Tele-intervention for children with hearing loss: A comparative pilot study

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Abstract

Introduction: This pilot study compared tele-intervention to conventional intervention for children with hearing loss in terms of communication performance, parental perceptions and clinician perceptions.

Methods: A within-subject design was employed, including 10 children with hearing loss and their parents who each received a structurally similar tele-intervention and conventional intervention session in a counterbalanced manner. Quality of communication performance was analysed using a modified Tait Video Analysis method. Parent- and clinician perceptions were collected through rating-scale surveys and thematic analysis of qualitative responses.

Results: No significant difference ($p>0.05$) was found between tele-intervention and conventional intervention in terms of communication performance of children. Parent perceptions were not significantly different ($p>0.05$) between conventional and tele-intervention in terms of facilitating meaningful communication interaction. Significant differences were evident for comfort level during the session, whether they found it to be a beneficial experience and whether they would like to continue receiving intervention through this method. Clinician perceptions of conventional and tele-intervention were not significantly different ($p>0.05$) and tele-intervention was deemed a valuable method of service delivery for clients.

Discussion: This study provides preliminary evidence that tele-intervention is effective for communication intervention and can be a valuable solution to typical barriers such as distance and the shortage of trained interventionists.

Keywords

Tele-intervention, tele-rehabilitation, children with hearing loss, clinical outcomes, communication performance, parent perceptions, clinician perceptions.

Introduction

Early detection, identification and diagnosis of hearing loss, allows for timely delivery of early intervention services.[1] If family-centered early communication intervention commences before the age of six months and is continuously provided throughout the critical period of central auditory pathway development (0-5 years), a child can develop language abilities which are similar to their normal-hearing peers.[2-7]

Of the estimated 32 million children living with disabling hearing loss worldwide, 90% reside in developing countries and many in geographically disperse areas with limited access to the necessary intervention and educational services.[9-12] Additionally, there is a major shortage of appropriately trained professionals who deliver intervention services to children with hearing loss.[13-19] A recent global survey has revealed that the gap between the need and available services for individuals with hearing loss in sub-Saharan Africa is among the largest in the world and that many sub-Saharan countries lack trained health personnel, education facilities, data and national plans to address the needs of those living with ear and hearing problems.[12]

Alternative methods are pursued as a necessity to increase access to services across sub-Saharan Africa.[16] These methods include the use of automation, telehealth and now also mobile health. Telehealth is a method of providing health care services remotely via distance technologies and has been demonstrated to allow for remote screening, diagnosis, intervention, counseling, education and specialised interdisciplinary care.[20-22] It also holds promise in addressing the supply and demand of intervention services by increasing access of families with children who have hearing loss to appropriately trained clinicians.[15,16] This method of remote service delivery is referred to as tele-intervention.[15,22] Tele-intervention allows for intervention service delivery to families living in rural and remote areas where services were previously unavailable, due to barriers such as distance and travelling costs.[15] Recent advances in telehealth, together with declining internet connectivity costs, is enabling tele-conference software as a viable means of providing high quality tele-intervention services in settings where it is difficult or unnecessarily expensive to have the health care provider and the patient meeting in person.[15,21]

Tele-intervention has been deemed, in a number of studies and literature reviews, to be a viable alternative to its conventional counterpart in speech-language pathology,[15,23,24] specifically for the assessment of motor speech

disorders,[25] language development in school-aged children[26] and treatment for stuttering,[27] speech disorders,[28] acquired neurologic speech and language disorders[29] and parent training in early autism.[30] In related fields, such as occupational therapy, physical therapy and psychology, research studies involving 0 to 2 year olds have also concluded that tele-intervention is a viable alternative where in-person services are not feasible[31] and that it allows for time- and resource saving.[32]

Parent-reported benefits include high family satisfaction, cost-savings, fewer waiting lists, fewer travel arrangements, fewer unforeseen obstacles and reduced feelings of anxiety and depression, due to the emotional support, reassurance and guidance provided by the therapist on an on-going or weekly basis.[15,33-35] Parents felt that their children were reaching their listening and language goals and were satisfied with their progress in therapy.[15,35] Benefits reported by clinicians involved in tele-intervention programs for children with hearing loss, include active parental engagement and more rapid acquisition of early intervention skills, allowing for easier integration of therapy strategies into everyday life.[15,33,35,36] In this family-centered model of intervention, the parent takes on the role as the child's primary communication partner with limited physical involvement from the clinician/therapist.[15,33] Clinicians furthermore reported increased participation by fathers and other family members.[15,33]

Even though tele-intervention offers benefits, implementation of services in certain settings may pose a number of challenges.[37] The infrastructure, equipment and high-quality broadband internet connectivity, which is necessary for reliable video communication between the clinician and the family, is often expensive and even unavailable in communities where children and their families need it most.[35,36] Even with these elements in place, technology can be fickle with audio/video quality varying, depending on the time of day or other external circumstances.[35] Some families may experience a lack of confidence with technology and even those who are comfortable using technology might need technical support. Another challenge is creating an ideal therapy space in the house, taking acoustic and visual elements into account. Lastly, some families may simply prefer the physical presence of the clinician. It is thus important to bear in mind that tele-intervention is merely one possible vehicle of delivering quality family centered early intervention services.[35,36]

Even with its challenges, preliminary evidence suggests that tele-intervention could be used to overcome barriers like the shortage of trained early-intervention providers and the high costs of providing services to geographically dispersed families of children with hearing loss.[15,22,35] Despite increasing use of tele-intervention for children with hearing loss there is limited evidence on its

clinical efficacy compared to conventional intervention.[15,38,39,51] The current study therefore investigated home-based tele-intervention for children with hearing loss compared to clinic-based conventional intervention in South Africa according to communication performance and perceptions of caregivers and clinicians. In particular the current study served also to describe initial responses to receiving tele-intervention and the associated child and family characteristics that impact perceptions.

Methods

This within-subject study compared tele-intervention to conventional intervention for ten children with hearing loss and their families using a counterbalanced cross-over design to compare quality of communication performance, and parent and clinician perceptions. Ethical clearance was obtained from the appropriate ethics committees prior to the onset of the study.

Research participants

Ten children with hearing loss (8 female, 2 male) and their parents were selected from the Centre for Listening and Spoken Language client base, along with their early interventionist, according to predetermined selection criteria. Participating families needed to be able to travel to Pretoria, where the Centre

for Listening and Spoken Language is based, for at least one conventional intervention session and have internet access in their homes. The children and their participating parents (all mothers) provided written consent for their participation and their children's participation in the study. All 10 children started receiving conventional intervention for the development of listening and spoken language prior to the study for varying durations of time (average 32.4 months;

Table 1. Participant characteristics

Participant characteristics	
Average age of child	53.2m (17.3 SD)
Gender	8 Female; 2 Male
Degree of hearing loss *	1 Moderate (41-55dB) 1 Moderate-to-severe (56-70dB) 4 Profound (71-90dB) 4 Profound (>90dB)
Type of hearing loss	8 Sensorineural 1 Mixed 1 Auditory Neuropathy Spectrum Disorder
Amplification	5 Bilateral Cochlear Implants 2 Bilateral Hearing Aids 1 Bilateral Bone Anchored Hearing Aids 1 Bimodal amplification 1 No amplification
Device used for tele-intervention session in current study	1 Desktop PC 7 Laptop 2 Tablet
Parent has used Skype™ before	8 Yes 2 No
Parent comfortable using Skype™	1 Not applicable 7 Yes 2 Somewhat

***** *Degree of hearing loss was categorised using the calculated average pure-tone air-conduction thresholds at 0.5, 1, and 2 kHz in the better ear.*[40,41]

range 16 to 61 months; SD 16.1 months). None of the participants had received tele-intervention prior to the onset of the study.

Age of children at the time of data collection ranged from 30 to 79 months (average 53.2 months; 17.3 SD) with their mothers aged 33.4 years on average (range 28 – 40 years; 3.9 SD). Table 1 describes further characteristics of the participating children.

Material

Intervention sessions. Each intervention session comprised of one hands-on activity and one corresponding book-reading activity to facilitate joint attention and interaction between the parent and the child. The themes and language content of the intervention sessions corresponded with the titles of the four books, namely “In the Garden”, “Animal Friends”, “In the Park” and “Deep Blue Sea” from the “Fidgety Fingers” series.[42-45] The hands-on activity consisted of small three-dimensional plastic animals corresponding to the animal characters in the books. Each parent and their child were randomly presented with two of the four themes, one during the tele-intervention session and one during the conventional intervention session.

Tele-intervention Information and Communication Technology (ICT). Technical apparatus utilised by the clinician in her office included a laptop with Skype™ software installed, ADSL internet connection, a web camera, a flexible desk lamp to create optimal lighting during tele-intervention sessions, a white sheet to use as a backdrop to ensure optimal visibility of the clinician during tele-intervention sessions and a video camera to film all conventional and tele-intervention sessions from the clinician's office.

Technical apparatus utilised by parents included their own personal desktop computer, laptop or tablet with Skype™ software installed, Internet connection and a web camera. Nine parents indicated that they would not need technical assistance; one parent indicated that she might need technical assistance. All ten participants reported that they have access to internet connectivity in their homes (fixed line or 3G cellular network). Due to the fact that in some countries Skype™ is considered to be insufficient for health care interactions, the following was implemented to safeguard the data and protect privacy and confidentiality of participants: strong password protection; dedicated use of the computer or Voice over Internet Protocol (VoIP) system for tele-intervention; virus protection and use of virus-free computers; use of audit controls to record how often data are accessed by or released to internal and outside entities.

Tait-based communication interaction assessment tool. The Tait Video Analysis was originally designed as a method of monitoring preverbal and early linguistic development of children with hearing loss who were wearing amplification devices.[46,47] This method entails video recording child-adult interactions in a conversational setting, and the subsequent methodical analysis of six aspects of interaction, namely non-looking turns, vocal responses, non-vocal responses, vocal initiatives, non-vocal initiatives and no responses. The Tait Video Analysis has been shown to be a reliable method for assessing the level of auditory communication in children beyond the preverbal stage of language development.[48,49] It has also demonstrated high inter-observer reliability for assessing communicative skills of young children.[49] The original Tait Video Analysis[47] was modified for the current study by adding eye-contact as another aspect of interaction, since eye-contact shows communicative intent and contributes to the quality of communication interaction. This included eye-contact between child and parent or between child and clinician. In this study, the modified tool was used to analyse and compare each participant's quality of communication interaction in a single-recording during one tele-intervention and one conventional intervention session.

Parent- and clinician perception questionnaire. Parent- and clinician perceptions were surveyed through the use of a questionnaire completed after each tele-

and conventional intervention session. Each questionnaire comprised four rating scale questions and two open-ended questions, to add qualitative depth to the descriptions of perceptions conveyed by participants. On completion of both the tele- and conventional sessions, parent participants and the clinician participant completed a third questionnaire consisting of one closed-ended and three open-ended questions to determine the parents' and the clinician's overall perceptions and opinions pertaining to the use of tele-intervention.

Procedures

Participants were divided into two equal groups according to the convenience in the scheduling of appointments. Child- and parent participants in the first group received a clinic-based conventional intervention (control condition) session first, followed by a home-based tele-intervention session (experimental condition) two weeks later. Using a counterbalanced cross-over design to reduce systematic error, participants in the second group first received a tele-intervention session followed by a conventional intervention session two weeks later.

Tele-intervention sessions were conducted with the parent and child in their own home, communicating with the clinician in her office via synchronous (real-time) video-communication software (Skype™). On the day prior to recording tele-intervention sessions, a Skype™ test-call was conducted with each parent

participant to troubleshoot for any video- or audio-quality difficulties. Tele-intervention sessions were recorded at 06:30 a.m. on weekdays, as arranged with each parent individually. All conventional intervention sessions were conducted by the clinician participant at the Centre. Conventional intervention sessions were scheduled during the timeslot of each child's existing weekly intervention session. All conventional and tele-intervention sessions were 30 minutes in duration and structurally similar in terms of activities and materials to ensure minimal variability in the amount of opportunities to communicate for comparative purposes. Each tele-intervention session started with a technical check of two-way audio and video signal between the parent at home and the clinician at the clinic. The conventional and tele-intervention would commence in the same way with the clinician introducing and discussing the predetermined activities and therapy techniques that will be used during the session. The parent was encouraged to lead the session during which the clinician provides ongoing feedback or suggestions to the parent on how to provide effective intervention. The clinician intervened directly with the child in cases where techniques or activities needed to be demonstrated to the parent.

Samples that represented each child's range of communicative abilities were selected by the first author, in consensus with the clinician participant, from the video recordings of the tele- and conventional intervention sessions of each participating family. As the usefulness of a sample depends on the degree to

which it is representing normal interaction between parent and child, specific measures specified by Cole and Flexer (2007) were used to ensure natural interaction between the parent and child during observational videotaping.[50] Each sample comprised of 40 communicative turns between the child and the parent and was selected from the onset of either the hands-on activity or the book-reading activity.

Data analysis

The representative samples were transcribed and analysed by the clinician participant and the first author using the modified Tait Video Analysis communication interaction tool.[47] Independent analyses by the participating clinician and first author (objective coder) were subsequently compared. A third external objective coder was consulted in cases where the clinician participant and first author had conflicting results in the analyses of the samples. Statistical analysis software (SPSS v.21) was used to investigate within-subject differences in communication interaction between conventional and tele-intervention sessions. Parent and clinician ratings were averaged and compared between conventional and tele-intervention sessions using the Wilcoxon Signed Ranks Test (significance set to $p<0.05$).

Thematical analysis of open-ended questions allowed for common trends or central themes to be identified among the parent and clinician participants. In

this study, central themes together with illustrative quotes from parents' and clinician's perceptions of conventional- and tele-intervention sessions were extracted following a thematic analysis approach.

Results

Quality of communication interaction

The quality of communication interaction in the conventional compared to tele-intervention sessions, assessed using the Tait-based communication interaction tool across 7 categories, demonstrated no significant difference ($p>0.05$; Wilcoxon) between within-subject scores (Table 2).

Parental perceptions

Conventional compared to tele-intervention was rated higher ($p<0.05$; Wilcoxon) in terms of comfort level during the session, how beneficial they experienced the session to be and whether they would like to continue receiving intervention through this method (Table 3). There was no significant within-subject difference between parent ratings of conventional compared to tele-intervention in terms of facilitating meaningful communication interaction between the parent and their child ($p>0.05$; Wilcoxon).

Table 2. Quality of children's interactive turns (Tait-based communication interaction tool) in conventional and tele-intervention sessions (n=10)

	Mean (SD)	Range	p-values
1. Vocal responses			p=0.944
Conventional	10.8 (4.3 SD)	4 - 16	
Tele-intervention	10.9 (5.0 SD)	3 - 17	
2. Non-vocal responses			p=0.391
Conventional	3.2 (2.6 SD)	0 - 8	
Tele-intervention	2.8 (2.1 SD)	0 - 6	
3. Vocal initiation			p=0.888
Conventional	3.6 (1.9 SD)	0 - 6	
Tele-intervention	3.5 (3.5 SD)	0 - 10	
4. Non-vocal initiation			p=0.340
Conventional	1.8 (2.4 SD)	0 - 6	
Tele-intervention	2.4 (3.4 SD)	0 - 10	
5. No response			p=0.317
Conventional	0.7 (0.8 SD)	0 - 2	
Tele-intervention	0.4 (0.7 SD)	0 - 2	
6. Eye-contact			p=0.812
Conventional	14.5 (5.1 SD)	6 - 20	
Tele-intervention	15.2(4.7 SD)	6 - 20	
7. Non eye-contact			p=0.677
Conventional	4.8 (5.0 SD)	0 - 14	
Tele-intervention	4.4 (4.7 SD)	0 - 14	

Table 3. Parents' perception regarding conventional and tele-intervention sessions Rating of "Strongly Agree (5)", "Agree (4)", "Not Sure (3)", "Disagree (2)" or "Strongly Disagree (1)".

Questions	Conventional Intervention	Tele-Intervention	Significance
Felt comfortable during session	Median (IQR**): 5.0 (0)	Median (IQR): 4.0 (1)	p<0.05*
Found this intervention to be a beneficial experience for me and my child	Median (IQR): 5.0 (0)	Median (IQR): 4.0 (1)	p<0.05*
Found this intervention to facilitate meaningful communication interaction between me and my child	Median (IQR): 5.0 (0)	Median (IQR): 5.0 (1)	p>0.05
Would like to continue intervention through this service delivery method	Median (IQR): 5 (0)	Median (IQR): 4.5 (3)	p<0.05*

**Significantly different scores (Wilcoxon Signed Ranks Test)*

***IQR= Interquartile range*

After completing the conventional and tele-intervention sessions, parents were asked whether tele-intervention could be utilised with the same success as conventional intervention. Five parents (50%) indicated "Yes", one (10%) indicated "No" and four (40%) indicated that they were "Not Sure".

Parents were further requested to substantiate their ratings with qualitative descriptions (Table 4). Main themes that presented in the qualitative component included the benefits, such as convenience of tele-intervention, the comfort level of the child and less travelling, but also challenges such as the technical

Table 4. Central themes and illustrative quotes from parents' perceptions of conventional- and tele-intervention sessions

Central Themes	Illustrative Quotes
Conventional intervention	
Familiarity	- *"My child is used to conventional therapy."* - *"It is what we know."*
Physical presence of therapist	- *"Having the therapist present gives me confidence…"* - *"It gives me as a parent guidance on what to focus on with my child."*
"Gold standard" for therapy	- *"Face-to-face therapy remains the best means of intervention as it allows for transmission of subtle cues that may not be visible or apparent in a tele-intervention. As such a tele-intervention remains a viable second option in my opinion and should not replace conventional therapy where latter is available."* - *"If close to therapist, then conventional therapy is the most optimal option"*
Tele-intervention	
Convenience	- *"Convenient for our family with small children."* - *"Technology is very advanced now and a great part of our daily lives. So this tele-intervention would be a success. And we still see (the therapist) on the screen so it wouldn't be difficult to proceed with our normal sessions."*
Distance & travelling	- *"We live very far, so tele-intervention would be ideal for us."* - *"Staying at home in own comfort zone and less travelling."* - *"(Tele-intervention might be beneficial) where geographical constraints limit the possibility of having regular conventional sessions. E.g. if the child lives in another city of country."*
Comfort level of child	- *"My child tends to react more comfortably in his own environment."* - *"My child reacts better in her own surroundings…"*
Technical issues	- *"Frustrated with constant loss of signal"* - *"Too many external factors consuming valuable time, such as loss of signal, power outages etc."* - *"Technical issues might prevent having meaningful sessions."*
Distractions	- *"Child might be distracted easily with his own toys he wants to play with instead of paying attention to session."* - *"Busy environment at home made the session almost impossible"* - *"Our younger child made the session very difficult."*
Parents' therapeutic and technical skill	- *"As the parent, I feel we would benefit with a bit of training first."* - *"(Tele-intervention would not be beneficial) if the parent does not know what to do exactly."*

difficulties, parental therapeutic skill level and distractions in the home environment which may play a role in the outcome of such a session.

Clinician perceptions

The clinician was surveyed regarding her experience of the conventional and tele-intervention session (Table 5). There was no statistically significant difference between the clinician's perceptions of conventional compared to tele-intervention ($p>0.05$; Wilcoxon) in any of the four aspects addressed in the 5-point rating scale questions.

Table 5. Clinician's perception regarding conventional and tele-intervention sessions. Rating of "Strongly Agree (5)", "Agree (4)", "Not Sure (3)", "Disagree (2)" or "Strongly Disagree (1)".

Questions	Conventional Intervention	Tele-Intervention	Significance
Felt comfortable during session	Median (IQR): 5.0 (0)	Median (IQR): 5.0 (1)	p> 0.05
Found this intervention to be a beneficial experience for parent and child	Median (IQR): 5.0 (0)	Median (IQR): 5.0 (1)	p> 0.05
Found this intervention to facilitate meaningful communication interaction between parent and child	Median (IQR): 5.0 (0)	Median (IQR): 5.0 (1)	p> 0.05
Would like to continue to provide intervention through this service delivery method	Median (IQR): 5.0 (0)	Median (IQR): 5.0 (1)	p> 0.05

**Significantly different scores (Wilcoxon Signed Ranks Test)*

***IQR= Interquartile range*

Table 6. Central themes and illustrative quotes from clinician perceptions of conventional- and tele-intervention sessions

Central Themes	Illustrative Quotes
Conventional Intervention	
Conventional or tele-intervention viable options	- *"Easy family to work with, could work either way with them."* - *"This family is so much further along in the process, either Skype or conventional could work."*
New/ inexperienced families	- *"(Conventional intervention) currently important for building a relationship"* - *"(Child) is beginning to understand how session works, and is engaging more"*
Tele-intervention	
Unfamiliarity	- *"Would probably need a few sessions before one could really get a therapeutic session going with this child."* - *"(Child) was a little shy; would need to get used to this type of therapy"*
Comfort level of child	- *"(Child) was much less distractible at home; saw more skills demonstrated than seen in conventional therapy."* - *"Would rather want to work with this child via tele-intervention – he was more at ease in his own home."* - *"(Child) much more comfortable in her home environment."* - *"This child responds as well and is comfortable with technology."* - *"In this particular case, the child demonstrated a higher quality interaction + better language skills in the safety of her home, with her family around."* - *"This child much more trusting in his own home; more comfortable engaging with mom."*
Technical issues	
Distractions	- *"Require a more stable connection so as not to stress/frustrate the parent."* - *"…dropped once during the session. But quickly re-established connection."* - *"Closer to 8a.m. we began experiencing signal issues."* - *"Signal a little poor; but did not lose contact."* - *"Many, many technical difficulties, kept losing video on one or both sides."* - *"Delayed video transmission, but sound good."*
Parents' therapeutic and technical skills	- *"Could continue but would need to plan sessions very carefully to include sibling."* - *"Difficulties experienced with sibling present..."*
Valuable alternative to conventional therapy	- *"Easy family to work with. Both mom and daughter relaxed with the technology and mom's skill level makes it easy."* - *"Mother and son comfortable with the technology and Mom's skills base good"* - *"Inexperienced parents might be a challenge."* - *"It would appear it could be a valuable method of service delivery to parents away from the centre/therapy base."*
Follow-up sessions	- *"More regular follow-up with 'out-of-towners"*

The clinician was further requested to substantiate her ratings with elaborative descriptions (Table 6). Main themes that presented themselves included the unfamiliarity of tele-intervention, the comfort level of the child during the session, technical issues and distractions during the sessions, the level of parents' therapeutic and technical skills and the use of tele-intervention as a viable alternative to conventional intervention.

Discussion

This study compared one 30-minute conventional clinic-based session to one 30-minute home-based tele-intervention session in terms of communication performance, parental perceptions and clinician perceptions. The quality of children's communication performance in tele-intervention was comparable to that of conventional intervention with no significant within-subject differences. Previous case control studies reported on language outcomes of children with hearing loss receiving conventional and tele-intervention longitudinally. Constantinescu et al. (2014) reported similar language outcomes between a control group and children receiving eAVT (tele-Auditory Verbal Therapy) at a two-year assessment.[39] Blaiser et al. (2013) reported higher mean scores for receptive and expressive language in a tele-intervention group, compared to a control group.[36] The current study, however, compared actual communication performance between one conventional and one tele-intervention session within

subjects. This provides further evidence in support of the efficacy of tele-intervention for facilitating quality communication interaction.

Benefits of tele-intervention reported in the current study included reduction in travel time and expense, which are in agreement with findings reported by McCarthy et al. (2010).[15] Parents felt that it was convenient to have the sessions in their homes as also indicated by Behl et al. (2010)[35] and reported that their children interact more comfortably in their own homes.[33]

Reported challenges of tele-intervention in the current study included technical difficulties, parental therapeutic skill level and distractions in the home environment. External factors, such as the time of day, type and strength of internet connectivity and hardware and software caused technical issues, such as varying quality of video and audio output. Similar challenges were reported in previous studies regarding tele-intervention for children with hearing loss [35,51,52] and was also reported in a study regarding tele-intervention for acquired neurological speech disorders.[29] In the current study, time of day had a significant effect on connectivity and audio and video output. Poorer audio and video output and interruptions in connectivity was experienced after 08:00 a.m. on weekdays, when working hours commence and Internet usage in the area increased. Overall, these reported technical challenges were found to directly

correlate with parents' perceptions on whether they thought that tele-intervention could be used with the same success as conventional intervention. One parent indicated that she would benefit from sufficient therapeutic and technical training in order to conduct successful and quality tele-intervention sessions. McCarthy et al (2010) also reported that training is strongly recommended for parents involved with tele-intervention.[15]

Parents rated conventional intervention significantly higher than tele-intervention in three of the four areas. They felt more comfortable during the conventional intervention session, found it to be a more beneficial experience for them and their children and would like to continue receiving conventional intervention in the future. It should be noted that all participants received conventional intervention services prior to the study, which is likely to cause some bias due to the mere-exposure effect, where persons develop a preference to something merely because of its familiarity.[53] Behl et al. (2010) also reported that some parents prefer the physical presence of the therapist in conventional in-person intervention, due to familiarity.[35] Interestingly, parents perceived no significant difference between tele- and conventional intervention in terms of facilitating meaningful interaction between them and their children, which was also reported by Behl et al. (2010).[35] This suggests that even with a preference for conventional intervention, parents acknowledge the ability of tele-

intervention to allow for the facilitation of meaningful interaction between them and their children in the same way as conventional intervention.

The clinician reported that children's comfort level with the use of technology during tele-intervention was noteworthy. Five children (50%) appeared more comfortable in their home environment and displayed larger varieties of communication skills than what is usually observed in the conventional intervention context. This was reported previously by Constantinescu (2012), Behl et al. (2010) and McCarthy et al. (2010).[15,35,52] The clinician perceived tele-intervention as a valuable method of service delivery to families who may live far from therapy centres to allow more regular follow up. Tele-intervention could therefore overcome barriers of distance and the shortage of early interventionists in some cases.[15,22,29,35] In the current study, the clinician indicated that two participating families (20%) in particular would do well in receiving further intervention through tele-intervention as their parents had received sufficient therapeutic training and were comfortable with the use of technology.

The clinician's main concerns regarding tele-intervention, was the unfamiliarity to all the participating families, the technical challenges involved, the technical and therapeutic skill level of the parents and possible distractions in the home.

These aspects were noted by the clinician as a possible cause of frustration that could hinder the performance of parents and children. Behl et al. (2010) also reported that a lack of parental confidence with the use of technology is a significant barrier in tele-intervention.[35]

The clinician preferred conventional intervention for 3 of the participating families as these families were new to the intervention process and needed further therapeutic training before tele-intervention should be considered. The clinician suggested conventional methods for intervention and parent guidance for families who are new to the intervention process. Constantinescu (2012) also recommended a higher number of in-person sessions for new families[52] and trial tele-intervention sessions were recommended by the clinician in the McCarthy et al. (2010) study to allow families in the RIDBC Tele-intervention program to become familiar to the set-up and to become confident in troubleshooting when technical difficulties present themselves.[15]

Other studies investigating parent and clinician perceptions in tele-intervention programs have reported high satisfaction with and a preference for tele-intervention due to the high quality of services provided.[15,22,35,52] However, tele-intervention studies with larger populations and longitudinal monitoring of actual communication outcomes in children with hearing loss are still required.[38]

Initial challenges faced by the researcher in implementing tele-intervention included ensuring sufficient bandwidth and to re-establish connections when failures occurred. All participants had previous exposure to conventional intervention but none to tele-intervention, which was a limitation. Participants of future studies should ideally have no exposure to either tele-intervention or conventional methods. The clinic- and home-based environments also varied in terms of visual and auditory aspects, which could affect children's communication performances in the different environments.

Since this pilot study included only one clinician and 10 children, future studies with larger numbers will allow for a more comprehensive investigation. The inability of statistical tests to find significant differences in clinician- and parent perceptions, may be due to the small number of parent- and clinician participants. The relationship between parental therapeutic skill level and the child's communication performance in tele-intervention would be a valuable aspect to investigate. The relationship between parental openness to tele-intervention and factors such as parents' past video-conference experience, education level and the child's age would also be valuable to investigate. The quality of connectivity and possible association with whether families would continue to use tele-intervention would also be worth investigating. Lastly, future

studies that focus on how to prepare and train families in utilizing tele-intervention methods and on what training clinicians require in providing parent guidance and coaching online would be valuable.

Conclusion

Communication performance in children with hearing loss elicited during tele- and conventional intervention was similar. Whilst most parents indicated a willingness to continue with tele-intervention they preferred conventional intervention, which may in part be due to prior familiarity. Tele-intervention challenges included technical difficulties, distractions in the home environment and parents lacking in technical and/or therapeutic skills. The clinician generally perceived both tele-intervention and conventional intervention to be equally effective, except where families were new to the intervention process and in-person parent training was required. This study provides preliminary evidence that tele-intervention could be a valuable solution to typical intervention barriers such as distance and the shortage of trained interventionists.

Acknowledgements

We thank the children, families and program director at The Centre for Listening and Spoken Language, as well as technical support personnel for their contribution to the research.

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