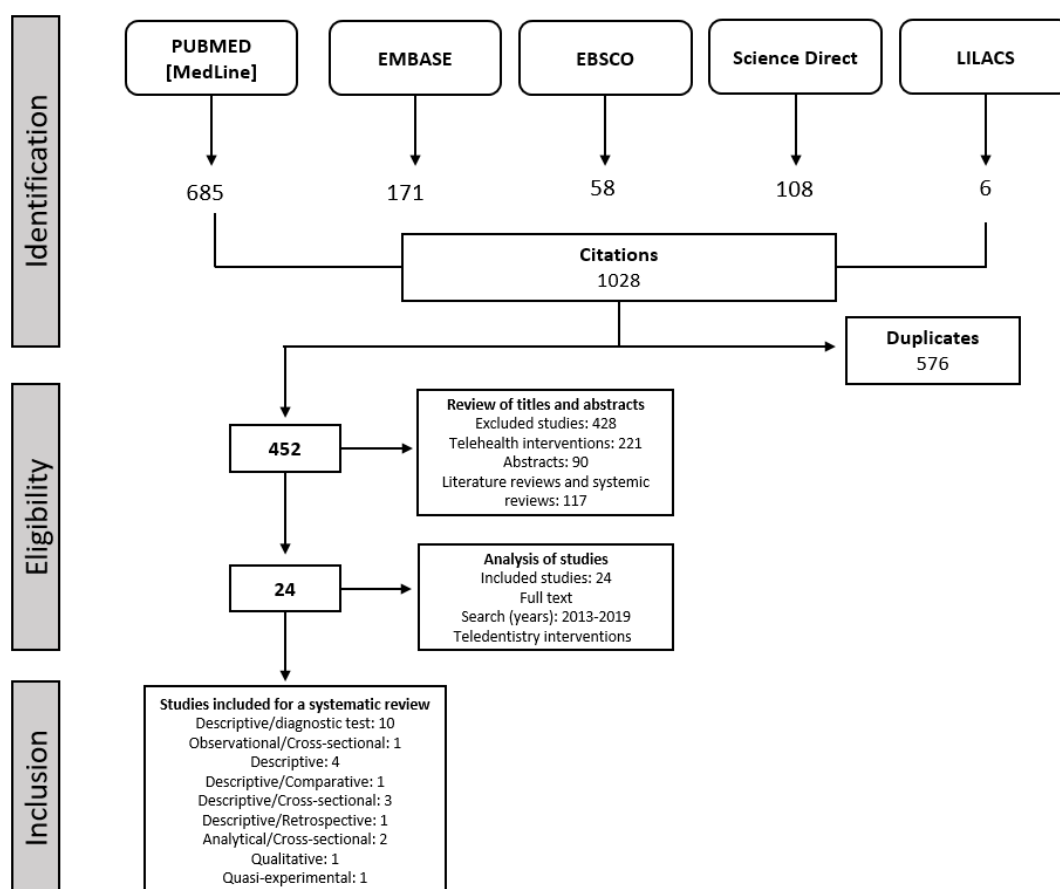


Figure 1. Flowchart of assessed studies per PRISMA

Source: by the authors

Results of cross-sectional studies

In total, seventeen (70.8%) of the 24 evaluated studies mentioned teledentistry as an alternative method in rural areas, health centers, and prisons for diagnosing and treating oral diseases such as oral cancer, tooth decay, and dentoalveolar trauma through different means such as applications and mobile devices: iTeethey™, WhatsApp, Remote-I, mobile microscope, digital fluorescence (QLF-D), Soprocare photo camera®, teledentistry consultations, and clinical photographs by dentists, specialists and health professionals such as nurses and nutritionists. Similarly, one study

identified knowledge and beliefs about teledentistry from college in students and dental professionals, and six studies assessed the applicability and use of teledentistry for health promotion and disease prevention during consultation, through questionnaires, interviews and databases in children, mothers and other adults.

Results of intervention studies

One quasi-experimental study was found, which evaluated and compared the visual and infrared detection methods to identify early non-cavitated ex vivo demineralization through three tests to detect

occlusal demineralization: Midwest Caries ID™ (MID), visual photographic examination (CAM), and cross-polarization optical coherence tomography (CP-OCT) on teeth removed 1 to 2 weeks apart. The teeth were then sectioned, and each lesion's depth was confirmed, reporting that MID and CP-OCT were helpful in detecting the presence of demineralization, though not in the depth of

the injury. It also did not present diagnostic values such as CAM for use in teledentistry.

Bias risk analysis

Of the included studies, 95% had moderate to high bias risk. Table 2 shows the bias risk analysis for observational studies only. On the other hand, the only intervention study was considered to have low bias risk as shown in Table 3.

Table 2. Quality assessment according to the Agency for Healthcare Research and Quality (AHRQ)

Author	Source of information (survey, records, review)	Inclusion and exclusion criteria	Time period evaluated	Consecutive population	Reports other aspects of participants	Quality assessment	Exclusions of participants in the analysis	Assessment and control of confounding variables	Data collection response rate	Handling missing data in the analysis	Clarity in follow-up
Purohit, et al (2017)	+	+	+	+	-	-	-	-	+	-	N/A
Estai, et al (2015)	+	-	-	+	-	-	-	-	+	-	N/A
Roxo, et al (2017)	+	+	+	+	-	-	-	-	+	-	N/A
Paixao, et al (2018)	+	+	+	+	-	-	+	-	+	-	N/A
Vinayagamoorthy, et al (2019)	+	+	+	+	-	-	-	-	+	-	N/A
Girardeau, et al (2017)	+	+	+	+	+	-	-	-	+	-	N/A
Boringi, et al (2015)	+	-	-	+	+	-	-	-	+	-	N/A
Estai, et al (2016)	+	-	-	+	+	-	-	-	+	-	N/A
Skandarajah, et al (2017)	+	-	-	+	+	-	-	-	+	-	N/A
McLaren, et al (2016)	+	+	+	+	+	-	-	-	+	-	N/A
Kohara, et al (2018)	+	+	+	+	+	-	-	-	+	-	N/A
Bhatta, et al (2018)	+	+	+	+	+	-	-	-	+	-	+
Daniel, et al (2017)	+	+	+	+	-	-	-	-	+	-	N/A
Martin, et al (2016)	+	+	+	+	+	-	-	-	+	-	N/A
Jung, et al (2018)	+	+	+	+	-	-	-	-	+	-	N/A
Haron, et al (2017)	+	-	-	+	-	-	-	-	+	-	N/A
McLaren, et al (2017)	+	-	+	+	-	-	-	-	+	-	N/A
de Almeida, et al (2017)	+	-	+	+	-	-	-	-	+	-	N/A
Birur, et al (2019)	+	+	+	+	-	-	-	-	+	-	N/A
Alklaybsa, et al (2017)	+	+	+	+	-	-	-	-	+	-	N/A
Estai, et al (2016)	+	+	+	+	-	-	-	-	+	-	N/A
Morosini, et al (2014)	+	+	+	+	-	-	-	-	+	-	N/A
McFarland, et al (2017)	+	+	-	+	-	-	-	-	+	-	N/A

+ Yes: Meets the assigned item - No: Does not meet the assigned item N/A: Not applicable

Source: by the authors

Table 3. Quality assessment according to Cochrane Collaboration

Author	Random sequence generation	Concealing the assignment	Blinding participants and staff	Incomplete results data	Selective reports	Other bias
Van Hielsen, et al (2013)	+	+	+	+	-	N/A

+ Yes: Meets the assigned item - No: Does not meet the assigned item N/A: Not applicable

Source: by the authors

DISCUSSION

The concept of teledentistry includes the combination of the use of computers, telecommunications technology, digital diagnostic imaging services, devices and software for oral health analysis and monitoring, through diagnosis and treatment recommendations in the distance.⁴² All the aforementioned aids have been used in fields such as care, education, and public health due to easy access to remote areas, and reduced time and costs for patients.⁴³

Two teledentistry methods are practiced nowadays: store and transmit and/or videoconferencing. However, its implementation is minimal, and a more frequent use of this modality in the diagnosis of pathological conditions is suggested.⁴⁴

Pentapati et al evaluated the reliability of an intraoral camera in teledentistry for the detection of oral diseases through an examiner who was trained and calibrated in an intraoral camera to take videos of the oral cavity, against clinical examination to evaluate cavities, bacterial plaque, calculus, dental wear, and fluorosis in children, reporting significantly higher values with the use of the intraoral camera than with clinical examination ($p = 0.001$), by means of the Spearman correlation coefficient.⁴⁵

Similarly, Purohit et al evaluated the reliability of videography to detect tooth decay among 12-year-old schoolchildren in a rural Indian

region through clinical examinations using the decayed, missing and filled teeth index (DMF-t) and a standardized video recording of the oral cavity. Sensitivity (0.86) and specificity (0.58) values were calculated for videographic evaluation of tooth decay, and concordance was evaluated using the Bland-Altman graph, concluding that teledentistry can be used as an alternative for dental cavity detection and for consultations in remote or hard-to-reach areas.³⁷

Torres-Pereira et al evaluated the applicability of tediagnosis in oral medicine through the transmission of clinical images by email to two specialists, using two clinical hypotheses for each case, which were compared with the biopsy results, showing that in 80% of cases at least one specialist provided the correct diagnosis, showing that the use of information technology provides an acceptable rate of correct diagnoses, thus supporting its application as a tool for detecting oral diseases.⁴⁶

Regarding users' satisfaction with the use of applications and mobile devices in teledentistry, Estai et al evaluated users' acceptance of a teledentistry model using Remote-I, a store and transmit telemedicine platform, to assist in the detection of oral diseases transmitted directly from the application to the server, finding out that users showed optimism towards the use of the teledentistry system, and positively evaluated the items in terms of content and quality of service.²⁴

However, to achieve efficiency and quality standards in teledentistry, it is necessary to adequately train professionals and insist in instant response to avoid careless service, educating dentists in the practice of teledentistry, including information on legal, ethical and technological implications, as well as clinical methods for patient care.

The findings of this systematic review show that, while the use of teledentistry is recent, there are some studies evaluating the knowledge, perceptions, and attitudes in teledentistry among dental students, general dentists and specialists, as well as the use of applications, mobile devices and intraoral cameras for oral health education and diagnosis of oral diseases such as tooth decay, periodontitis, and oral cancer, as well as the adherence to recommendations provided by dentists. This provides an important source of information and advice for health policy makers, service managers and clinicians, resulting in increased access to health services and dental consultation.⁴⁷

Most evaluated studies have multiple limitations, and even though this review was limited to the use of teledentistry in recent years, there appears to be scarce use of this technology. This review found out that there are only a few studies that help identify good quality standards, since most studies did not show prior evaluations, and there was only one experimental study, showing that the degree of scientific evidence is currently poor.

Similarly, while teledentistry has a high potential for addressing needs in the rural population or in remote areas, the findings of this review show that more than half of the evaluated studies were performed in urban areas rather than rural environments, or did not report the location where they were conducted, and most studies were

developed in the U.S., Europe, Asia and Australia. This may be due to economic factors (financing), poor access to networking in rural areas, or because the studies are in their pilot stage; it is therefore necessary to conduct further studies with a significant sample and related follow-up studies in Latin American countries.

CONCLUSION

This review helped determine the impact of teledentistry in different dental areas. However, most revised studies showed limitations in terms of short-term use of teledentistry and low level of evidence due to the methods and results obtained. It is therefore necessary to conduct further studies to evaluate the efficacy and follow-up of teledentistry services for consultation, diagnosis, and recommendations in dental treatment, as it may be a viable alternative in the reduction of time, transfers, and costs.

AUTHORSHIP STATEMENTS

All persons who meet authorship criteria are listed as authors of this document, and all authors certify that they have participated in its planning, design, and development, as well as in the interpretation of results. In addition, each author critically reviewed the paper, approved its final version and agreed with its publication. No responsible signature of the document has been omitted and the criteria for scientific authorship are met.

ACKNOWLEDGMENTS

The authors thank COLCIENCIAS for its contribution in the development of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

CORRESPONDING AUTHOR

Natalia Fortich Mesa
Corporación Universitaria Rafael Núñez
+57-5-6517088 Ext 1007
natalia.fortich@curnvirtual.edu.co
Centro Calle de la Soledad # 5 - 70
Cartagena de Indias, Colombia

REFERENCES

1. Kopycka D, McLaren S, Billings R. Advancement of teledentistry at the University of Rochester's Eastman Institute for oral health. 2018; 37(12): 1960-66. DOI: <https://doi.org/10.1377/hlthaff.2018.05102>
2. Rodríguez Díaz W, Alfaro Carballido L. Pasado, presente y futuro de la teleodontología: un nuevo reto. Puente. 2017; 8(1): 91-99. DOI: <http://dx.doi.org/10.18566/v8n1.a10>
3. Parrasi Castaño EY, Celis Carvajal L, Bocanegra García JJ, Pascuas Rengifo YS. Estado actual de la telemedicina: una revisión de literatura. Ingeniare. 2016; 20: 105-20. DOI: <https://doi.org/10.18041/1909-2458/ingeniare.20.412>
4. Friction J, Chen H. Using teledentistry to improve access to dental care for the underserved. Dent Clin North Am. 2009; 53(3): 537-48. DOI: <https://doi.org/10.1016/j.cden.2009.03.005>
5. Daniel SJ, Kumar S. Teledentistry: a key component in access to care. J Evid Based Dent Pract. 2014; 14(Suppl): 201-8. DOI: <https://doi.org/10.1016/j.jebdp.2014.02.008>
6. Mariño R, Tonmukayakul U, Manton D, Stranieri A, Clarke K. Cost-analysis of teledentistry in residential aged care facilities. J Telemed Telecare. 2016; 22(6): 326-32. DOI: <https://doi.org/10.1177/1357633X15608991>
7. Gilligan G, PiemonteED, Panico R. La consulta estomatológica en la era de la telemedicina. Claves Odontol. 2018; 76: 23-34.
8. Alabdullah JH, Daniel SJ. A systematic review on the validity of teledentistry. Telemed J E Health. 2018; 24(8): 639-48. DOI: <https://doi.org/10.1089/tmj.2017.0132>
9. Estai M., Kanagasingam Y., Tennant M, Bunt S. A systematic review of the research evidence for the benefits of teledentistry. J Telemed Telecare. 2018; 24(3): 147-56. DOI: <https://doi.org/10.1177/1357633X16689433>
10. Fonseca B, Amenábar J, Piazzetta C, Schussel J, Lemos-Júnior C, Torres C. Diagnóstico à distância de lesões bucais com fotografias de smartphones. Rev. Assoc Paul Cir Dent. 2016; 70(1): 52-7.
11. Kale S, Kakodkar P, Shetiya SH. Assessment of mother's ability in caries diagnosis, utilizing the smartphone photographic method. J Indian Soc Pedod Prev Dent. 2019; 37(4): 360-64. DOI: https://doi.org/10.4103/JISPPD.JISPPD_349_18
12. Santana Celes R, Rossi TRA, Barros SG, Santos CML, Cardoso C. A telessaúde como estratégia de resposta do Estado: revisão sistemática. Rev Panam Salud Publica. 2018; 42: e84. DOI: <https://doi.org/10.26633/RPSP.2018.84>
13. Jiménez Barbosa WG, Acuña Gómez JS. Avances en telesalud y telemedicina: estrategia para acercar los servicios de salud a los usuarios. Acta Odontológica Colombiana. 2015; 5(1): 101-15.
14. Colombia. Congreso de la República. Ley 1419 de 2010: lineamientos para el desarrollo de la Telesalud en Colombia; 2010.

15. Moher D, Shamseer L, Clarke M, Ghera D, Liberati A, Petticrew M et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015; 4: 1. DOI: <https://doi.org/10.1186/2046-4053-4-1>
16. Guise JM, Chang C, Viswanathan M, Glick S, Treadwell J, Umscheid C et al. *Systematic reviews of complex multicomponent health care interventions*. Rockville (MD): agency for Healthcare Research and Quality (US); 2014.
17. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD et al. The Cochrane collaboration's tool for assessing risk of bias in randomized trials. *BMJ*. 2011; 18: 343: d5928. DOI: <https://doi.org/10.1136/bmj.d5928>
18. AlKlayb SA, Assery MK, AlQahtani A, AlAnazi M, Pani SC. Comparison of the effectiveness of a mobile phone-based education program in educating mothers as oral health providers in two regions of Saudi Arabia. *J Int Soc Prev Community Dent*. 2017; 7(3): 110-15. DOI: https://doi.org/10.4103/jispcd.JISPCD_95_17
19. Bhatt S, Isaac R, Finkel M, Evans J, Grant L, Paul B et al. Mobile technology and cancer screening: lessons from rural India. *J Glob Health*. 2018; 8(2): 020421. DOI: <https://doi.org/10.7189/jogh.08.020421>
20. Birur NP, Gurushanth K, Patrick S, Sunny SP, Raghavan SA, Gurudath S et al. Role of community health worker in a mobile health program for early detection of oral cancer. *Indian J Cancer*. 2019; 56(2): 107-13. DOI: https://doi.org/10.4103/ijc.IJC_232_18
21. Boringi M, Waghay S, Lavanya R, Babu DB, Badam RK, Harsha N et al. Knowledge and awareness of teledentistry among dental professionals: a cross sectional study. *J Clin Diagn Res*. 2015; 9(8): ZC41-4. DOI: <https://doi.org/10.7860/JCDR/2015/13303.6320>
22. Daniel SJ, Kumar S. Comparison of dental hygienists and dentists: clinical and teledentistry identification of dental caries in children. *Int J Dent Hyg*. 2017; 15(4): e143-e148. DOI: <https://doi.org/10.1111/idh.12232>
23. de Almeida Geraldino R, Rezende LVML, da-Silva CQ, Almeida JCF. Remote diagnosis of traumatic dental injuries using digital photographs captured via a mobile phone. *Dent Traumatol*. 2017; 33(5): 350-57. DOI: <https://doi.org/10.1111/edt.12347>
24. Estai M, Kanagasingam Y, Xiao D, Vignarajan J, Bunt S, Kruger E et al. End-user acceptance of a cloud-based teledentistry system and Android phone app for remote screening for oral diseases. *J Telemed Telecare*. 2017; 23(1): 44-52. DOI: <https://doi.org/10.1177/1357633X15621847>
25. Estai M, Kanagasingam Y, Huang B, Checker H, Steele L, Kruger E et al. The efficacy of remote screening for dental caries by mid-level dental providers using a mobile teledentistry model. *Community Dent Oral Epidemiol*. 2016; 44(5): 435-41. DOI: <https://doi.org/10.1111/cdoe.12232>
26. Estai M, Kanagasingam Y, Xiao D, Vignarajan J, Huang B, Kruger E et al. A proof-of-concept evaluation of a cloud-based store-and-forward telemedicine app for screening for oral diseases. *J Telemed Telecare*. 2016; 22(6): 319-25. DOI: <https://doi.org/10.1177/1357633X15604554>
27. Giraudeau N, Inquimbert C, Delafoy R, Tramini P, Valcarcel J, Meroueh F. Teledentistry, new oral care tool for prisoners. *Int J Prison Health*. 2017; 13(2): 124-34. DOI: <https://doi.org/10.1108/IJPH-04-2016-0011>
28. Haron N, Zain RB, Nabillah WM, Saleh A, Kallarakkal TG, Ramanathan A et al. Mobile phone imaging in low resource settings for early detection of oral cancer and concordance with clinical oral examination. *Telemed J e-Health*. 2017; 23(3): 192-99. DOI: <https://doi.org/10.1089/tmj.2016.0128>
29. Jung EH, Lee ES, Jung HI, Kang SM, de Josselin de Jong E, Kim BI. Development of a fluorescence-image scoring system for assessing noncavitated occlusal caries. *Photodiagnosis Photodyn Ther*. 2018; 21: 36-42. DOI: <https://doi.org/10.1016/j.pdpdt.2017.10.027>

30. Kohara EK, Abdala CG, Novaes TF, Braga MM, Haddad AE, Mendes FM. Is it feasible to use smartphone images to perform telediagnosis of different stages of occlusal caries lesions? *PLoS One*. 2018; 13(9): e0202116. DOI: <https://doi.org/10.1371/journal.pone.0202116>
31. Martin AB, Nelson JD, Bhavsar GP, McElligott J, Garr D, Leite RS. Feasibility assessment for using telehealth technology to improve access to dental care for rural and underserved populations. *J Evid Based Dent Pract*. 2016; 16(4): 228-35. DOI: <https://doi.org/10.1016/j.jebdp.2016.08.002>
32. McFarland KK, Nayar P, Chandak A, Gupta N. Formative evaluation of a teledentistry training programme for oral health professionals. *Eur J Dent Educ*. 2018; 22(2): 109-14. DOI: <https://doi.org/10.1111/eje.12265>
33. McLaren SW, Kopycka-Kedzierawski DT. Compliance with dental treatment recommendations by rural paediatric patients after a live-video teledentistry consultation: a preliminary report. *J Telemed Telecare*. 2016; 22(3): 198-202. DOI: <https://doi.org/10.1177/1357633X15590705>
34. McLaren SW, Kopycka-Kedzierawski DT, Nordfelt J. Accuracy of teledentistry examinations at predicting actual treatment modality in a pediatric dentistry clinic. *J Telemed Telecare*. 2017; 23(8): 710-15. DOI: <https://doi.org/10.1177/1357633X16661428>
35. Morosini Ide A, de Oliveira DC, Ferreira Fde M, Fraiz FC, Torres-Pereira CC. Performance of distant diagnosis of dental caries by teledentistry in juvenile offenders. *Telemed J E Health*. 2014; 20(6): 584-9. DOI: <https://doi.org/10.1089/tmj.2013.0202>
36. Paixão LC, Costa VA, Ferreira EFE, Ribeiro Sobrinho AP, Martins RC. Analysis of the asynchronous dental teleconsulting of Telehealth Brazil Networks in Minas Gerais. *Braz Oral Res*. 2018; 32: e128. DOI: <https://doi.org/10.1590/1807-3107bor-2018.vol32.0128>
37. Purohit BM, Singh A, Dwivedi A. Utilization of teledentistry as a tool to screen for dental caries among 12-year-old school children in a rural region of India. *J Public Health Dent*. 2017; 77(2): 174-180. DOI: <https://doi.org/10.1111/jphd.12195>
38. Roxo-Gonçalves M, Strey JR, Bavaresco CS, Martins MAT, Romanini J, Pilz C et al. Teledentistry: a tool to promote continuing education actions on oral medicine for primary healthcare professionals. *Telemed J E Health*. 2017; 23(4): 327-33. DOI: <https://doi.org/10.1089/tmj.2016.0101>
39. Skandarajah A, Sunny SP, Gurple P, Reber CD, D'Ambrosio MV, Raghavan N et al. Mobile microscopy as a screening tool for oral cancer in India: a pilot study. *PLoS One*. 2017; 12(11): e0188440. DOI: <https://doi.org/10.1371/journal.pone.0188440>
40. Van Hilsen Z, Jones RS. Comparing potential early caries assessment methods for teledentistry. *BMC Oral Health*. 2013; 13: 16. DOI: <https://doi.org/10.1186/1472-6831-13-16>
41. Vinayagamoorthy K, Acharya S, Kumar M, Pentapati KC, Acharya S. Efficacy of a remote screening model for oral potentially malignant disorders using a free messaging application: a diagnostic test for accuracy study. *Aust J Rural Health*. 2019; 27(2): 170-76. DOI: <https://doi.org/10.1111/ajr.12496>
42. Böhm da Costa C, Peralta FDS, Ferreira de Mello ALS. How has teledentistry been applied in public dental health services? An Integrative Review. *Telemed J E Health*. 2019. DOI: <https://doi.org/10.1089/tmj.2019.0122>
43. Khan SA, Omar H. Teledentistry in practice: literature review. *Telemed J E Health*. 2013; 19(7): 565-7. DOI: <https://doi.org/10.1089/tmj.2012.0200>
44. Subbalekshmi T, Anandan V, Apathsakayan R. Use of a Teledentistry based Program of screening of early childhood caries in a school setting. *Cureus*. 2017; 9(7): e1416. DOI: <https://doi.org/10.7759/cureus.1416>

45. Pentapati KC, Mishra P, Damania M, Narayanan S, Sachdeva G, Bhalla G. Reliability of intraoral camera using teledentistry in screening of oral diseases - Pilot study. *Saudi Dent J.* 2017; 29(2): 74-7. DOI: <https://doi.org/10.1016/j.sdentj.2017.03.002>
46. Torres-Pereira CC, Morosini Ide A, Possebon RS, Giovanini AF, Bortoluzzi MC, Leão JC et al. Teledentistry: distant diagnosis of oral disease using e-mails. *Telemed J E Health.* 2013; 19(2): 117-21. DOI: <https://doi.org/10.1089/tmj.2012.0087>
47. Jampani ND, Nutalapati R, Dontula BS, Boyapati R. Applications of teledentistry: A literature review and update. *J Int Soc Prev Community Dent.* 2011; 1(2): 37-44. DOI: <https://doi.org/10.4103/2231-0762.97695>