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REVIEW ARTICLE

HOME-BASED PEDIATRIC TELEPRACTICE IN SPEECH-LANGUAGE PATHOLOGY: EVALUATION OF A PILOT STUDY

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ABSTRACT

Introduction: There has been considerable interest in whether a home-based telepractice in speech-language pathology (TSLP) can increase access to the services of speech-language pathologist (SLP). Most of the studies reported in the literature suggest that TSL Prepresents a promising avenue. However, the evidence on the clinical efficacy of this treatment modality in home-based applications isvery limited. The aim of the current study was to assess the technical and clinical feasibility of home-based TSLP in an application with children with voice disorders. It also sought to assess the impact of TSLP on the patients' and SLP satisfaction, economic cost, and voice performance. **Method:** We conducted a double-design study. The target population was patients under the age of 18 with a voice disorder and Internet access at home. A convenience sample was used, with six patients recruited prospectively. A structured questionnaire was administered to measure the feasibility of the TSLP service and its impact on the SLP, parents and children satisfaction, and ontwo economic cost dimensions.As for the health outcomes (voice performance), we used two validated scales: the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) and the pediatric Voice Handicap Index (pVHI). **Results:** Across all six patients, a total of 46 TSLP sessions were delivered by a registered SLP. Our results show that TSLP is clinically feasible. In terms of technical feasibility, some problems were encountered such as connection problems, freezing of images and sound, and signal transmission delays. Notwithstanding, both the patients and SLP were satisfied with the service in all sessions. From a patient economics point of view, the mean estimated amount of money saved was US$167.80/patient (SD ± 116.88), and the amount parents would bewilling to pay for sucha service was US$140(SD ± 52.83). As for health outcomes, a Wilcoxon Signed-Ranks Test showed thatpost-TSLP overall severity, measured with the CAPE-V scale, was significantly lower than pre-TSLP scores (P=.027). Similarly, the total score on the pVHIwas significantly lower after the TSLP sessions (P= .043). Both positive outcomes indicate that the TSLP service can contribute to voice improvement. **Conclusion:** These results support the feasibility, utility and benefit of TSLP services for children with voice disorders. Good logistical preparation is required before launching the service. Effectiveness should be further documented through comparative clinical trials and utility through qualitative study of parents' and clinicians' experiences.

INTRODUCTION

Overthe last few years the use of information and communication technologies has become increasingly widespread in the assessment, diagnosis and treatment of communication disorders. There has been considerable interest in pediatric telepractice to overcome distance barriers and to increase access to specialized services such as those offered by speech-language pathologist (SLP), whose availability is very limited, particularly in remote regions (O'Brian, 2014; Sicotte, 2003).

In addition, children and adolescents enjoy using computers and the Internet, and this can considerably enhance patient motivation (Carey, 2012). In an era of rapid technological change, new digitalplatforms providing interactive and synchronous (real-time audiovisual communication) telecommunication between the SLP and the patient can be effective in the evaluation of speech and/or language disorders and related interventions (Isaki, 2015), especially for patients who live in remote and rural regions. Such new telehealth solutions with interactive audiovisual communication features, which are more responsive and flexible than traditional

videoconferencing, may provide accessible alternatives and provide affordabletelepractice in speech-language pathology (TSLP) services. A home-based TSL Ponone of these advanced platforms dedicated to serving children with speech-language disorders could improve access to a SLP and ensure appropriate care for children at a distance. Furthermore, the difficulties, inconveniences and costs associated with repetitive travel represent major barriers that could be overcome by such a TSLP service. As for the service's technical aspects, numerous studies have demonstrated successful implementation of telehealth in speech-language pathology. Preferred TSLP technologies are traditional videoconferencing (Sicotte, 2003; Jessiman, 2003) or software (e.g. Skype, Face Time, Polycom PVX (O'Brian, 2014; Carey, 2012; Isaki, 2015; Carey, 2014; Grogan-Johnson, 2013; Gabel, 2013; Grogan-Johnson, 2011; Grogan-Johnson, 2010) that can establish an audiovisual connection between personal computers. As telehealth emerged in the first decade of this century, some studies reported technical difficulties and poor sound and image quality, making it impossible to carry out an accurate evaluation of remote patients without face-to-face consultations (Jessiman, 2003; Eriks-Brophy, 2005).

Otherstudies found the technical quality good enough to evaluate and treat children with stuttering or speech sound disorders (Sicotte, 2003; Isaki, 2015). Note that some technologies offered limited potential for interaction with the patients, which may have affected their motivation (Isaki, 2015). By contrast, those that allow inclusion of a playful element in the therapeutic protocol can enhance the children's motivation and improve attendance at the therapy sessions. Clinically, the majority of published studies related to TSLP services were conducted in schools or healthcare centers and were mainly non-experimental assessments. Only one randomized controlled trial (RCT) (Grogan-Johnson, 2013), involving 14 children with speech sound disorders, was carried out in rural schools in the United States and showed an improvement in both groups of children. This RCT suggested that the use of telepractice interventions for children with speech or language disorders is comparable to face-to-face treatment.

Other studies (Gabel, 2013; Grogan-Johnson, 2010; Fairweather, 2016) on TSLP reported similar results. The pilot study conducted by Grogan-Johnson et al. (Grogan-Johnson, 2010). revealed that families were satisfied with TSLP and the progress made by the children with speech-language disorders was similar regardless of the two treatment modalities: at distance or in person. These results are concordant with those reported by a recent study conducted in Australia (Fairweather, 2016), showing that a TSLP program improved the speech and language skills of children in both early childhood settings and primary school. In 2017, a systematic review supported that both telehealth and in-person primary school-age children can make significant and similar improvements. According to this review, telehealth delivery model has the potential to improve access to SLP services for children living in remote areas, reducing travel time and alleviating the detrimental effects of communication difficulties on education, social participation and employment (Wales, 2017). Studies carried out in healthcare centers (Sicotte, 2003; Isaki, 2015) also reportedclinical positive outcomes of TSLP. Sicotte et al. (2003) conducted a study on four children and two adolescents with stuttering who were assessed and treated remotely at a local primary care center near their places of residence. This study reported very high levels of satisfaction among the families and SLP, on both the technical and clinical scales. Improved speech fluidity was observed among all the patients, who maintained (at least partially) their achievements after the intervention. Similarly, a series of treatments given to five children through Face Time for iPad showed that the children reached the majority of their speech or language therapy goals, with the exception of a child with cognitive difficulties[4]. Nevertheless, some authors emphasized an inherent constraint of TSLP,to the extent that an initial face-to-face assessment remains necessary (Jessiman, 2003; Eriks-Brophy, 2008). Currently, home-based TSLP programs have seldom been evaluated, even if some studies[1, 3, 6]have indicated that interventions in the patient's environment are potentially more effective than those performed in clinical settings. In Australia (O'Brian, 2014), three children with stuttering were assessed and treated at home using the Lidcom be program delivered via webcam. The parents' acceptance of home TSLP was good, despite some occasional problems with the technology. Also, the results of the intervention were similar to those obtained in another study with children treated face-to-face (Rousseau, 2007). Several benefits related to home treatment were reported, including a greater level of comfort among the children in their environment and the time saved. However, the authors pointed out that more sessions or supplementary follow-up, and more sessions may be required (O'Brian, 2014).

Two other studies have described the use of the Camper down program via webcam (Carey, 2012) anda videoconference platform with adolescents with stuttering (Carey et al., 2014). The Phase I study showed that intervention using this modality resulted in an average of 93% reduction of stuttering among the three participating adolescents (Carey, 2012). These results were only reproduced in the Phase II study involving 16 adolescents, where only 50% of the patients showed a positive response to intervention (Carey, 2014). In summary, most studies suggest that TSLP is a promising avenue since it addresses a need among families that, without it, mightbe deprived of care. However, the evidence on the clinical effectiveness of this treatment modality it still limited. The number of studies investigating home-based TSLP is also restricted and, to our knowledge, none has involved children with voice disorders. Therefore, this study aims to enrich knowledge in the field of home-based TSLP for treating children with voice disorders using a secure new technology that promotes greater interaction. Our study addressed several objectives. First, we assessed the technical and clinical feasibility of a TSLP platform providing tele-treatments to children suffering from voice disorders. Second, we evaluated the levels of satisfaction of the SLP, children and parents with the TSLP treatments. Third, we assessed two economic cost dimensions associated with home care, from the parent's point of view. Finally, we evaluated the impact of the TSLP service on health outcomes in terms of voice performance.

METHODS

Study design: We conducted a double-design study. Adopting a prospective design, a structured questionnaire was administered at the end of each tele-treatment session to achieve the first three objectives.

The same questionnaire was also used at the end of the entire experiment to obtain a summary evaluation of the full treatment. Questions were added to this questionnaire to assess the economic cost dimensions. The last objective was assessed through a pre/post design by comparing the voice outcomes before and after the intervention.

Study setting: The home-based TSLP was offered by the speech-language pathology department of the Centre Hospitalier Universitaire Sainte-Justine (CHUSJ), a pediatric university hospital center located in Montreal.

The platform under study: The TSLP service involves the use of an interactive audio-video communication platform called REACTS™ (Remote Education, Augmented Communication, Training and Supervision), which is designed for virtual communication. It is an integrated, secure solution, with tools that allow clinicians to participate in synchronous, face to face communication, high-quality video calls, in point-to-point or conference mode and multi-stream videoconferencing with patients, parents and other users. It also permits file sharing (documents, videos, images, 3D objects), live file transfer, secure and encrypted exchanges with patients using the camera of a desktop computer, tablet or smart phone. These exchanges can engage in simultaneous live chats with multiple users (Reacts, 2015). In addition, it allows users to share virtual pointers in order to direct attention to any element of a live broadcast and to simultaneously stream multiple video flows, including medical devices with video output (Beaulieu, 2017). It was specifically developed for the healthcare environment with the strictest security standards, where all connections are tunneled and encrypted using an SSL3 or higher system. The designers use peer-to-peer (P2P) session control (signaling) for multimedia interactions using XMPP and the Jingle library (https://www.iitreacts.com/Features; https://www.iitreacts.com/News/InTheNews/20150212_canadianHealthCareTechnology). For legal and data protection purposes, no clinical data can be saved on the telehealth platform during a remote consulting session, so no clinical data were stored outside the CHUSJ.

Participants and recruitment: The target population was patients under the age of 18 with a voice disorder. Because the voice clinic at CHUSJ has a supraregional mandate, offering SLP services to children across the province and not limited to the Montreal area, it was of interest to select patients treated in this clinic for the current study. In addition, a few parents of children with voice disorder, traveling long distances, had previously expressed their wish for an alternative treatment modality instead of face-to-face services. A convenience sample of six patients was recruited and considered sufficient to conduct a pilot study and perform the assessment.

To be eligible for this study, each selected family had to have the following technologies:

- A personal computer (PC type) with a 2.8 GHz processor or higher;
- A Windows 7 or later operating system (Apple Mac not supported) and 2 GB of RAM (RAM).
- Disk spaceof 75 MB or more;
- A camera and microphone (USB or integrated);
- An Internet connection with a bandwidth of at least 1 Mbit/s.

In addition to these preconditions, participants had tomeet the following inclusion criteria:

- Be over 6 years old;
- Have laryngeal nodules and be referred by an ear, nose and throat specialist to the voice clinic for assessment and follow-up in speech therapy;
- Able to interact via a visual modality;
- Demonstrated involvement by the parents to ensure good remote monitoring.

The exclusion criteria for the children were the following:

- Associated disorders, such as language disorder, speech sound disorder, intellectual disability, hearing loss or ADHD, that may interfere with distance interactions;
- Have received speech-language treatments in the six months prior to the study.

Study Intervention: All patients were seen by a certified SLP with four years of experience with this population. The intervention for each patient was launched at the CHUSJ with a 60 minutes face-to-face consultation for an initial voice assessment according to the usual protocol. At the same time, to ensure proper handling and use of the platform, a training session was also held with the recruited families to familiarize them with the platform's settings and features. Following this initial consultation, the virtual individual treatments were remotely delivered for all the TSLP sessions.

Every TSLP session took place in a four-step process that included:

- Discussion with the parent and child (explanations and / or feedback from the previous meeting);
- A warm-up;
- Work on the goal according to the child's progress;
- Explanation of the self-training exercises in preparation for the next session.

At the beginning of the tele-treatment, the sessions were given once per week. Later, the treatment sessions were provided once every two weeks according to the child's progress, i.e. once he/she had attained 80% of the intervention's objectives. Finally, when the patient began to generalize the objectives in a spontaneous context, the TSLP sessions were given on a monthly basis. In this manner, a maximum of 12 sessions were offered over a period that varied from 3 to 6 months. Once the required TSLP sessions were completed, a second face-to-face consultation was held at the CHUSJto re-evaluate the children's voice performance.

Measuring instruments and health outcomes: A structured questionnaire was developed to measure the feasibility of the TSLP service, the level of satisfaction of the SLP, children and parents and the two economic cost dimensions. For health outcomes (voice performance), we used two validated scales: the Consensus Auditory-Perceptual Evaluation of Voice

(CAPE-V)[19] to assess perceived voice quality deviations and the pediatric Voice Handicap Index (pVHI)[20]to evaluate pediatric dysphonia. Two items of the CAPE-V scale (pitch and loudness) were removed from the measure since the included children did not reveal problems with these voice parameters. The internal consistency of each scale was validated using Cronbach's alpha.

Feasibility, satisfaction, economic impact and health outcomes
The technical feasibility of the TSLP service was assessed by measuring three main features of the platform (Appendix 1): its **intrinsic technical qualities** with seven dimensions: ease of use (three items), image quality (two items), workflow integration (two items), response time (two items), reliability (three items), accessibility (one item), and perceived usefulness (three items);**data quality** with two dimensions: completeness (one item), and reliability and validity (one item); and, **quality of technical support** (three items).Clinical feasibility was assessed by measuring two dimensions: the degree of patient adherence to the SLP instructions (one item) and the therapeutic relationship between the patient and the SLP (four items).

As for satisfaction, we assessed the overall level of satisfaction (eight items) among the SLP, the children and their parents. For the economic component, four questions were used to assess two cost dimensions: the magnitude of economic savings from the point of view of the patients and their willingness to pay for access to such tele-treatments. The health outcomes were first measured using the pVHI, which is a 23-item parental proxy scale that is regularly used to assess the effects of dysphonia in the pediatric population. We also used the CAPE-V, which assesses six quality features: overall severity, roughness, breathiness, strain, pitch, and loudness. Both scales were used pre-post treatment to evaluate the change in the child's voice disorders as measured before and after the intervention. The present study was approved by the research ethics committee of the Centre Hospitalier Universitaire Sainte Justine (#4188) and written consent was obtained from all parents.

RESULTS

Sociodemographic characteristics: A total of six patients (mean age, 9 years; range, 6-11 years) were enrolled in the study. More than 80% (83.3%) of them consulted the SLP for a hoarse voice and/or frequent voice loss and 16.7% because of nodules. Forty-six TSLP sessions were delivered to these patients by the same SLP. Out of a total of 46 sessions, only five were not completed due to technical problems, resulting in a mean of 6.83 sessions per patient. As shown in Table 1, the total mean duration of a TSLP session was 43.52 minutes, with a pre-session that averaged 16.62 minutes and was used for preparation purposes. All the participants lived within a 5 Km to 25 Km radius of the CHUSJ (mean, 14.6 km). The mean home download bandwidth available for the TSLP treatment was 33.46 megabits/second.

Feasibility assessment: Throughout the TSLP sessions, the SLP evaluated both aspects of feasibility: clinical and technical. Concerning the clinical aspect, the SLP was highly satisfied (84%) with the degree of patient adherence to her instructions (Figure1). However, her satisfaction with the technical aspects was significantly lower. High percentages of dissatisfaction were observed regarding sound quality (40% dissatisfied) and image quality (48% highly dissatisfied). Similarly weak ratings were observed for response time: delays in the sound signal (40% dissatisfied) and delays in the image signal (45% dissatisfied). We also assessed the quality of the therapeutic relationship. The average levels of satisfaction were 4.61 (SD ± 0.44) for the patients and 4.5 (SD ± 0.83) for the SLP (Figure2).Three children (2, 3, 4) reported the highest level of satisfaction (a score of 5/5), a score similar to that for the SLP. The three other children (1, 5, 6) also had high satisfaction scores (4 or higher). Two of them had higher scores than the SLP. Overall, the results show that the therapeutic relationship was highly appreciated by both the patients and the SLP.

Parents' satisfaction and patients' motivation: The children's motivation mean was high both during (4.8; ±0.31) and after (4.6; ±0.54) the TSLP sessions. The mean satisfaction of the parents at the completion of TSLP sessions was quite high (4.5; ±0.57) and almost the same among all six parents. Five showed a high level of satisfaction with the quality of TSLP, with scores close to 4.8/5(Figure 3).

Analysis of the two economic cost dimensions analysis: Two cost dimensions of TSLP from the point of view of the patients were documented: an estimate of the amount of money saved and an estimate of the amount of money that the parents would be willing to pay to have access to such healthcare services. The mean amount of money saved was US$167.80/patient (SD ± 116.88) (Figure4), taking into account the fact that the patients lived within a 25-kilometer radius of the CHUSJ. The savings were mainly attributable to transportation and parking costs (recurrent costs for each in-person speech therapy session). Only one parent (patient 5)economized more than the others due to the saving of hisnon-paid leaves from work. The mean amount that the parents would be willing to pay for such services was US$140/parent for the entire treatment (SD ± 52.83) with four of the six parents declared the amount ofUS$174.10(Figure 4). These amounts only covered the telecommunications component of the services, i.e. the annual fees for the platform license and the family's purchase of necessary equipment. In Quebec, the cost of healthcare services is covered by a universal health insurance program. Thus, in the present case, the costs of the services provided by the SLP were covered by the state (financed by tax revenue), such that no direct care costs were incurred by the parents.

Health outcomes: voice performance

CAPE-V scale: As Table 2 shows, the pre-post TSLP median scores(overall severity, roughness, breathiness, and strain) dropped from 25.00, 26.50, 34.50, and 36.50 to8.50, 10.50, 5.00, and 4.50, respectively, in the post-TSLP sessions. In order to verify whether the differences between the pre and post-TSLP were statistically significant, we used the Wilcoxon Signed-Rank Test. The results indicate that the post-TSLP CAPE-V scores were statistically significantly lower than the pre-TSLP scores. More specifically, the four subscales of CAPE-V—overall severity (P=.027), roughness (P=.043), breathiness (P= .028) and strain (P=.027)—decreased after the TSLP treatments, and these decreases were statistically significant. These results suggest that intervention using TSLP is effective to improve children's voice disorders.

Table 1. Sociodemographic, clinical, and technical characteristics of the children treated(N=6)

	Age	Gender	Distance home-hospital (km)	Reason for consultation	Computer skills of parents	No. of sessions / patient	Preparation time/session in minutes (mean)	Download bandwidth in mbps (Mean)	Session duration in minutes (Mean)
Patient 1	10	M	15	Nodules	Intermediate	11	13.18	24.65	29.54
Patient 2	11	M	5	Hoarse voice	Intermediate	6	15.83	36.07	42.50
Patient 3	6	M	5	Hoarse voice Frequent voice loss	Intermediate	7	16.42	23.94	44.28
Patient 4	11	M	25	Hoarse voice Frequent voice loss	Intermediate	6	20.83	43.22	51.50
Patient 5	8	F	15	Frequent voice loss	Intermediate	6	17.50	51.54	43.33
Patient 6	8	M	20	Hoarse voice	Intermediate	10	16	21.37	50
Total Mean	9	Male: 5 Female:1	14.6	Hoarse voice and/or Frequent voice loss (83.3%) Nodules (16.6%)	Intermediate (100%)	6.83	16.62	33.46	43.52

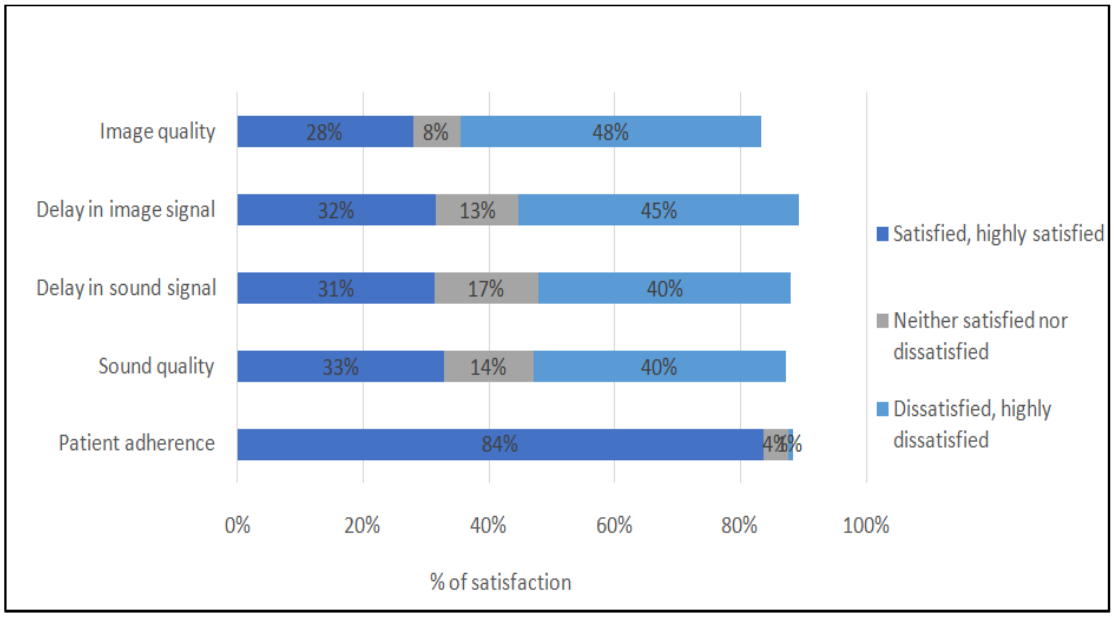
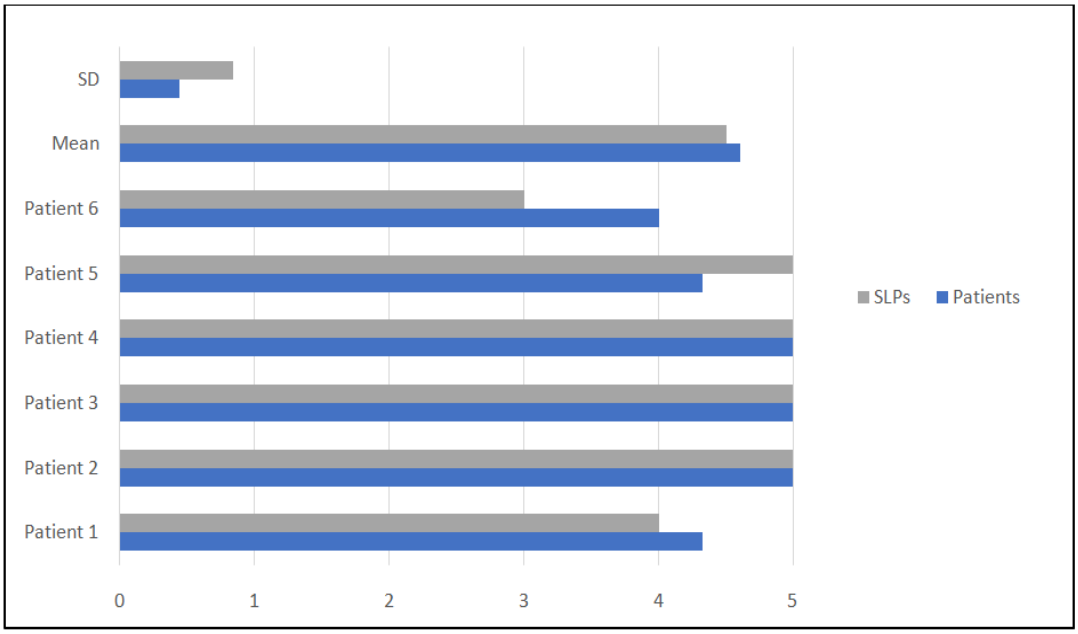
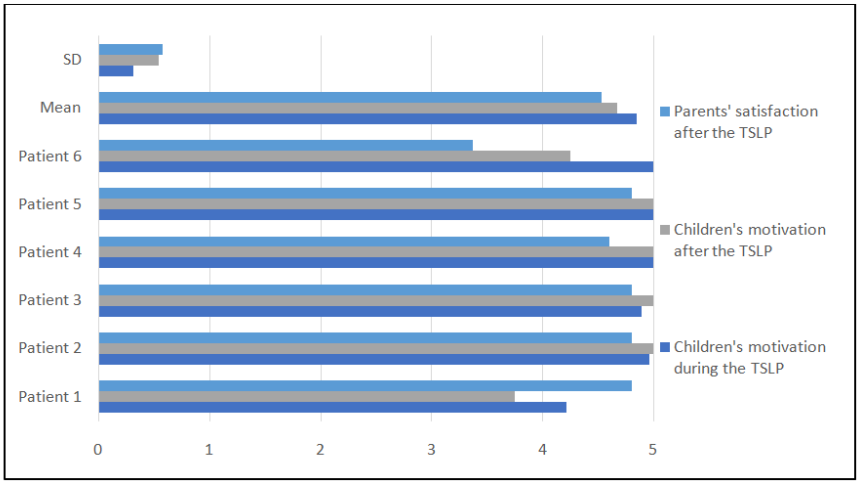


Figure 1.Feasibility of the TSLP service according to the SLP (N=6).



[a]Where a rating of 1 indicates "Highly dissatisfied" and 5 indicates "Highly satisfied".

Figure 2. Satisfaction with the therapeutic relationship in the TSLP sessions (N=6).



[a]Where a rating of 1 indicates "Highly demotivated/dissatisfied" and 5 indicates "Highly motivated/satisfied".

Figure 3. Patient's motivation and parents' satisfaction (N=6)

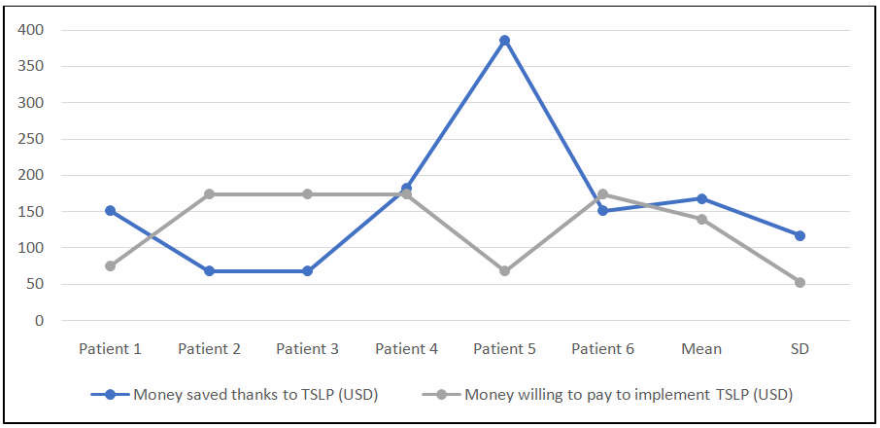


Figure 4. Cost estimates from the patient's perspective (N=6)

Table 2. Results of the Wilcoxon Signed Rank Test on the CAPE-V subscales (N=6)

Subscale	Mean (SD)	Median (¬/100)	P-value (2-tailed)
Overall severity	28.67 (±12.92) *	25.00 *	.027 ***
	8.00 (±3.95)**	8.50**	
Roughness	24.17 (±9.36) *	26.50 *	.043 ***
	9.83 (±5.38)**	10.50**	
Breathiness	34.83 (±14.89) *	34.50 *	.028 ***
	5.00 (±3.28)**	5.00**	
Strain	38.33 (±12.94)*	36.50 *	.027 ***
	4.67 (±3.20)**	4.50**	
Pitch	0.00 (±.00) *	0.00 *	1.000
	0.00 (±.00)**	0.00**	
Loudness	0.00 (±.00) *	0.00 *	1.000
	0.00 (±.00)**	0.00**	

* Pre-TSLP ** Post-TSLP *** (*P<.05)*

Table 3.Results of the Wilcoxon Signed Rank Test on the pVHI scores

Subscale	Mean (SD)	Median	P-value (2-tailed)
Functional scale (I-F)	5.33 (±3.20) *	6.50 (¬/28) *	.068
	1.67 (±1.50) **	1.00 (¬/28) **	
Physical scale (II-P)	17.00 (±3.16) *	16.50 (¬/36) *	.046***
	8.33 (±5.20) **	9.00 (¬/36) **	
Emotional scale (III-E)	4.50 (±4.46) *	4.00 (¬/28) *	.136
	1.00 (±1.26) **	0.50 (¬/28) **	
Total score	26.83 (±8.70) *	28.50 (¬/92) *	.043***
	11.00 (±6.72) **	9.50 (¬/92) **	
Overall severity	2.00 (±.63) *	2.25 (¬/4) *	.024***
	0.50 (±0.54) **	1.00 (¬/4) **	

* Pre-TSLP; ** Post-TSLP; *** (*P<.05)*

pVHI scale: The Pvhi scale also showed a similar improvement (Table 3). The total median score showed a positive improvement, decreasing from a pre-TSLP score of 28.50 to a post-TSLP score of 9.50. Regarding overall severity, the median rating fell by 1.25 points from the pre (2.25) to post-TSLP (1.00). In order to statistically verify the differences between pre and post-TSLP, we ran a Wilcoxon Signed-Rank Test of the three subscales presented below (Table 3). Only one of the three pVHI subscales showed a statistically significant decrease (physical subscale) in the post-TSLP treatment (P= .046). Even though the two other scores decreased post-TSLP, the differences were not statistically significant ([functional scale, P= .068], [emotional scale, P= .136]). Despite this lack of statistical differences in two of the subscales, the total score on the pVHI scale showed a statistically significant difference at post-TSLP treatment (P= .043), where a beneficial improvement was foundin the voice performance. In addition, the score for overall severity was low post-TSLP compared to the pre-TSLP period, and the result was statistically significant (P= .024). As for the previous scale, these results also showed the efficacy of TSLP in improving voice disorders in children in the functional, physical, and emotional dimensions.

DISCUSSION

TSLP has sparked significant interest in recent years. However, its impact through home-based tele-treatments remains ill-defined. The current study of a sample of children with voice disorders evaluated an innovative Internet-platform that provides home-based TSLP treatments. This pilot study demonstrates that the use of synchronous telehealth in speech-language pathology is feasible, sustainable and clinically efficacious in improving the voice performance of children. Furthermore, the intervention was positively assessed in terms of the satisfaction expressed by both the SLP and the parents. Overall, these results are consistent with previous pilot studies (Sicotte, 2003; Isaki, 2015; Grogan-Johnson, 2013; Gabel, 2013; Grogan-Johnson, 2010), which demonstrated high satisfaction among patients and SLPs and efficiency in TSLP treatments. Our results also show that the SL Pevaluation of the TSLP treatments differed with respect to their clinical and technical performances. Satisfaction with their clinical performance was high, reflecting positive appraisal by the SLP of the ability to deliver speech-language therapy at a distance. A high level of satisfaction was also found with the functionalities of the TSLP platform that allowed the use of illustration materials and visual aids. These functionalities enhanced patient adherence to instructions and strengthened the therapeutic relationship between the SLP and thechild. The SL Pevaluation of the platform's technical performance was less favorable. Our results are partly discordant with those obtained by Sicotte et al.[2], who reported that the perceptions of the SLP and the children were more favorable for the technical performance. In the current study, dissatisfaction was especially present for the first treatments sessions. One explanation is that solutions were proposed along the project to overcome the technical problems. The technical problems were in part attributable to the quality of the Internet connection needed between the CHUSJ delivering the TSLP treatments and the children's homes. Due to high security standards, the TSLP platform was not recognized by the internal network of the CHUSJ and wash enceblocked by its firewall. At the beginning of the project, the SLP was obliged to use a public network (which was usually overloaded and provided a slow Internet connection). This was the main reason for the delay in image and sound signals transmission. With the help of the information technology technicians and direction, a better solution was developed to overcome the firewall block. Furthermore, the results were very positive in terms of the patients' motivation and the parents' satisfaction, with no difference found between the period during the TSLP sessions and the period after they were complete. These results are congruent with Isaki et al.[4], which found no statistically significant change in personal opinions about telepractice before and after therapy, reflecting a similar consistency.

In addition, the economic cost estimates showed a positive appraisal by the parents. First, lower personal expenses to access care represented direct savings to the parents. Second, the parents' willingness to pay for the infrastructure needed to secure TSLP—here the telecommunications and software expenses—showed the clientele's positive opinion of such a tele-service. The high level of satisfaction with the TSLP treatments and the rather low cost of the TSLP infrastructure may explain their willingness to pay for access to such tele-treatments at home. These findings are consistent with the current literature[2], which has demonstrated in a similar context, that parents consider the personal expenses reasonable. Last but not least, it is important to mention that the TSLP treatments achieved significant benefits in terms of voice performance and thus health outcomes. The treated children showed statistically significant improvements in the roughness, breathiness, strain and overall severity of their voices. Similarly, this study has found a statistically significant decrease in voice handicap, mainly in terms of the physical aspect and the overall severity.

There are, however, several limitations to this study. First, we acknowledge that it is a pilot study, with a small sample size which limits its ability to support the effectiveness of the TSLP. Second, the selection process of the patients and the absence of control group may have cause a selection bias. Third, for the purpose of this exploratory study, only one patient profile (voice disorders) in one setting (CHUSJ) was included. It would be useful to conduct other studies including patients with other speech and/or language disorders and in other settings. In sum, this study confirms that TSLP treatment is not only feasible, it also appears to be sustainable. It offers a promising alternative to face-to-face treatment without compromising health outcomes to the extent that the positive results of this study are consistent with other studies demonstrating improved speech and language outcomes[1-3, 6, 7]. It would be interesting to conduct a cluster RCT with a sufficient number of patients to confirm these preliminary results.

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Appendix 1. Outcomes, dimensions and items used in the questionnaire

Outcomes	Dimensions	Items
Technical Feasibility a.Intrinsic technical qualities	a.Ease of use	1.Are you satisfied with the ease of use of the REACTS platform? 2.Are you satisfied with the time it took to learn how to usethe REACTSplatform? 3.Are you satisfied with your level of fluency in using the REACTSplatform?
	b.Screen quality	1.Are you satisfied with the quality of the image? 2.Are you satisfied with the sound quality?
	c.Workflow integration	1.In your opinion, is it easy to integrate and use your usual therapeutic tools with the REACTSplatform? If not, why? 2.What changes/modifications did you have to make to your speech therapy interventions related to use REACTS?
	d.Response time	1.Are you satisfied with the delay in signal transmission delay for the image? 2.Are you satisfied with the signal transmission delay for sound?
	e.Reliability	1.Are you satisfied with the stepsrequired to prepare sessions on the REACTSplatform? 2.What types of difficulties were encountered by the patient/parent when using REACTS(practical, technical, clinical, etc.)? 3.What was most difficult to grasp about using the REACTSplatform?
	f.Accessibility	1.What problems did you encounter when using REACTSfor your speech therapy interventions?
	g.Perceived usefulness	1.In your opinion, is the REACTSplatform an effective medium for speech therapy interventions?Why? 2.How would you describe the improvements in your patient's voice? 3.What benefits did you see in using REACTSfor your speech therapy interventions?
b.Data quality	a.Completeness	1.In your opinion, was the quality of service received the same as if it had been offered in the regular intervention room (i.e. face-to-face treatment)?
	b.Reliability & validity	1.Was the quality of the intervention toolsusedwith REACTSas reliable as those used in face-to-face treatment?
b.Quality of technical support		1.Are you satisfied with the quality of the technical support offered? 2.Are you satisfied with the online help resources (tutorials and other documents)? 3.What problems did you encounter when using REACTSto conduct your speech therapy interventions?
Clinical Feasibility	a.The degree of patient adherence to guidelines	1.Are you satisfied with the degree of patient adherence to your guidelines?
	b.The therapeutic relationship	1.Are you satisfied with the quality of the therapeutic relationship with the patient (perspective of the SLP)? During the previous sessions (perspective of the child): 2.I felt at ease with my SLP. 3.I found that the SLPcared for me. 4.I found that the SLPwanted to help me.
Satisfaction		* Perspective of the SLP The activities during the various sessions: 1.Are useful for the patient. 2.Are important to the patient. 3.Will help me to improve. *Perspective of the child At today's session: 4.I did what I could. 5.I'm happy with what I did. 6.I had fun. 7.I worked well. *Perspective of the parents 8.In general, was your child motivated to receive his speech therapy treatment with the REACTS platform?
Economic Cost	a.Money saved	1.Did you have to spend money on equipment to gain access to the REACTS platform (camera, microphone, etc.)? 2.If you would have had to travel for the treatment, how much transportation costs would you have incurred?
	b.Amount willing to pay	1.In a hypothetical scenario, would you be willing to pay for your child to receive treatment with the REACTS platform? 2.What amount you would be willing to pay for such treatment?
Health Outcomes		1.pVHI 2.CAPE-V

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