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Teledentistry System in Dental Health Public Services: A Mixed-Methods Intervention Study

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ABSTRACT

Introduction: Health information and communication technologies, such as Teledentistry, can help expand access to dental health public services making it more effective. Objective: To analyze the factors that affect the implementation of a Teledentistry system in dental health public services.

Methods: The study follows the Implementation Research methodological framework. A mixed-method approach was applied using a triangulation design–sequential model to collect, analyze, and interpret qualitative and quantitative data about the implementation of a Teledentistry system. A compulsory teleconsultation from the general dentist was planned to access periodontics specialized care. The study was developed in a South Brazilian capital city and the platform of the Santa Catarina Telehealth Center was used. Qualitative and quantitative data were collected sequentially to achieve a better understanding of implementation research issues. Results: In seven months, 68 teleconsulting was performed by 22% of the general dentists, prior to the referrals on periodontics. Only one reported not needing to refer the patient to the periodontist as a result of the teleconsulting guidance. Teledentistry system implementation and usage were influenced by the managers' political and administrative awareness to deploy and maintain the intervention. Lack of sufficient resource investment, lack of system integration, and internet failures were relevant limiting factors. The teleconsultant guidelines contributed to general dentistry's better decision-making regarding treatment, urgency of case management, and prioritization of referrals to the periodontists

Conclusion: Identifying the factors that influence the implementation and finding solutions to overcome them, can prevent future failures and improve usage of the system

1. Introduction

Tooth decay and periodontal disease are common [1], leading to toothache and diminished function, affecting overall physical, psychological, social, and economic well-being [2] with consequences for the economy and public health [3,4]. As they can be prevented, it is important to have oral health professionals available to people [4]. Unfortunately, dental health services are often unavailable and inaccessible for most populations [5] and oral diseases persist with high prevalence, especially in low- and middle-income countries [1].

Oral diseases are complex and have multifactorial causes [6], strong socio-determinants, with an important component being access to services as a social mediator [1,4] for its morbidity. For all these reasons, the inclusion of oral health professionals in public healthcare networks is vital to solving this overload [5]. These networks are structured to provide basic dental care in primary health care (PHC) [7,8]. The procedures requiring the expertise of dental specialists are referred to the public Dental Specialties Center (DSC) [9], or even hospital

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intervention. Two major problems are the lack of access to specialized oral rehabilitation and inadequate referrals from primary care to DSC [10].

Health information and communication technologies (ICT), such as Teledentistry, can help expand access to dental health public services making it more effective [11,12]. Dental specialists can help general dentists' (GD) practice workflow through teleconsulting guidance [13]. They can give advice on diagnostic hypothesis, recommendations for the management/treatment at the PHC or need for referral to DSC [14–18]. Systematic reviews and previously published studies reported results related to the use, accuracy, and cost-effectiveness of teledentistry [12,19–21]. Studies aimed at reporting the factors that affected the implementation of this technology, especially in the context of dental health public services, were not found. The aim of this study is to analyze the factors that affect the implementation of a Teledentistry system (TS) in a dental health public service.

2. Method

The study follows the Implementation Research methodological framework [22] to implement a new intervention in the practice workflow. A mixed method approach [23] was applied using a triangulation design–sequential model [24] to collect, analyze, and interpret qualitative and quantitative data about the implementation [24] of a TS to access DSC. Qualitative and quantitative data were collected sequentially to achieve a better understanding of implementation research issues [24].

2.1. Study Site

The study was developed in a South Brazilian capital city that had, in 2019, 583,000 inhabitants and a Human Development Index of 0.809. The platform of the Santa Catarina Telehealth Center (SC-TC) was used. Besides offering tele-education, public health professionals can access diagnostics and scientifically based recommendations from experts through teleconsulting [25,26].

2.2. Data Collection and Research Participants

An intentional sample was selected, and nine GD from PHC and eight specialists from DSC were invited to participate in quantitatively exploring the use of Teledentistry. The intervention analysis was performed 7 months of implementation. The 26 GD who used the TS were invited to share their views on their experiences. Secondary quantitative data were collected from SC-TC reports on system utilization from November 2018 to May 2019.

3. Research Stages

The research was divided into four stages. Stages 1 and 2 were guided by the Consolidated Framework for Implementation Research (CFIR) [27] while Stages 3 and 4 were guided and evaluated by adapting the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) Framework for Public Health [28].

CFIR [27] was applied to plan the intervention process adapting the dimensions [28]. Intervention Characteristics, Outer Setting, Inner Setting, Characteristics of Individuals, and Process to the research context. The first implementation step focuses on intervention characterization. Stage 1 sought to understand the scenario of the oral healthcare network regarding the communication problems between the PHC and DSC dental staff, and the professional acceptance regarding the new ICT.

Stage 1 – Understanding the referral and counter-referral problems and analyzing the acceptance of TS by oral health professionals

The aim of Stage 1 was to identify problems related to comprehensive care, focusing on the reference and counter-referral difficulties faced. Two focus groups were conducted, one with the nine GD and the other with eight specialists. CFIR [27] was used to guide the focus group discussion script.

Stage 2 – Pilot project

The results of Stage 1 were presented to local managers. Based on the acceptance of the TS, researchers proposed a pilot project to improve access to DSC by qualifying the patient's referral through teleconsulting.

A working group, composed of researchers, city managers and technicians, faculties, and SC-TC technicians defined the steps of the pilot project and teleconsulting flow, guided by the CFIR [27] to identify implementation factors (Table 1).

Stage 3 – Intervention: Performing teleconsulting

A teleconsultation begins with a professional uncertainty; then with the proper registration to the restricted access SC-TC platform, they generate a request to the dental specialist. From November 2018 to May 2019, the intervention took place before referral to periodontal treatment. The teleconsultant had 72 hours to answer the questions and referral demands. The answers were structured in three paragraphs: direct response to what was requested; explanation based on scientific evidence; and recommendations of references from the literature. The teleconsultant may advise on patient management in PHC, request examinations, further information, or refer the patient to DSC.

Stage 4 – Intervention analysis

After the 7-month intervention period, quantitative and qualitative data were collected to assess the intervention using the RE-AIM framework [28]. This evaluation framework operates as a model to measure the impact of a public health intervention by considering five factors: Reach, Effectiveness, Adoption, Implementation, and Maintenance [28].

Secondary quantitative data on teleconsulting were collected from the SC-TC reports. Qualitative data regarding the experience of GD, periodontists, and teleconsultants were collected between June and August 2019 through individual interviews conducted by two trained interviewers. In addition, CFIR[27] guided questions on the implementation evaluation interview script for GD, periodontists, and teleconsultants.

3.1. Data Analysis

Qualitative data were analyzed using Bardin's content analysis [29] technique. A priori indicators were formulated based on the CFIR [27] and RE-AIM [28] frameworks. Code frequency was measured for analysis of the RE-AIM elements: effectiveness, implementation, and maintenance. Quantitative data were used to quantify Reach (individual participation rate) and Adoption (representativeness of settings) of the TS intervention. Descriptive statistics were generated using Excel® on the frequency and primary uses of TS. Data regarding participant profiles were also considered. After analyzing the qualitative and quantitative data, all data were merged according to RE-AIM [28] to find the factors that affected the TS intervention.

Table 1
Consolidated Framework for Intervention Research: Intervention characteristics.

Dimensions	Examples of what was discussed by the working group
Source	Establish partnership between MHD and SC-TC platform.
Relative advantages	Opportunity to improve communication between GDs and specialists and the access to DSC and to qualify the patient's referral process.
Adaptability	Teaching GDs and teleconsultants to use the new system and workflow.
Test Period	~ 6 Months
Complexity	Evaluate the capacity of all elements involved in the project, professionals' skills and information systems structure.

Source: Adapted from CFIR by the researchers, 2017.
*MHD – Municipal Health Department; SC-TC Santa Catarina Telehealth Center; GDs – general dentist; DSC – Dental Specialties Center.

The research project was approved by the formal local Human Research Ethics Committee (2.229.099).

4. Results

The main results of the focus groups pointed to a fragile communication system between the PHC and DSC, improper referrals, and prolonged wait time for some DSC services. Participants also requested an updated information system that would enable virtual integration of facilities and improve the communication between dental teams.

Most GD have a great expectation regarding a system that allows communication to a specialist prior to the referral, mainly in the areas of Oral and Maxillofacial Pathology, Periodontics, and Temporomandibular disorders. GD stated that prior contact with specialists to facilitate answering questions about treating patients in PHC and avoid unnecessary referrals. In addition, the most severe cases may be prioritized for timely treatment.

Specialists recognize that SC-TC has the potential to contribute to all specialties to diminish the queues and select patients with high-risk as priorities. For example, if patients with previously clear diagnoses in PHC were then guided by the specialists through TS, those with severe diagnoses could be given high priority.

The same PHC participants were invited to use the teledentistry modalities of the SC-TC platform for at least four months (August to December 2017). Following this, a one-step focus group (December 2017) was conducted by the primary researcher to gather their opinions about the experience.

The GD stated that they had no difficulty accessing the system and gave high praise regarding the lectures and teleconsulting. They commented that they used the content in clinical practice and as didactic material for lectures. All GD highly recommended SC-TC to other colleagues. These data are oriented toward the next research stage. Several meetings were held to build the pilot project. In May 2018, the Working Group approved the proposal. Periodontics was chosen to begin a teleconsulting program based on the technical, operational, and convenience criteria. To enable this proposal, a formal partnership between the Municipal Health Department (MHD) and SC-TC was established.

From November 2018 to May 2019, 68 teleconsulting was performed by 26 GD (~22%) prior to the referrals to DSC on periodontics, using the SC-TC platform. Of these, only one GD reported not needing to refer the patient to the periodontist as a result of the teleconsulting guidance. Intervention analysis was performed with RE-AIM, and quantitative and qualitative data were merged (Table 2).

Reach: Nine GD and eight specialists discussed the possibilities of using TS. It was suggested that TS could be useful in all specialties. Onsite and online orientation lectures were held at 120 GD. Instruction manuals were distributed, and an instructor was available for further guidance and clarification. If professionals asked for help, it was provided. This strategy was considered relevant, as 63% of the participants considered the system easy to use.

Effectiveness: GD showed satisfaction with the quality of the teleconsultant's responses and revealed that they changed some of their practices as a result of the referrals. They stated that the guidance they received helped clarify doubts and confirm the patient's diagnosis, helping to qualify them for the referral process.

Teleconsultants requested clinical data that GD did not usually provide, such as periodontal pocket depth, bleeding on probing, clinical attachment level, and other elements that contribute to improving the clinical diagnosis of periodontal disease. Thus, the most urgent cases could be correctly assessed by the teleconsultant, facilitating the risk classification of the regulatory service. Furthermore, the most severe cases were treated as a priority.

Another relevant aspect highlighted was the opportunity to improve knowledge. The teleconsultant provided information that enabled the management of patients in PHC based on reference literature. The GD evaluated this practice as contributing to the avoidance of some referrals and improvement of the patient's clinical condition while waiting for the appointment with the periodontist. The periodontists perceived an improvement in referral quality as GD began to provide more complete information about periodontal problems.

Most participants (55%) mentioned that they noticed a slight increase in the number of steps necessary to refer patients to consultations with a periodontist, slightly delaying the procedure. The 72-hour delay was due to waiting for the response from the teleconsultant, but according to respondents did not compromise the patient's treatment.

Regarding the practicality of using the SC-TC, participants stated that

Table 2
RE-AIM evaluation framework.

Dimension	Measure	Source	Stage
Reach	26 out of 120 eligible GD enrolled in the project (22%).	SC-TC reports	1,3
Effectiveness (Positive outcomes)	Considered easy to use (63%).Very satisfied with teleconsultant's answers (37%).Timely time (18%). Considered that the teleconsultants answers contributed to improve patient's referral (26%). Affirmed that the teleconsultants answers based on scientific evidences gives more safety and confidence to general dental practitioners (26%).	Staff survey	3,4
Effectiveness (Negative outcomes)	Mentioned that steps were added to the patient referral for a specialist consultation, because a teleconsultation was required/compulsory. (55%).Complained about lack of integration of information systems (33%).Complained about internet failures (18%).Had difficulties to run SC-TC (14%).Dissatisfied with the choice of periodontics specialty (14%). Dissatisfied with the teleconsultant's responses (14%).	Staff survey	3,4
Adoption	The system was used in 18 of 40 PHC units (45%). Seven professionals (6%) had previous positive experiences with SC-TC.	SC-TC ReportsStaff survey	1,3
Implementation	A total of 26 dentists requested 68 teleconsultations (mean=2,5).General teleconsulting increased 85% and the web conferences increased 71% after the project's implementation.No extra charge was required.	Meetingreports; Focus groups and interviews;Pilot project	1,2,3,4
Maintenance	The teams suggested the use of teleconsulting in other dental specialties like Oral and Maxillofacial Pathology (41%); Pediatric Dentistry, Periodontics and Endodontics (11%); Temporomandibular disorders, Prosthodontics and Pharmacology (4%).	Staff survey	4

Source: Adapted from RE-AIM

the lack of integration of information systems (33%) and internet failures (18%) partially hampered the beneficial progress of the work and 14% said they had difficulties running the SC-TC. A small proportion of participants (14%) expressed dissatisfaction with some teleconsultants' responses and the choice of the periodontics specialty. They prefer the opportunity to use TS for oral medicine (41%) and other areas.

Adoption: Previous positive experiences with SC-TC may have contributed to the acceptance of the intervention. The system was used in 18 out of 40 PHC units (45%) by 26 (22%) GD who performed an average of 2.5 teleconsultations. The intervention contributed to the present the SC-TC for most (74%) oral health professionals. There was a significant increase in access to a web conference (71%) and general teleconsulting (85%). Between November 2018 and May 2019, 68 teleconsulting procedures were conducted related to the clinical management of periodontal diseases in general.

The teleconsultant's response included the definition of the type of periodontal disease [30] and its characteristics as well as risk factors and information regarding the relationship between systemic conditions and periodontal disease. According to the specific situation, the teleconsultant suggests referral to the specialist and/or patient's management and therapeutic indication in PHC. The teleconsultant performs disease risk classification and guides the GD about important information for the clinical diagnosis of periodontal disease, such as periodontal pocket depth, bleeding on probing, clinical attachment level, severity and extent of chronic periodontal disease, presence of suppuration, and systemic condition of the patient.

Implementation: Teleconsultant training was carried out using the SC-TC virtual platform. During the seven months of the intervention, the teleconsultants took three hours a week to answer questions (teleconsulting) sent through the SC-TC platform. No extra costs were generated as these hours were taken from the regular working hours as clinical periodontists in DSC.

Most GD attended explanatory lectures to learn about SC-TC virtual platform resources and to understand the intervention protocol. Regarding the basic components of the system, they were well implemented, and no difficulties were reported. There was one technician in charge of helping the team access the SC-TC virtual platform.

Maintenance: Most respondents (63%) found the TS practical and easy to use. However, there was a complaint regarding the lack of integration of information systems which caused some changes in the GD' workflow. In addition, they were concerned about the delay caused by the extra time taken to access both information systems and to improve a patient's case description for teleconsulting assessment. Many GD (41%) stated that teleconsulting would be very useful for oral and maxillofacial pathology, as they have difficulty diagnosing soft tissue oral diseases in PHC. Contributing to maintenance, the SC-TC allowed the teleconsultant to contact GD to understand their doubts regarding periodontics and the workflow process in PHC.

5. Discussion

To reduce oral health problems, comprehensive care should be available to the population [2,5,31]. Oral health research should serve to develop and support viable strategies to promote access [2]. In this context, it was sought to analyze the use of TS to improve access to specialized dental services.

TS was used by 22% of GD in 45% of the PHC units, and 68 teleconsultations were performed. The lack of extra investments, especially in human resources, infrastructure, and computational issues, were relevant limiting factors. Many professionals did not know the SC-TC previously, or how to use it, and consequently did not recognize the potential benefits. This finding has already been reported, as many professionals do not understand and value the support of telehealth services [19,21,32]. Once these obstacles are overcome, a greater range of TS interventions is expected [25].

TS is effective for carrying out educational and preventive actions [33–36], which provide positive results and is more cost effective than conventional dental treatment [12,16,20,37]. In this implementation research, only one referral could be avoided because the teleconsultant's guidance offered a correct clinical diagnosis procedure. In this sense, some factors to consider when explaining these results may include an inadequate description of the case, GD skills in concerning the incorporation of ICT in daily practice and focus on dental procedures. Also, the teleconsultant's assessment of the ability of GD to solve the case (which may be underestimated), and the quality of their response, which needs to be clear and informative to provide management and avoid referrals, should be considered. Although it is a sparse number, teleconsulting has the potential to avoid future referrals that would be generated if the professional did not receive proper support and training. In addition, it addresses the advantage of the referral qualification in terms of previous clinical case management and risk classification.

Most GD had no difficulties using TS and were very satisfied with the teleconsultants' answers. They emphasized the opportunity to update knowledge on periodontics and to keep in touch with periodontists before patient referral. Other studies highlighted the educational potential of teledentistry [38,39]. Some considered that the answers contributed to improving patient's treatment and referral and affirmed that scientific evidence gave more safety and confidence to GD's performance. Teledentistry has the potential to improve the quality of distance dental care as GD receive teleconsultant guidance and support [33].

It was clear that the need to improve the previous professional qualifications with the aim to obtain collaborative communication, better acceptance, and full use of telehealth system resources. The literature shows that low levels of motivation and lack of ICT skills are important obstacles to the effective use of TS [15,39]. The results also pointed out the anxiety and difficulty that some professionals experience in dealing with ICT and that they would benefits from having personnel available to provide information technology support for the new systems and a familiarity with the platform prior to use [13].

Investments in ICT are required to integrate the SC-TC platform software with current municipal health information systems to facilitate the use of this technology. The lack of good infrastructure and technological connectivity also affects the successful implementation of TS [15,35]. In addition to periodontics, the professionals stated that it would be very helpful if they could use SC-TC for other specialties such as oral and maxillofacial pathology, pediatric dentistry, endodontics, temporomandibular disorders, prosthodontics, and pharmacology. Several studies have shown that the use of teledentistry in these areas perfectly allows remote treatment [15,18,20,40]. TS allows capacity building, accuracy, and effectiveness because experts can guide GD with real-time communication, or store and forward teleconsultations [13].

It is relevant to reassure that Teledentistry has the potential to contribute in scenarios where it is imperative to avoid closer contact between people. In the current scenario of the COVID-19 pandemic, an infectious disease caused by the new coronavirus (SARS-CoV-2), in addition to the general symptoms of fever, tiredness, and dry cough, there are also secondary oral manifestations. And a significant presence of the virus can be detected in saliva [41] and supportive tissues [42]. Thus, is highlighted the importance of incorporating teledentistry for screening and monitoring of cases, or even dental treatments, as virtual consultations and guidance.

Regarding screening, it means to say that patients can be previously questioned about the presence of flu-like symptoms or malaise related to Severe Acute Respiratory Syndrome (SARS-CV) helping the dental team to decide the opportune moment to carry out the face-to-face consultation. For monitoring after dental treatment, guidelines are included, such as strengthening oral hygiene practices in patients undergoing periodontal treatment; pregnant women; people with mobility restrictions; in specific cases of diet guidelines to high risk of caries patients, or post-surgical events. In this way, health professionals can monitor the evolution of dental treatment and promote greater

effectiveness [13].

The limitations of this study are the brevity of the period since the implementation of the service and the number of teleconsultations performed, which compromises the analysis. Other contexts and dental specialties must be investigated, including patient perception. Taking into account the potential of communication technology to qualify patients with access to dental health public services, it is recommended that new studies on the implementation of Teledentistry, focusing on better strategies of adoption, effectiveness, and maintenance be performed.

6. Conclusions

TS implementation and usage were influenced by the managers' political and administrative awareness to deploy and maintain the TS intervention. Moreover, there is a lack of sufficient resource investment, especially human resources. Lack of system integration and internet failures were relevant limiting factors. Some GD's reported a negative perception mainly due to the changes in workflow and extra time spent accessing the separate databases in order to improve case descriptions. The teleconsultant guidelines contributed to GD's better decision-making regarding treatment, urgency of case management, and prioritization of referrals to the periodontists. Identifying the factors that influence the implementation of TS and finding solutions to overcome them, can prevent future failures and improve usage of the system. By studying new communication channels between PHC and specialized care, which strengthens the health network proposal, other possibilities of joint work that qualify oral health care in public health services can be created.

Authors contributions

CBC and ALSFM – contributed to the study conception, data collection and analysis, interpretation of the results, and drafted the paper. MAM, FSP, and RGC contributed to the data analysis, and revised critically the paper. All authors approved this final version submitted for publication.

8. Conflicts of interest:

Costa CB and Peralta FS are public health employees at the Joinville Municipality Health Department, where the study took place.

9. Summary Table:

What was already known on the topic:

- Teledentistry can expand access to dental health services resulting in a better oral care of underserved population.
- The referral process from general dentist at the primary healthcare to specialized care presents some workflow problems mainly because of the lack of effective communication strategies between care levels.
- Teleconsulting is a recognized strategy that improves professional communication, giving advice on diagnostic hypothesis, and recommendations for the management the dental disease.

What this study added to our knowledge:

- Political, organizational, structural and human factors influence negatively the implementation of teledentistry systems aimed to improve access to specialized dental care.
- Teleconsulting has the potential to avoid future inadequate referrals generated if the general dentist did not receive proper support and training.
- By addressing the negative factors that influence the implementation of teledentistry system, and finding creative solutions to overcome them, it is possible to prevent failures and improve usage of the systems in dental public health.

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