

# A systematic review of the use of telehealth in speech, language and hearing sciences

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## Abstract

**Introduction:** We conducted a systematic literature review to investigate the domain of speech-language and hearing sciences (SLHS) in telehealth.

**Methods:** The databases used for the literature search were Web of Knowledge, Pubmed, Scopus, Embase and Scielo. The inclusion criteria consisted of papers published up to August 2014. Papers without peer-review evaluation, and those without abstracts or available full texts were excluded.

**Results:** A total of 103 papers were selected. The selected studies have focused primarily on hearing (32.1%), followed by speech (19.4%), language (16.5%), voice (8.7%), swallowing (5.8%), multiple areas (13.6%) and others (3.9%). The majority of the studies focused on assessment (36.9%) or intervention (36.9%). The use of telehealth in SLHS has been increasing in many countries, especially in the last 5 years. The country with the largest number of published studies was the United States of America (32.03%), followed by Australia (29.12%). The remaining studies were distributed in lower numbers among other countries.

**Discussion:** The advancement of information and communication technologies provides more favourable conditions for providing distance care in several areas. Most of studies concluded that the telehealth procedure had advantages over the non-telehealth alternative approach (85.5%); however, 13.6% reported that it was unclear whether the telehealth procedure had advantages. Some barriers still need to be overcome, such as technology, training, regulation, acceptance and recognition of the benefits of this practice by the public and professionals. The need for speech-language pathologists and audiologists to adapt to this new health care modality is evident.

## Keywords

Telehealth, telehealth, telerehabilitation, telemedicine, tele-education

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## Introduction

Advances in telehealth have resulted in a substantial increase in the use of technological resources for remote screening, assessment, intervention and health education in speech, language, and hearing disorders (SLHD). There is growing support from professional organizations for the use of this service delivery model because telehealth provides increased access to health care services, facilitates greater continuity of care, and reduces costs while preserving or enhancing patient outcomes.<sup>1</sup>

Both the American Academy of Audiology<sup>2</sup> and the American Speech-Language-Hearing Association<sup>3</sup> have developed position statements supporting the use of telehealth when the services are provided by a qualified provider, primarily developed for patients with limited access to health care, validated for efficacy and cost-effectiveness, and equivalent to those achieved via face-to-face (FTF) measures.<sup>4</sup>

Previous literature reviews reported that although the use of telecommunication technologies has been growing, as has the number of studies about telehealth, it is still necessary to expand its application to SLHD services and further evaluate its use. Many of the studies are not systematic reviews; they include preliminary studies or studies with limited validity and reliability and low levels of evidence.<sup>5,6</sup> Furthermore, systematic reviews regarding the use of telehealth in all speech-language and hearing

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sciences specialities in the same study are not available in the current literature.

As telehealth becomes a standard means of conducting diagnostic and treatment services in SLHD, it is essential to assure that research supports its use. The aim of this paper is to provide a systematic literature review that investigates telehealth applications within the domain of speech-language and hearing sciences.

## Methods

We conducted a systematic review following the guidelines outlined by the Cochrane Handbook.<sup>7</sup>

### Selection criteria

The selected keywords in telehealth were Teleaudiology, Teleaudiometry, Telehealth, E-health, Telemedicine and Teleducation. The keywords related to speech, language and hearing sciences were Speech-language and hearing sciences, Language, Hearing, Voice and Speech. The databases used for the literature search were Web of Knowledge, Pubmed, Scopus, Embase and Scielo. The inclusion criteria consisted of papers in English or Portuguese that were published before August 2014 and were related to any sort of telehealth applications involving speech, language and hearing sciences. Papers in other languages and those without peer-review evaluations, abstracts or complete texts were excluded.

### Abstract review

Two independent reviewers selected relevant papers based on information obtained from the titles and the abstracts according to the inclusion criteria mentioned above. If the two reviewers disagreed, they conducted a discussion to seek consensus. If the disagreement persisted, a third reviewer was consulted. If necessary, the full publication was consulted. Duplicate publications and literature reviews were excluded.

### Review of the complete papers

Four reviewers formed two pairs, and each pair independently examined the data. If the two pairs' opinions differed, a discussion was conducted to reach a consensus. Some studies were excluded during this stage because they failed to fulfil the inclusion criteria upon detailed evaluation. Data related to the following factors were obtained: (1) the study's country of origin, year of publication and journal; (2) the research specialty area (hearing, language, speech, voice, multiple areas – more than one area simultaneously – and other); (3) methodological characteristics (screening, assessment, intervention, education, and other); (4) population characteristics (sample size, gender, and diseases/conditions); (5) telehealth modes (synchronous/asynchronous/hybrid) and means of telecommunication (internet/telephone/satellite/other); (6)

whether a speech-language pathologist (SLP) or audiologist participated in data collection; (7) conclusions regarding the use of telehealth (positive: the telehealth procedure had advantages over the non-telehealth alternative approach; negative: the non-telehealth alternative approach had advantages over the telehealth procedure; inconclusive: it was unclear whether the telehealth procedure had advantages/further work is probably needed); (8) the object of the study (a comparison of telehealth and FTF measures; software or telehealth process development; telediagnosis and/or telemonitoring and/or teleintervention: the use of software or processes; evaluation of/opinions on the use of telehealth; database issues: composition/improvement of databases for telehealth; teleconsulting; teleducation; other); (9) main findings: improved quality of care (i.e. equivalent care across telehealth and FTF; the validity and reliability of assessment and diagnosis; user and clinician satisfaction), improved access to care (i.e. decreased travel, decreased delays in obtaining the required quality care or in gaining access to a specialist), cost-effectiveness (i.e. reduced costs for the patient and the health service), management changes (i.e. changing the mind-sets of the people involved and effectively managing human and organizational process), policy issues (i.e. the implementation of national policies that include telehealth); and (10) barriers to telehealth.

## Results

### Descriptive information

A total of 103 papers were selected according to the previously established criteria (Figure 1).

### Country of origin, year of publication and journal

The countries with the largest number of published studies were the United States of America (32.03%) and Australia (29.12%). The remaining studies were distributed in lower numbers among other countries (Figure 2).

Most of the studies were published between 2008 and 2014 (73.7%), with the highest concentration published in 2010 (19.4%; Figure 3).

Most of the selected papers were published in journals that are not specific to telehealth (59.2%). The papers that were published in specific telehealth journals ( $n = 42$ ) were distributed as follows: 52.4% in the Journal of Telemedicine and Telecare, 42.8% in Telemedicine Journal and eHealth, 2.4% in the Journal of Medical Internet Research and 2.4% in the International Journal of Telemedicine and Applications.

### Research specialization

Most of the studies focused on hearing (32.1%), followed by speech (19.4%), language (16.5%), voice (8.7%), swallowing (5.8%), multiple areas (hearing and/or language and/or speech and/or voice: 13.6%) and others (3.9%).

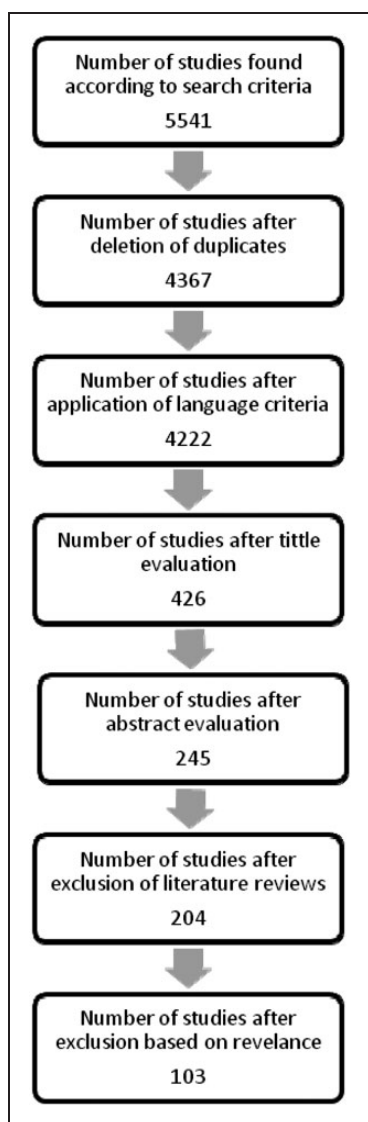


Figure 1. Search and selection process.

These data will be further discussed in each specific session.

**Methodological characteristics**

The majority of the studies focused on assessment (36.9%) or intervention (36.9%). The other studies focused on screening (8.7%), education (1%), various methodologies (including screening, assessment, intervention, monitoring and/or education: 11.6%) and others (4.9%).

**Population characteristics (sample size, gender, diseases/conditions)**

Of the papers that involved human participants, the number of subjects ranged from 1 to 3830 (mean 104.69, SD = 441.1). Four of the studies (3.8%)<sup>8-11</sup> did not involve subjects because they concerned the development of telehealth proposals that were not being applied to people at the time. Most of the studies used both genders (75.7%),

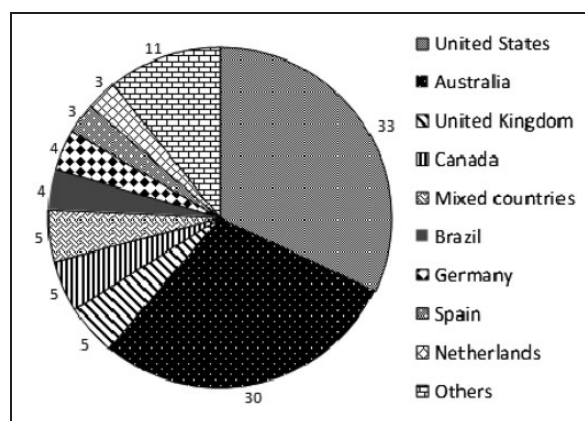


Figure 2. Countries involved in the telehealth studies (n = 103). If two countries were involved, the study was categorized as mixed. If a country had only one or two studies, it was categorized as “Others”.

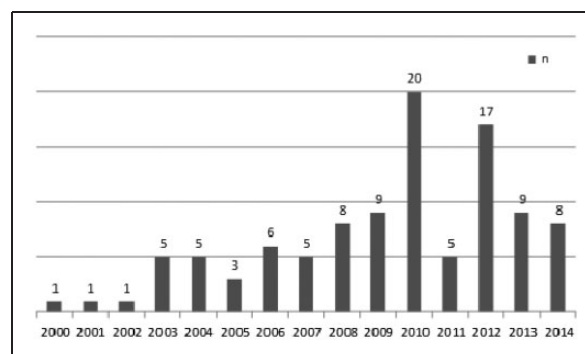


Figure 3. Year of publication.

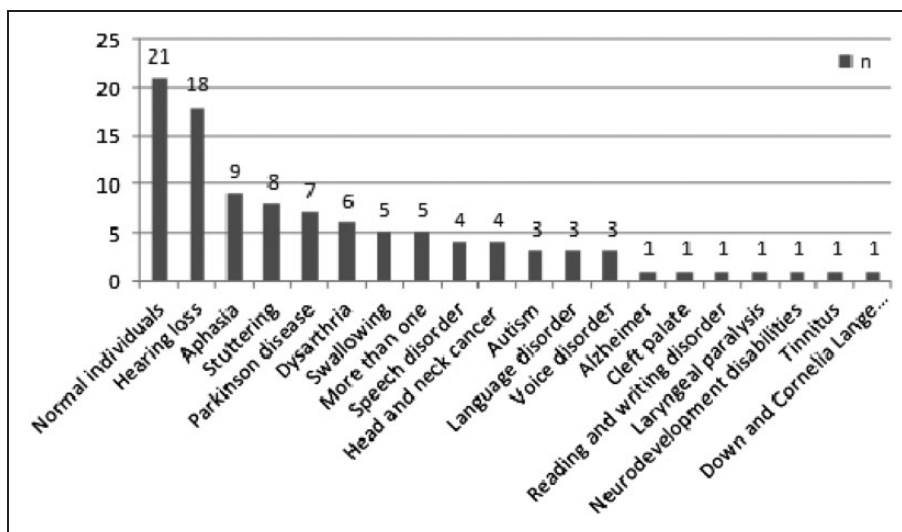
but 3.8% investigated only men. The remaining studies (16.5%) did not mention the gender of the participants.

Regarding age, the subjects were categorized as follows: children (0–12 years old), adolescents (12–17 years old), adults (18–59 years old) and the elderly (60 years and older). Thus, 54.4% of the studies focused on adults and the elderly, 26.2% focused on children and adolescents, and 5.8% focused on all age groups simultaneously; other studies (9.7%) did not mention the ages of the participants.

Regarding diseases/conditions, most of the studies focused on individuals without known disorders (20.3%), followed by those with hearing loss (17.5%), aphasia (8.7%) and stuttering (7.7%; Figure 4). These data will be further discussed in each specific area.

**Modes of telehealth and means of telecommunication**

Most of the studies employed a synchronous mode (real-time interaction;<sup>4</sup> 54.3%), followed by hybrid (a process that mixed synchronous and asynchronous modes; 26.2%) and non-synchronous modes (offline or asynchronous, store-and-forward process;<sup>4</sup> 17.5%); for two of the studies, this classification did not apply.<sup>8,12</sup>



**Figure 4.** Population characteristics (diseases/conditions).

Regarding the means of communication, we found that the vast majority used the internet alone (74.8%) or combined with an additional internet-based device (14.6%), followed by a phone only (7.9%). Other telecommunications media, such as digital lines and satellite transmissions, appeared in only one study each (0.9%); one study did not describe the communication media used (0.9%), and one did not use any medium (questionnaire to assess the availability of using telehealth) (0.9%).<sup>12</sup>

#### *SLP and audiologist participation in data collection*

For most of the studies, SLPs or audiologists participated in the data collection (82.5%); 13.6% did not mention whether SLPs or audiologists were involved, and only 3.9% did not include these professionals.

#### *Conclusions regarding the use of telehealth*

Most of the studies concluded that the telehealth offered advantages over the non-telehealth procedures (85.5%), and 13.6% reported that it was unclear whether the telehealth procedure offered advantages. Only 0.9% of the selected studies concluded that the non-telehealth alternative approach offered advantages over the telehealth approach.

#### *Studies according to topic*

A summary of the study results according to topic is presented below. Complete results (including specific and detailed results by topic) according to SLHD topics are presented in the Appendix.

**Hearing.** In total, 33 papers<sup>11,13-44</sup> on hearing were selected. Most of them (63.6%) were published after 2010. Nineteen studies (57.6%) included subjects without known disorders, and one of the papers also studied

individuals with hearing loss; eight (24.2%) studied individuals with cochlear implants, five (15.2%) studied hearing aid users, and one (3%) investigated individuals with tinnitus. The main goal of the studies was to identify the presence of hearing loss. The main findings of most of the studies (93.9%) indicated a benefit of telehealth with regard to improved access to care. The cost-effectiveness was reported by 21.2% of the papers, while changes in management and policy issues were cited by only one study.

#### *Language*

Seventeen papers<sup>8,45-60</sup> on language were selected. From 2001 to 2014, there was no year with a predominant number of published papers. Among the study participants, aphasia was the most common disorder (41.2%), followed by autism spectrum disorders (17.6%). The main purposes of the studies were to evaluate satisfaction with the use of telehealth (64.7%) and to assess the use of software or remote diagnosis (64.7%); the next most common aim was the comparison between data obtained via FTF and via telehealth (58.8%).

The vast majority of the papers reported ease of access as the greatest gain from the use of telehealth. Virtual health care allows users who have no SLPs in their area or who are bedridden and have limited mobility to benefit from speech-language therapy. The participating patients and/or their parents reported that they perceived remote therapy to be as valuable as that delivered directly by a clinician.

**Speech.** Twenty papers<sup>10,61-79</sup> on speech were selected, and 55% of these were published in the last 5 years. Regarding the pathologies studied, 40% of the papers concerned stuttering, and 30% concerned dysarthria. In most of the studies, the methodological proposal focused on intervention (75%); the main objective was the comparison of



remote and FTF interactions (75%), followed by the evaluation of the satisfaction with telehealth (45%) and teleconsulting (45%). Five of the studies presented all of these purposes together.

All of the studies suggest that telehealth delivery was as efficient as FTF delivery, but was more successful and more cost-effective. The feasibility of telehealth applications in speech assessment and treatment has been documented. Overall, the patients and their families were satisfied with this mode of treatment.

**Voice.** Nine papers<sup>9,80-87</sup> on voice were selected. One (11.1%) was published more than 5 years ago. The population studied included patients with dysphonia related to Parkinson's disease (44.4%), poor vocal quality with several aetiologies (44.4%), and laryngeal paralysis (11.2%).

Most of the studies (66.6%) presented improved access to care and speech therapy professionals and the possibility of performing follow-up telemonitoring as the main findings. The studies also mentioned cost-effectiveness as a positive result; telehealth reduced costs by decreasing the need for patients to travel to access health services, decreasing the space needed to store voice samples, and permitting the internet-based transmission of samples for analysis.

**Swallowing.** Six papers<sup>88-93</sup> on swallowing were selected; all were published in the last 5 years. The studied population included patients with dysphagia; one paper (16.6%) involved subjects who were actors simulating swallowing disorders.

All studies compared the use of telehealth with FTF practice. Most of them mentioned improved quality of care for individuals with swallowing disorders. Furthermore, the studies presented as their main finding improved access to care and professionals. The studies emphasized the need for early diagnosis and intervention in cases of dysphagia, considering the associated morbidity and mortality risks.

Multiple areas (hearing and/or language and/or speech and/or voice).

Fourteen of the selected studies were classified as belonging to more than one category because they presented procedures in multiple SLHD areas.<sup>94-107</sup> Five studies (35.7%) focused on speech and language; three (21.42%) focused on hearing, speech and language; another three (21.42%) focused on swallowing and voice; two (14.28%) focused on speech and voice; and one (7.14%) focused on orofacial myology and swallowing. Most of the studies (57.14%) assessed the user's satisfaction with telehealth and found that the majority of the users felt comfortable with it.

Regarding the comparison of telehealth and FTF practice, the results suggested that online assessment is a potentially viable, feasible and reliable service. The studies mainly mentioned the improvement of access to care.

**Others.** Four studies examined disorders that were classified as "other" (4.2%) given their low frequency in our

systematic review of telehealth applications in SLHD. All of these studies were published in the last 5 years.

**Orofacial Myology.** Two studies focused on orofacial myology: one involved subjects,<sup>108</sup> and the other addressed the quality, scope and readability of websites containing information about speech therapy and orofacial functions.<sup>11</sup> In the first study,<sup>108</sup> the overall results supported the validity and reliability of internet-based screening in the studied population. In the second study,<sup>11</sup> the results showed that on average, websites that deal with orofacial functions presented standard reading clarity.

**Reading and writing disorders.** One study addressed the remote assessment of reading and writing disorders.<sup>109</sup> The overall positive results of the study support the validity and reliability of remote assessment for these disorders.

**SLPs' opinions regarding communication via telehealth.** One study discussed professional opinion regarding the use of strategies to facilitate communication via telehealth.<sup>109</sup> The residents had better and positive access to the technologies for speech-language pathology service delivery than expected for the SLPs.

### **Benefits and barriers**

The results indicated that telehealth presented advantages and barriers. All of those topics are presented separately below.

**Improved access to care.** Improved access to care was the main benefit mentioned in the studied papers (80.6%). The use of telehealth can reduce patients' driving time, make health care more accessible for patients who live in communities with few specialists, and can promote patient-centred care. Increased use of telehealth also allows providers to reach more patients. In both rural and urban areas, telehealth can be used for screening and for providing routine health care services, thus reserving limited FTF appointment times for those who need to be seen in person.

**Cost-effectiveness.** Only 12.6% of the 103 studies mentioned cost-effectiveness. The full social benefits of these initiatives are therefore unknown, making it difficult for decision-makers to compare different programmes and make informed decisions about which are worth implementing from a social perspective. Telehealth reduces the time required for health care, missed work, costly transports and unnecessary home visits. In addition, home monitoring programmes can reduce expensive hospital visits.

**Satisfaction.** The results revealed that telehealth improved the quality of care, resulting in a good level of satisfaction from the users. Parents felt comfortable or as comfortable

as they did with FTF situations when discussing matters with the therapist online, and they were satisfied or as satisfied as FTF with their level and their child's level of interaction/rapport with the therapist. For adults, remote treatment has been described as convenient; they considered that this new approach would make life easier, stressing the ease of access to quality health care. Telehealth was also considered similar to the FTF approach in most cases. The therapists determined that telehealth applications as safe as FTF for the recipient, are comparable with a FTF session and are easy to use.

**Barriers to the implementation of telehealth.** The main barriers cited were the need of more data to improve the software used; the acceptance for a new proposal for health care; internet speed; and other technological limitations. It is important to point out that 25.24% of the studies did not mention barriers to the implementation of telehealth.

## Discussion

The results of this systematic review indicated that the number of studies about telehealth applications in SLHD has increased, especially in the last 5 years.

The countries with the largest number of published studies were the United States of America and Australia. These two countries have widely dispersed populations, and service delivery via telehealth is important. The remaining studies were distributed in lower numbers among different countries.

Concerning age, most of the studies involved adults and the elderly. The small number of studies with children, especially younger children, may be due to the fact that children need a mediator to help them interact with the speech therapist at a distance and to operate the equipment. The long-distance telehealth interaction may be most suitable for children who are older than 6 years of age. Ages and education levels are also important and need to be considered.

Telehealth is essential in situations where the availability of a qualified professional is limited. This statement is relevant to care and treatment related to hearing considering the high prevalence of hearing loss and a shortage of professionals in this area. Thus, there is a need to develop teleaudiology services aimed at increasing access to hearing health care. This need is reflected by the large number of studies that aim to develop, enhance, validate or compare telehealth tools with FTF measures to improve the possibilities for patients with a hearing loss diagnosis. These studies suggested that many questions about the suitability of software programs and the cost-effectiveness of telehealth still need to be solved.

Providing language therapy to persons with language disorders is an intensive and dynamic process. However, because of cuts in health care spending, patients may not receive the necessary amount of language therapy to achieve significant gains in language abilities. In this context, the role of parents or caregivers as agents of

intervention becomes increasingly obvious, and telehealth enables professionals to train them using remote access via the internet.

The present study confirms that valid and reliable assessment of speech disorders can be achieved via telehealth and that it could be a good tool for providing access to care and long-term care. Telehealth may be useful for delivering therapy in areas that do not have adequate speech-language therapy services. It is an effective and well-appreciated service that can contribute to the quality of care in remote areas. The improvement of technology and the evaluation of assessment protocols can make patients more familiar with this mode of treatment.

The main needs that had motivated voice professionals to study the feasibility and applicability of telehealth resources in their practice are mostly related to: improving access to services related to assessing and treating voice disorders; the storage and transport of voice samples to be analysed for diagnosis; and to monitor patients' progress. The main benefits of the related studies were the possibility of quickly conducting distant vocal screening and assessment for a larger number of individuals, improving access to care and reducing the costs.

Despite some changes in the vocal signal wave after long-distance transmission, the remote assessment proposal was considered reliable and viable, even though our results highlighted the importance of conducting further studies.

The main professional needs that motivated the study of the feasibility and applicability of telehealth resources in swallowing disorders were related to improving access to services and promoting higher-quality ratings to guide diagnosis. These needs reflect the shortage of skilled professionals in the field in many regions of the world and the need for a second opinion by experts on diagnosis and treatment.

The overall results of the present systematic review indicated that telehealth activities demonstrated mainly advantages over the alternative non-telehealth approaches. Regarding the advantages, the studies predominantly showed improvements in access to care, followed by cost-effectiveness and satisfaction. In addition, some barriers to the implementation of telehealth were mentioned. Many people have inadequate or no access to a primary care provider, and access to specialty care is limited. People on a low income and those living in rural and medically underserved areas face additional economic and geographic barriers to care. Telehealth can improve access to health services, mainly for those low-income individuals, and can promote patient-centred care because it enables individuals to take more control over their own health and becomes an intrinsic part of the individual care pathway. Telehealth also allows information about such patients' health conditions to be monitored regularly so that issues can be flagged before they become 'care critical'.

Considering that cost-effectiveness analysis is a more inclusive economic evaluation method in that both costs

and programme outcomes are investigated, the vast majority of the economic evaluations of telehealth focus on cost estimates alone. Consequently, the full range of economic benefits of telehealth programmes is rarely considered and quantified. The costs associated with the new technologies raised serious questions about the sustainability of telehealth and who should bear the costs of a telehealth service.

Regarding satisfaction, the studies showed that telehealth provides great potential for supplementing traditional delivery of services and channels of communication in ways that extend therapists' ability to meet their patients' needs. The majority of the patients reported that they felt well supported in spite of not having a therapist physically present. Telehealth was also considered similar to the FTF approach in most cases, and it can facilitate access to quality health care.

Although telehealth was generally presented as an advantageous modality for health care in SLHD, the reviewed studies mentioned some barriers to its implementation. The need for more data to improve the software packages used for telehealth is linked with limitations related to developing more accurate digital measures and audio and video technologies to support remote access. It also involves costs and the need for technical support for therapists and users. Furthermore, it can be difficult to access patients' prior health conditions or medical data, resulting in a lack of important information for remote assessments and diagnosis.

Although the opinion of patients, parents and therapists regarding the use of telehealth has been in general positive and motivating, the acceptance of telehealth as an alternative to personal contact was also identified as a barrier to its implementation in some studies. Telehealth activities also require basic individual computer competence and familiarity with internet applications, as well as some cognitive and audiovisual skills. In addition, sometimes there are some difficulties with the positioning of participants in front of the web-camera; these difficulties make it difficult to gain an adequate view of the patient's face, an important requirement for distinguishing among similar-sounding phonemes in speech and language assessments, for instance, or for examining orofacial structures and functions.

Internet speed and other technological limitations were also mentioned as barriers. Some places are still limited by the lack of available high-speed internet, and problems such as difficulties in transmitting audio and video information and the risk of not successfully completing the session are faced. The challenge is to ensure that the functionality of the system is fully achieved at these low bandwidths. Other technological limitations involved the need to increase the frame rate when acquiring patients' images; this adjustment is important for guaranteeing the quality of images needed mainly for remote assessment and diagnosis in SLHD.

In conclusion, most of the studies reviewed positively evaluated the use of telehealth compared with the FTF

modality and examined cost minimization when considering the aspects related to access and quality of care. However, the studies also provide evidence of the need for additional investigations that would enable the generalization of results.

The need for SLPs and audiologists to adapt to this new modality of health care is evident. Professionals should become familiar with the available technologies for conducting clinical and diagnostic procedures and for educational and professional training activities.

Furthermore, future studies, particularly randomized controlled trials, should be conducted to provide more evidence for establishing best practices in SLHD telehealth, considering procedures related to remote screening, assessment and intervention. The development of standards and guidelines is essential for promoting the effective implementation of telehealth in SLHD. Moreover, cost-effectiveness analyses are needed to justify telehealth applications and reimbursement.

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The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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