Telehealth use in Speech-Language Pathology:

An exploratory scoping review

Lillian Krikheli, BHSc, MSpPath, CPSP

Lindsay B. Carey, MAppSc, PhD

Claire E. McDonald, BHSc

Nada Malik Abdu, BHSc

Department of Public Health,

School of Psychology and Public Health,

La Trobe University, Melbourne, Victoria Australia

http://hdl.handle.net/1959.9/563260

CONTENTS

PREFACE

Purpose and Report Focus

This report is an initial exploratory scoping review prepared for staff at the Cabrini Health Speech Pathology Department (Melbourne, Victoria, Australia) as part of a Bachelor of Health Science final year internship program. Support for this research was provided by the Department of Public Health, School of Psychology and Public Health, La Trobe University (Melbourne, Victoria)

Department:

1. Department of Public Health

Authoritative Support

2. School of Psychology and Public Health
La Trobe University
Melbourne, Australia 3083

Amendments:
Updated 19 December 2017

Commencement: 01 September 2017
Completion: 08 December 2017

Referencing System:

APA 6th Edition

Access: Open

Reference Citation:

Krikheli, L., Carey, L.B., McDonald, C.E. Malik, N. (2017). Telehealth use in Speech-Language Pathology: An exploratory scoping review (prepared for Cabrini Health, Victoria). Melbourne: La Trobe University, Participatory Field Placement Report, pp.1–52. http://hdl.handle.net/1959.9/563260

POC Details:

Ms. Lillian Krikheli
Palliative Care Unit, Department of Public Health School of Psychology and Public Health, La Trobe University, Kingsbury Drive, Bundoora, Victoria, 3084;
Phone (M): + 61 (0) 394798808
Email: L.Krikheli@latrobe.edu.au

Dr. Lindsay B. Carey
Palliative Care Unit, Department of Public Health School of Psychology and Public Health, La Trobe University, Kingsbury Drive, Bundoora, Victoria, 3084;
Phone (M): + 61 (0) 394798808
Email: Lindsay.Carey@latrobe.edu.au

Acknowledgements: The authors would like to thank Dr. Jennifer Brooker (YMCA George Williams College, London, UK), Dr. Susan Chong (Department of Public Health, La Trobe University, Melbourne) and Ms. Rosanna Ripoli (Senior Learning Advisor, Borchardt Library, La Trobe University, Melbourne, Victoria, Australia).

Telehealth use in Speech-Language Pathology: An exploratory literature scoping review

Lillian Krikheli, Lindsay B. Carey, Claire E. McDonald, Nada Malik

Abstract:

Purpose: The utilisation of telehealth services in speech-language pathology is increasing and becoming more accessible to individuals. This review aims to explore the effects of telehealth on speech-language pathology outcomes. In addition, this review highlights the extent to which speech pathologists implement telehealth services. **Method:** An exploratory scoping review was conducted in order to identify the literature and research central to the topic of telehealth in speech-language pathology. Arksey and O'Malley's (2005) scoping review method was utilised for searching multiple databases. Seven databases were utilised in this review. **Results:** Over 1,500 articles were identified across several databases. A large number of articles were deemed relevant (217). After a secondary screening this number was reduced to seventy-nine (n=79). In addition, some of the identified literature explored telehealth in multidisciplinary settings, which provides an insight into telehealth outcomes, yet do not solely focus on speech-language pathology.

Keywords: Telehealth, speech-language pathology

Introduction:

According to the Australian Government Department of Health (AGDOH, 2015), telehealth is the use of telecommunication to improve the health and knowledge of individuals and communities at a distance. As technology continues to develop, medical advances have been internationally recognised and can contribute to increased life expectancy and wider access to treatment options (Kully, 2000). A number of research articles have noted the implications telehealth can have on speech pathology outcomes. However, little research has been done to review the effectiveness of these interventions and how speech pathologists implement these alternate services into their practice. As telehealth is an increasing alternative method to traditional face-to-face therapy, an exploration into the efficiency and value of telehealth needs to be undertaken in order to increase awareness of the types of services available.

Purpose & Method

The purpose of this review is to explore the literature regarding telehealth services in speech-language pathology. In addition, this review aims to highlight how efficacious telehealth is in various settings. Telehealth services that aim to increase access to treatment and therapy for those residing in rural and remote areas which will also be explored in this review.

A total of seven databases were used to conduct this search: Medline, CINAHL, SpeechBITE, Google Scholar, SCOPUS, PsycINFO and PubMed. Arksey and O'Malley's (2005) exploratory scoping review method was utilised to explore the literature found. Articles were then screened by the authors and deemed relevant or irrelevant. The key search terms utilised for this report are summarised in the table below:

Table 1

Literature review search terms and sources of research

Databases utilised	Medline (OVID), CINAHL (Ebsco), SpeechBITE, Google Scholar, SCOPUS (Elsevier), PsycINFO 1806- (Ovid), PubMed		
Search terms			
Speech-language Patholog* **OR** Speech Therap* **OR** Speech intervention **OR** Language Therapy	**AND**	Telehealth **OR** Ehealth **OR** Telepract* **OR** Telerehab* **OR** Telemedicine / Telecare	**AND** Improved efficiency **OR** Improved effectiveness **OR** Enhanced efficiency
P	**I**	**C**	**O**
Speech-language Pathology Speech-language Pathologist Speech-language Pathologists Speech Therapy Speech Therapist Speech Therapies Speech Intervention Language Therapy	Telehealth eHealth Telepractice Telepractices Telepractitioner Telerehabilitation Telemedicine Telecare	(Not applicable)	Improved efficiency Improved effectiveness Enhanced efficiency

Results

A total of 1,517 articles were found after a search of seven databases. After screening the abstracts of all articles, 212 were found to incorporate telehealth and speech-language pathology outcomes. A secondary screening was necessary to obtain articles relevant to the topic. A total 212 articles were read in full; 133 of those articles were deemed irrelevant. The total number of relevant articles retained for this review totalled 79 (n=79) (see Appendix A).

The key findings of the literature have been summarised and coded to their appropriate themes and can be found below (refer Table 2; see Appendix C). As there were a large number of articles deemed relevant (n=79), an analysis of the key themes which were prominent across the range of articles will be discussed (see **Key Themes**). The table below highlights the six key themes prevalent within the identified studies and the thematic coding allocated (refer Table 2; see Appendix C).

Table 2

Thematic Coding

Thematic Coding	Themes
1	Videoconferencing
2	Rural & Remote areas
3	Adult
4	Paediatric
5	Changes to service development
6	Home-based intervention

Note: Articles could have more than one theme.

Key Themes

Videoconferencing

The first common theme identified among the articles was the significant use of videoconferencing in delivering speech-language pathology. More specifically, video-

conferencing can be delivered through various applications such as Skype, Webcam, Adobe Connect, Facetime, Zoom, smartphones and computer-based programs, which were prevalent in the articles retrieved. Videoconferencing can involve many benefits that included reducing the expense of travel to access treatment/services and mitigating the shortages of healthcare professionals in rural and remote populations. Forty-five articles focused on the use of telehealth applications compared to conventional face-to-face and in person therapy. The applications used within these studies are listed within the appendices (see Appendix B).

The majority of articles identified videoconferencing as an effective, valid, reliable, feasible and equal method of approach in delivering therapy compared to face-to-face conventional therapy. For example, an article by Grogan-Johnson et al. (2010), compared the progress made by school children receiving speech-language therapy provided through videoconferencing and conventional face-to-face speech-language therapy. They concluded that children made similar progress during the study whichever treatment method was used and there was no significant difference in outcomes between the two methods. Furthermore, Fairweather, Lincoln and Ramsden's (2016) determined that a teletherapy program using Adobe Connect was feasible and acceptable for children attending schools and early childcare settings in rural and remote areas.

Some literature discussed the barriers and limitations of video conferencing, the most frequently mentioned were technology failure such as, frozen video connection, unstable internet connection, computer crashing and non-significant training and minimal familiarity with treatment equipment. For example, in Harrington's (2012) study of Lee Silverman Voice Treatment delivered via distance therapy, minor technical difficulties occurred, which required time to fix and subsequently altered the results. In some sessions, the software did not record the speech-language pathologist who had paused the software or caused it to

restart. As technology continues to advance, the authors envisaged that minor difficulties would be overcome and therapies delivered at a distance can be improved.

Rural and Remote Areas

Geographic location has been reported to cause inconsistencies in accessing the correct treatment and can increase the amount of travel time and the overall out-of-pocket cost paid by the patient. Implementing telehealth services in rural and remote areas can improve health outcomes as it can eliminate the need to travel long distances and treatment can be instantaneous. In addition, shortages of health professionals such as speech-language pathologists in these areas, contributes to the lack of services available. Twelve articles studied participants living in rural and remote areas and/or included/discussed this factor in the research. Many articles noted that telehealth is an efficient method in delivering a service to individuals living in isolated areas who have inadequate access to health care services. For example, in the article "Expanding Use of Telepractice in Speech-language Pathology and Audiology" by Edwards, Stredler-Brown and Huston (2016), many advantages of telehealth are discussed. They concluded that telehealth could play a critical role in the early identification and treatment of speech and language disorders, as well as reducing the inequalities that individuals living in rural communities may experience. In addition, their review highlighted the need for further research within this area, especially with regard to the quality of the telehealth service being delivered.

Furthermore, Packman and Merideth's (2011) article, referring to use of technology in stuttering, also highlighted the impact technology has in today's society, and shown efficacy within rural and remote settings. It is important to note that studies conducted overseas also made mention of rural and remote areas. Whitehead et al. (2012) implemented a study whereby Spanish-speaking speech-language pathologists simultaneously evaluated the speech of patients with cleft palate in real time and through video conference between Tijuana,

Mexico and San Diego, California. Nine children and their parents participated in this study and the effectiveness was determined with a questionnaire. This international trial illustrated that is was feasible to evaluate speech through the use of telehealth. The findings from this study encouraged the use of telehealth to connect with speech-language pathologists in real-time who speak the native language of the patient, if they are living or staying in a country that does not speak their native language.

Many articles assessed parent and speech-language pathologist perspectives with regards to the development of telehealth therapies in rural and remote areas. Anderson, Balandin and Stancliffe's (2014) study conducted interviews with parents of children with communicative disorders and speech pathologists in order to explore their opinions of alternative therapies and support for those with speech generating devices. Despite this study being relevant to rural and remote areas, only one parent participant and one speech pathologist were from rural areas. This may have likely altered results, however, the evidence suggested that parents and other individuals can be trained and supported to use speech generating devices via telehealth.

Other reviews also aimed to explore the impact telehealth has on speech-language pathology, in particular whether speech-language pathologists utilise telehealth, and what future developments of telehealth may have on speech-language pathology. This was highlighted by Keck and Doarn (2014) in their literature review, "Telehealth Technology Applications in Speech-Language Pathology". This review introduced the idea that SLPs are cautious about adopting telehealth procedures for multiple reasons. Cost, implementation, lack of physical contact and individual patient needs were deemed valid reasons as to why SLPs are hesitant to try telehealth services. It was posited that removing the traditional face-to-face component of therapy may cause rapport issues with clients which could lead to non-compliance and decreased motivation. It is important for speech-pathologists to empower

their clients, so that maximum potential can be achieved. It is therefore crucial for SLPs to understand the technology equipment they are using, in the even that their workplace begins to shift to a telehealth approach. Keck and Doarn's (2014) evaluation explored 26 relevant articles, many of which are included within this scoping review. A key analysis of the themes was undertaken, with many articles highlighting the positive effect telehealth has on speech-language pathology outcomes. Ultimately, it was presented that the rising use of telehealth can improve voice and swallowing disorders, however, SLPs need to be responsible for providing the same amount of care with their patients via telehealth as they would face-to-face.

An article by Mashima and Brown (2008), explored 'remote management' of voice and swallowing disorders where speech-language pathology outcomes through the use of telehealth were discussed. A major theme within the article was personnel shortages of speech-language pathologists within rural and remote areas of Australia and the barriers of accessing health services. Telehealth, as described, offers a major solution to this issue, as those living in rural health areas can access speech-language pathology services without travelling long distances. Home-based interventions are largely effective for individuals residing within rural and remote areas and will be discussed further below.

A study by Fairweather, Lincoln and Ramsden (2016) implemented a telehealth program within a school in rural New South Wales which delivered speech pathology through videoconferencing. This study was of significance, as it aimed to decrease service inequities experienced by families living in rural and remote areas. The findings of this study were categorised into four main themes; (a) practicality and convenience, (b) learning, (c) difficulties, and (d) communication. These categories were used to identify whether a telehealth intervention was feasible and reliable in a rural or remote environment. The

discussion of these themes promoted telehealth and highlighted some limitations of this intervention. These will be discussed further below (see Limitations).

A study by Sutherland et al. (2016), focused on telehealth assessment of children living in rural New South Wales using consumer grade equipment in rural and urban settings. One session only was found to be 'poor' and the rest ranged from 'OK' to 'good'. Furthermore, all 23 (100%) sessions were completed. This is rare in a study of this nature as many difficulties, such as noncompliance, technical issues and scheduling issues can occur. Consumer feedback made by 13 of the participants' parents suggested that participants were 'somewhat comfortable' or 'definitely comfortable' with utilising telehealth services. Consumer feedback was critical to the refinement of such services as it gives insight to the positives and negatives of the intervention.

In another study, "A phase II trial of telehealth delivery of the Lidcombe Program of Early Stuttering Intervention" by Lewis et al. (2008), telehealth was shown to be a viable method to decrease the inequities experienced by these communities. A second Lidcombe Program related study by O'Brian, Smith and Onslow (2014), focused on three clients; two of whom lived too far from a speech-language pathologist and one who was unable to attend face-to-face therapy. The program was delivered via a webcam and all three participants made significant gains with regards to their stuttering; the three participants reduced their stuttering by 69% to 99%. The study concluded that telehealth delivery of this specific intervention was viable, however a larger sample size is needed for future research.

Vestal et al. (2006) examined the efficacy of language assessment in Alzheimer's disease. The authors were complimentary of telehealth use and made note of the benefits of telehealth in remote communities. It was found that areas which are under-served by health care practices due to their remoteness can indeed benefit from telehealth. The authors noted that it is crucial for future studies to use an age-appropriate intervention which can be

delivered within the home environment. Moreover, monitoring of these individuals often requires extra resources such as time and financial costs; the authors recommended that these factors should be reviewed in future studies.

Limitations

Limitations to implementing telehealth services within rural communities was discussed in all articles found. A major limitation across many studies was sample size and technical difficulties associated with the interventions. Therapy delivered by webcam would often pause or 'cut-out' and occasionally applications on iPads or mobile devices would crash. However, Ward et al. (2012) noted that technological difficulties in the delivery of telehealth services cause minor complications to the overall result. Technological difficulties in the delivery of telehealth through videoconferencing may have led to one participant's non-compliance with the intervention. Ward et al. highlighted that video quality and delays in audio or visual information caused by high congestion or low bandwidth connection may cause future problems for those living in rural or remote areas where fast internet speeds are limited. Cost-effective methods of telehealth practices are lacking research, funding and an overall comparison to traditional face-to-face methods. This will be discussed further below (see Changes to service delivery).

Reimbursement issues highlighted by authors such as Mashima and Brown (2008) also contribute to the overall limitations of telehealth services. Currently within Australia, telehealth and speech-language pathology is starting to be recognised as an effective intervention for health care consumers. According to the Australian Government Department of Human Services (AGDOH, 2017), Medicare benefits are available for telehealth services such as video consultations for individuals located within 'telehealth eligible' areas. Nonetheless, these services are underfunded, and consumers are still uninformed of their

access to telehealth. Ultimately, telehealth services have proven to be effective within rural and remote communities, however, limitations need addressed in order to create a sustainable and implementable program which can be accessed by all.

Adults

Another theme identified among many of the articles was the target population group of adult participants and the impact that telehealth services have on adults. Many articles reported rapid advances in the growth of telecommunications and distance technology and the new opportunities that are being presented to address the speech and language needs of adults. Speech-language pathologists are utilising telepractice to offer services to a range of adult patients who experience hearing, speech and communication delays that can be caused by various chronic conditions. Thirty-nine studies had a target population group involving adults. Many noted that telehealth was an effective method in delivering service and assessing treatment needs for people with chronic conditions. Burns et al. (2012) explored the feasibility of access to specialist speech pathology services via telehealth for patients with head and neck cancer and concluded that all cases were effectively managed through telehealth; all patients reported they were comfortable and would use telehealth services again. In addition to this, O'Brian, Packman and Onslow (2008) findings showed that adult participants had an 82% decrease in stuttering frequency right after treatment and 74% decrease six months after treatment. However, the lack of a comparison group made it difficult to conclude if participants would have benefited more from conventional delivery of the program.

Paediatrics

The target population of children was another theme among the articles in this review. Telehealth services identified in this theme were designed to assist in connecting children to various health care services such as video, audio or images.

In the article titled, 'Web based tele-rehabilitation assessment of receptive language' by Anderson (2017), the reliability of a web based telerehabilitation approach of assessing a child's receptive language abilities was explored. Nil significant difference between the web-based and traditional face-to-face method was identified. Validating the use of telehealth is required to ensure web-based methods are accepted by the broader population. Furthermore, Fairweather, Lincoln and Ramsden's (2016) study highlighted that partaking in a speech-language teletherapy program through videoconferencing improves the speech and language skills in primary school children and early childhood. However, limitations were observed, such as the small sample size and nil comparative group; although the sample size was larger compared to past studies.

Regarding the progression of technology in speech pathology the study, "Talking to Teo: video game supported speech therapy" (Navarro-Newball et al., 2014), developed a video game to deliver speech therapy to children. Therapy is commonly directed by the therapist during in-person sessions and children/parents may find this approach uninteresting, stressful or unaffordable. The development of 'Talking to Teo', intended to provide verbal therapy and educational objectives for rehabilitating children with early diagnosed hearing disability, had the aim of improving the intelligibility and naturalness in voice features. Overall findings showed that there is substantial evidence supporting telehealth methods in delivering speech-language pathology services to children, yet studies are limited, and further research is necessary to showcase the effectiveness of telehealth methods in a paediatric population.

Changes to service delivery

Another major theme discussed by many authors was the transition from a traditional approach to one which integrates telehealth into the overall service delivery of speech-language therapy. Traditional means of treatment include aspects such as face-to-face therapy, therapy delivered in a clinic or community health centre and therapy which integrates a multidisciplinary team of health professionals. Many telehealth services utilise digital platforms such as the internet, email, audio-visual conferencing and mobile applications. Combining telehealth with speech-language therapy in order to treat speech-language disorders at a distance warrants investigation with regards to its overall impact on health outcomes. All articles made predictions about the future of telehealth services in speech-language pathology; 28 key articles provided an analysis of the impact a change to service delivery may make. Papers not included in this review contained key insights as to what future speech-language pathology services may exist. As they are mere predictions, they were not included in this scoping review. A brief discussion of these articles and eBooks is highlighted later in this report.

Home-based Interventions

Seventeen articles focused on home-based interventions which utilised telehealth to produce speech-language pathology outcomes. Studies that involved participants presenting to a telehealth-enabled clinic have been excluded from this section. Table 3 categorises which technology interventions were utilised by telehealth for therapy purposes within the home (refer Table 3).

Real-time videoconferencing was the most popular form of home-based teletherapy. The use of visual and audio technologies, delivered in a present setting, appears to have

multiple benefits on the recipient of the intervention. As confirmed in the study by Guo et al. (2017) titled, "Assessment of Aphasia Across the International Classification of Functioning, Disability and Health Using an iPad-Based Application", videoconferencing is an effective way for individuals to access professional advice and treatment from within the home. Their iPad application, Access2Aphasia, allowed consumers to communicate and interact with speech-language pathologists in real-time videoconferencing. A benefit of this study was that consumer satisfaction was high and its efficacy was also confirmed by participating speech-language pathologists. More research is needed to refine the complications associated with technology; such as cutting out, disconnection during a call or frozen images.

Table 3

Categorisation of the technology utilised in specific articles

Technology	**Corresponding articles (titles only)**
Real-time Videoconferencing	• Home-based speech treatment for Parkinson's disease delivered remotely: a case report • Delivery of Intensive Voice Therapy for Vocal Fold Nodules Via Telepractice: A Pilot Feasibility and Efficacy Study • Successful remote delivery of a treatment for phonological alexia via telerehab • Service Evaluation of the Use of Assistive Technology to Deliver Speech and Language Therapy to People with Aphasia in Buckinghamshire • Telehealth delivery of Rapid Syllable Transitions (ReST) treatment for childhood apraxia of speech • Webcam Delivery of the Camperdown Program for Adolescents Who Stutter: A Phase II Trial
Webpages/online therapy exercises	• Web-based telerehabilitation assessment of receptive language • Evaluating the Feasibility and the Potential Efficacy of e-Learning-Based Speech Therapy (EST) as a Web Application for Speech Training in Dysarthric Patients with Parkinson's Disease- A Case Study • Combining Teletherapy and On-line Language Exercises in the Treatment of Chronic Aphasia: An Outcome Study
Telephone	• A Phase II Trial of Telehealth Delivery of the Lidcombe Program of Early Stuttering Intervention • Telehealth Delivery of the Camperdown Program for Adults Who Stutter: A Phase II Trial
Email	• The use of email as a component of adult stammering therapy: a preliminary report
Mobile or Tablet applications	• Assessment of Aphasia Across the International Classification of Functioning, Disability and Health Using an iPad-Based Application • Refining an Asynchronous Telerehabilitation Platform for Speech-Language Pathology: Engaging End-Users in the Process

	• Provision of Speech-Language Pathology Telepractice Services Using Apple iPads • Features and Quality of a Mobile Application Employed in a Speech-Language Therapy
Computer-based Play Character	• Secure Telemonitoring System for Delivering Telerehabilitation Therapy to Enhance Children's Communication Function to Home

Allen (2011) followed sixteen participants who used email in order to communicate as part of their therapy. Since 2004, the participants shifted from traditional face-to-face therapy to communication via online services. This shift in service delivery creates a feasible, alternate method of communication. This longitudinal study strengthens validity and supports the use of telehealth services within speech-language pathology as a means of follow-up.

O'Brian, Packman and Onslow's (2008) study also used email to follow-up the participants. Their trial predominately focused on telephone calls made between patients and speech-language pathologists and also involved the use of email to communicate. It was found that 82% of the ten adults who participated reduced their stuttering immediately after therapy, and there was a 74% reduction six months after therapy.

Interactive webpages and online resources are another way therapy can be delivered via telehealth. An article published by Beijer et al. (2010), titled "Evaluating the Feasibility and the Potential Efficacy of e-Learning-Based Speech Therapy (EST) as a Web Application for Speech Training in Dysarthric Patients with Parkinson's Disease: A Case Study" highlighted how 'independent speech' can be achieved through a web application. A 69-year-old male accessed the application with his personal laptop and aimed to improve his overall speech intelligibility after being diagnosed with Parkinson's. The application was effective in improving the patient's speech intelligibility and can be seen as a viable method of therapy. It should be noted that whilst webpages offer worthy information or activities for participants to access, it can often be difficult navigating through them. Steele et al. (2014) expressed concerns with the potential efficacy of web-based applications in the treatment of chronic aphasia.

One computer-based character role-play therapy was identified as a home-based intervention. This intervention was aimed at improving communication skills and verbal interaction in children. "Secure Telemonitoring System for Delivering Telerehabilitation Therapy to Enhance Children's Communication Function to Home" by Parmanto et al. (2008) explored the CosmoBot play and learn game. This interactive game engaged four participants and their progress was recorded and evaluated by the speech pathologist. This article, when compared to others, acts as a standalone intervention for a number of reasons. The first and foremost being that it was targeted at children with disabilities such as Autism Spectrum Disorder.

Lastly, mobile or tablet applications offer therapy in the palm of consumers' hands. iPad applications such as Access2Aphasia (Guo, et al., 2017) are easily accessible individuals with the appropriate equipment. Being able to speak to speech-language pathologists in real-time is a significant step to achieving immediate therapy for voice disorders. The addition of touch screens can make a program more interactive and visually stimulating. In a study conducted by Hill and Breslin (2016), titled "Refining an Asynchronous Telerehabilitation Platform for Speech-Language Pathology: Engaging End-Users in the Process", participant satisfaction across multiple categories was high. All participants were comfortable using the program confidently, however, navigating technical issues such as using the scroll bar were persistent. Software issues within technology is a constantly evolving process, so consumer feedback to enhance the quality of these services is fundamental in creating a successful application. Ultimately, the option and opportunity to have access to these iPad applications was significantly supported by participants of the study.

Whilst telehealth in the home environment can promote comfort, increase accessibility to assistance and allow the individual to schedule their therapy in a timely manner, many complications can arise from home-based interventions. For example,

telehealth services often incur an out-of-pocket cost paid by the consumer as Medicare and other government bodies currently does not fully reimburse all telehealth services. Moreover, if patients do not own the technology such as a laptop, computer or webcam, they need to buy the appropriate technology in order to participate. This would not be funded by government bodies and would come at a large cost to the individual. By purchasing the appropriate technology relevant to the telehealth service, the patient must then be competent in using the equipment and navigating through programs. This could lead to more complications, specifically if the patient is elderly or unfamiliar with technology. However, in a study conducted by Isaki and Fangman Farrell (2015), titled "Provision of Speech-Language Pathology Telepractice Services Using Apple iPads", participants were trained prior to returning home in order to understand how the mobile application worked. This is a crucial aspect when implementing a home-based intervention, as it strengthens the users' abilities and understanding of therapy technology.

Another issue with home-based interventions arises when there are technological difficulties present. As previously discussed, many studies experienced applications closing unexpectedly, images freezing or phone calls disconnecting. This can cause frustration for patients and lead to noncompliance with their therapy program. In addition, it was necessary to have an internet connection across all studies. This, as previously mentioned could cause complications for those living in rural and remote areas due to slower internet speeds and limited choice of internet providers. Furthermore, patients may not have an internet connection that can be readily troubleshooted or may not have correct access to equipment depending on where they reside. Future studies may explore whether an application could operate without a stable internet connection. Ultimately, home based interventions have high consumer satisfaction, high speech-language pathologist satisfaction and show an overall improvement of treating and managing voice and swallowing disorders.

Articles not included

A number of articles discussed (hypothetically) the implementation and sustainability of telehealth programs for individuals with speech and communication disorders. For example, in an article by Tindall (2014) titled "Initiating and Sustaining a Telepractice Program for Individuals with Aphasia", many suggestions were made in order to create an effective telehealth service (the article was found in the eBook published by Todd Houston [2014]). To create an effective telehealth intervention, Tindall (2014) suggested aspects such as environment, technology, business plan, staff preparation and marketing. These aspects are critical when implementing any service within a business, however, the skills speech-language pathologists need, require learning, adapting and altering methods to improve the outcomes of their clients. These findings act as a standard that telehealth services can work towards in order to implement and sustain successful programs all over the world. By resting principles on these future recommendations, further research, design and development of these services can be refined and integrated into a clinical, or long-distance setting. Future recommendations for telehealth services within speech-language pathology should be frequently considered as there appears to be multiple benefits of utilising telehealth within speech-language pathology.

Other articles deemed relevant explored the lack of discussion with regards to the cost effectiveness of implementing telehealth services to improve speech-language outcomes. Little-to-no discussion was provided about the cost of transitioning from a traditional face-to-face approach compared with a service delivered via telehealth across multiple studies. Cost effective programs were deemed to be essential for the implementation of telehealth services, as they increase access for a broader range of individuals and families.

The biggest advantage for changes to service development are for those living in rural and remote areas. As mentioned previously, those living in rural and remote areas experience disadvantage when accessing services from a speech-language pathologist (Edwards, Stredler-Brown & Houston, 2012).

A number of countries have explored the benefits and limitations of telehealth in speech-language pathology. Countries that have implemented telehealth services in speech-language pathology are making advancements into the diversity of treatment options and expanding the way in which people access health care. Table 4 summarises the countries from which the articles/studies took place (see Table 4).

Table 4

Number of articles from specific countries (alphabetical order)

Country	**Number of studies**
Australia	33
Brazil	1
Canada	2
Croatia	3
England	2
Greece	1
Ireland	1
Netherlands	2
Scotland	1
Singapore	1
United States of America	32

Qualitative data from participants; parents, children and speech pathologists, is fundamental in the development of telehealth interventions. This data provides researchers with feedback for what should be implemented within a program; feedback should be regularly sought after in order for interventions to be reassessed and adjusted accordingly.

Discussion and Conclusion

The purpose of this scoping review was to summarise the key findings of the relevant literature pertaining to the application of telehealth services in speech-language pathology. There were many aspects of the relationship between telehealth and speech-language pathology that were prominent across over 200 articles. The database search for this review produced a large number of results. A discussion of each article could not be achieved given the limited amount of time taken to complete this review. Whilst a discussion of the key themes surrounding the literature was appropriate it was difficult to provide an in-depth review of each article. In the future, a more specific, targeted research question would have helped shaped the results into a more specific review.

The large number of results highlights the expanding research behind telehealth in speech-language pathology and warrants further investigation in years to come. Ultimately, the review highlights six key themes which are relevant to speech-language pathology and telehealth, and forms a basis for future reviews. This wide range of literature suggests that telehealth in speech-language pathology is continuously evolving and research into the effectiveness of these services is increasing. In addition, the literature also suggests that speech-language pathologists utilise telehealth services, however, more research needs to be conducted in order to evaluate the cost of these services. Evidence suggests in multiple ways, that telehealth provides an alternate service, which produces efficacious results in speech-language pathology outcomes.

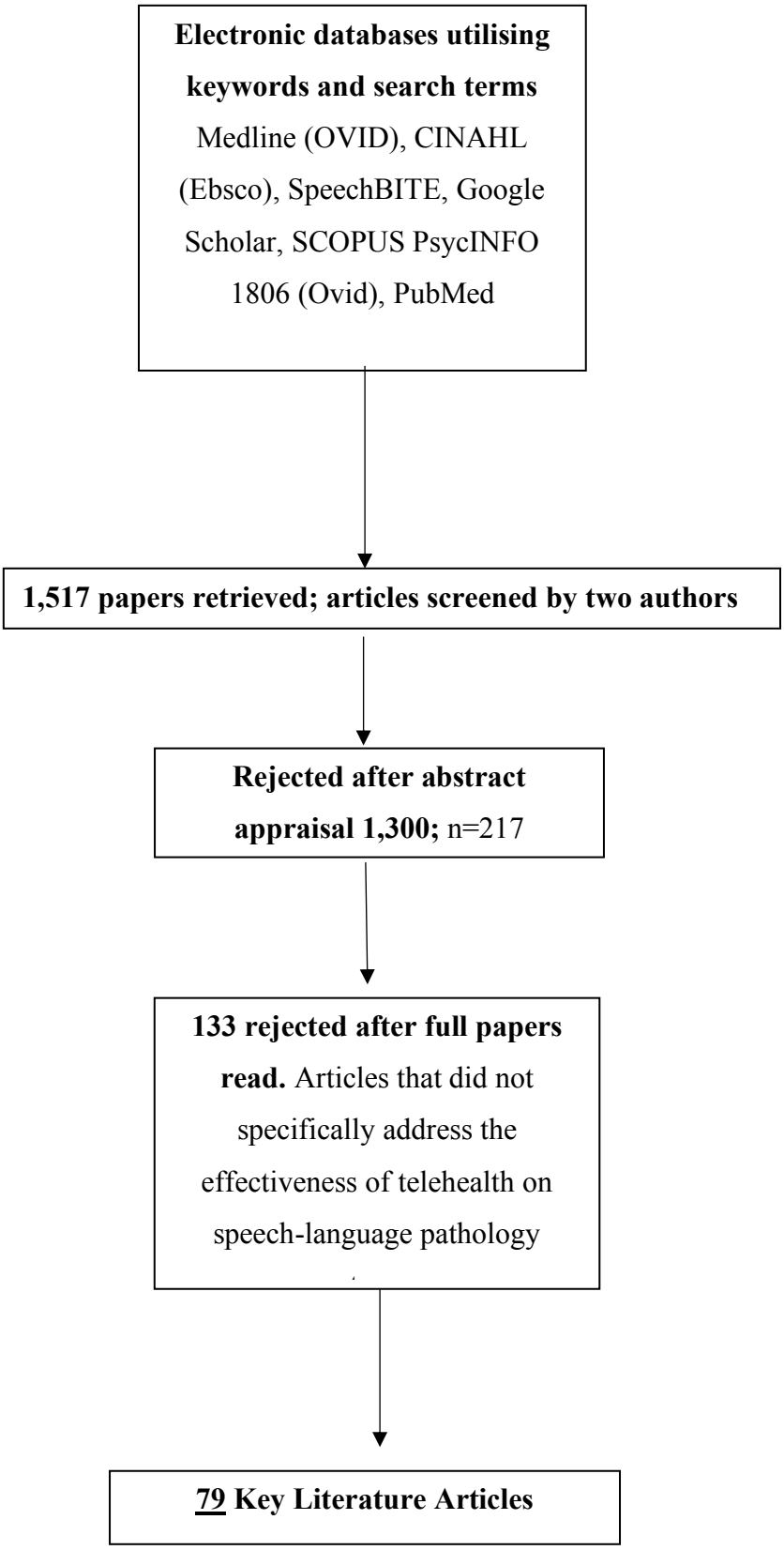
Moreover, before implementing a telehealth approach within a clinical setting, it is crucial that speech-language pathologists are familiar with and are competent using equipment, navigating through software and programs and ensuring the best quality of care is taken with their clients. Whilst speech-language pathology delivered via telehealth is still under investigation, the evidence appears promising. Ultimately, more research needs to be

conducted in order to develop, refine and better incorporate telehealth interventions as part of speech-language pathology services.

- o O o -

Appendix A

Scoping Review Selection process



Appendix B

Videoconferencing applications used by studies

Video-conferencing application	**Articles noting this application (titles only)**
Skype	1. Delivery of Intensive Voice Therapy for Vocal Fold Nodules Via Tele-practice: A Pilot Feasibility and Efficacy Study 2. The Lee Silverman voice treatment delivered via distance therapy
Webcam	3. Webcam delivery of the Lidcombe program for early stuttering: A phase I clinical trial 4. Webcam Delivery of the Camperdown Program for Adolescents Who Stutter: A Phase II Trial
Real-time Videoconferencing	5. Home-based speech treatment for Parkinson's Disease delivered remotely: a case report. 6. Expanding use of telepractice in speech-language pathology and audiology. 7. Successful remote delivery of a treatment for phonological alexia via telerehab 8. A pilot study comparing the effectiveness of speech-language therapy provided by telemedicine with conventional on-site therapy 9. A Pilot Exploration of Speech Sound Disorder Intervention Delivered by Telehealth to School–Age Children 10. A Comparison of Speech Sound Intervention Delivered by Telepractice and Side-by-Side Service Delivery Models 11. An internet-based Telerehabilitation System for the Assessment of Motor Speech Disorders- A Pilot Study 12. The Redesign and Re-evaluation of an Internet-Based Telerehabilitation System for the Assessment of Dysarthria in Adults 13. A Phase II Trial of Telehealth Delivery of the Lidcombe Program of Early Stuttering Intervention 14. Telehealth: Voice Therapy Using Telecommunications Technology 15. The Use of Video-Teleconferencing to Deliver Voice Therapy At-A-Distance 16. Computer-based treatment of poststroke language disorders: a non-inferiority study of telerehabilitation compared to in-person service delivery 17. Equivalence of functional communication assessment in speech pathology using videoconferencing 18. Efficacy of Using Telepractice Via the Internet to Assess Children's Language Abilities 19. Assessing Swallowing Disorders Online: A Pilot Telerehabilitation Study 20. Feasibility and outcome evaluation of a telemedicine application in speech–language pathology 21. Combining teletherapy and on-line language exercises in the treatment of chronic aphasia: an outcome study. 22. Telehealth language assessments using consumer grade equipment in rural and urban settings: Feasible, reliable and well tolerated 23. LSHSS Internet-Based Telehealth Assessment of Language Using the CELF–4 24. Assessing children's speech intelligibility and oral structures, and functions via an Internet-based telehealth system 25. Validity of Conducting Clinical Dysphagia Assessment for Patients with Normal to Mild Cognitive Impairment Via Telerehabilitation

	26. Telemedicine as a Means of Effective Speech Evaluation for Cleft Palate Patients 27. Using telerehabilitation to assess apraxia of speech in adults 28. Treating disordered speech and voice in Parkinson's disease online: a randomized controlled non-inferiority trial 29. Assessing disordered speech and voice in Parkinson's disease: a telerehabilitation application
Adobe connect	30. Speech-language pathology teletherapy in rural and remote educational settings: Decreasing service inequities 31. Telehealth delivery of Rapid Syllable Transitions (ReST) treatment for childhood apraxia of speech
Facetime	32. A Multisite Study Evaluating the Benefits of Early Intervention via Telepractice
Zoom	33. An Examination of Quality of Life and Communication Confidence in Aphasia through Telehealth Communication Groups
Mobile/telephone	34. A pilot trial of a speech pathology telehealth service for head and neck cancer patients 35. Telehealth delivery of the Camperdown Program for adults who stutter: a phase I trial 36. Features and Quality of a Mobile Application Employed in a Speech-Language Therapy 37. Randomized controlled non-inferiority trial of a telehealth treatment for chronic stuttering: the Camperdown Program
Television	38. Efficacy of language assessment in Alzheimer's disease: comparing in-person examination and telemedicine.
Computer web-based	39.Online Communication Training for Parents of Children with Autism Spectrum Disorder
iPad	40. Assessment of Aphasia Across the International Classification of Functioning, Disability and Health Using an iPad-Based Application

Appendix C

Literature summaries and thematic codes

ARTICLE	AUTHOR/S (YEAR)	KEY POINTS	THEMATIC CODING
The use of email as a component of adult stammering therapy: a preliminary report	Allen, C. R. (2011)	-16 clients have used email via means of communication as part of their therapy programme for stammering -This study found that whilst email is an effective, implementable method of treating adults who stammer, more research is needed to assess the ethical considerations with regards to clinical practice.	3, 6
Web-based telerehabilitation assessment of receptive language	Anderson, A. (2014)	- This study tested the reliability of the Peabody Picture Vocabulary Test administered via traditional paper assessment and a version available as a web design - This study found no significant statistical difference in time, raw or standard scores, however, serves as a backbone for future studies	4, 6
Alternative service delivery models for families with a new speech generating device: Perspectives of parents and therapists	Anderson, K. L., Balandin, S., & Stancliffe, R. J. (2015)	-This study explored the opinions of parents and speech pathologists with regards to an alternate method of traditional, face-to-face therapy sessions. Participants were required to fill out questionnaires which explored their feelings toward telehealth -This study concluded that the utilisation of alternate services is beneficial for those living in rural/remote areas	5, 3, 2
The Next 10 Years in Voice Evaluation and Treatment	Barkmeier-Kraemer, J. M., & Patel, R. R. (2016)	-Predictions for future speech-language outcomes were made, as technological advances continue to improve the overall effectiveness of speech related issues. -Literature on the efficacy and effectiveness of telehealth for voice treatment is not extensive, telehealth appears to be utilised to deliver voice therapy with comparable levels of treatment outcomes	5
Management of Communication Disorders Using Family Member Input, Group Treatment and	Baron, C., Hatfield, B., & Georgeadis, A. (2005)	-Explored three techniques designed to improve speech-language outcomes; management via telehealth, use of family member input to drive therapy and management of disorders via group treatment	1, 5, 2

Telerehabilitation		-Telerehabilitation can be seen as a feasible technique to implement, in order to expand access and to address functional goals	
A Multisite Study Evaluating the Benefits of Early Intervention via tele-practice	Behl, D., Blaiser, K., Cook, G., Barrett, T., Callow-Heusser, C., & Brooks, B. et al.. (2017).	-This study determined the effectiveness of tele-practice as an approach in delivering early intervention services to families of infants and toddlers who are deaf or hard of hearing. Forty-eight participants were involved in the study and the intervention period for this study was 6 months. -Higher statistical significance was achieved in children in the tele-practice group in comparison to the children in the in-person group on the PLS-5 receptive language subscale and PLS-5 total language standard scores but both groups scored comparably on other language measures.	1, 4
Evaluating the Feasibility and the Potential Efficacy of e-Learning-Based Speech Therapy (EST) as a Web Application for Speech Training in Dysarthric Patients with Parkinson's Disease- A Case Study	Beijer, L. J., Rietveld, T. C. M., Hoskam, V., Geurts, A. C. H., de-Swart, B. J. M. (2010)	-Participants were required to use EST in their home environment in order to achieve independent speech. A questionnaire was then provided to participants about their personal experience with EST, its suitability for other patients and the satisfaction with the program. -It was found that the patient was able to effectively navigate through EST and the questionnaire, however a larger population sample is needed to explore its clinical value and reliability.	3, 6
A pilot trial of a speech pathology telehealth service for head and neck cancer patients	Burns, C. L., Ward, E. C., Hill, A. J., Malcom, K., Bassett, L., Kenny, L. M., & Greenup, P. (2012)	-18 patients with head and neck cancer participated in 50 telehealth sessions over a 5-month period. These sessions involved video conferencing with specialist speech pathologists in order to improve swallowing and or communication. - It was found that patients were satisfied with the quality of the auditory and visual system and they would feel comfortable utilising telehealth services in the future	1, 5, 3
Randomized controlled non-inferiority trial of a telehealth treatment for chronic stuttering: the Camperdown Program	Carey, B., O'Brian, S., Onslow, M., Block, S., Jones, M., & Packman, A. (2010)	-40 adults who stutter were allocated to one of two groups; one group received telehealth therapy and the other received face-to-face therapy. Participants received individual teaching sessions, group practice days, individual problem-solving sessions and maintenance of their stutter. This was delivered face-to-face, over the phone, through audio-visual platforms or through mail.	1, 5

		-The results showed that telehealth delivery of the Camperdown Program is viable for future implementation in adults who stutter. This study also found that when using this model, a speech-language pathologist is likely to spend more than two hours less per client. This statistically significant finding showed that telehealth services allows individuals to travel through the exercises at their own pace and therefore increasing their abilities.	
Webcam Delivery of the Camperdown Program for Adolescents Who Stutter: A Phase II Trial	Carey, B., O'Brian, S., Lowe, R., & Onslow, M. (2014)	-16 adolescent boys who stutter participated in this study. This study was solely based upon the delivery of the Camperdown Program via a webcam and involved weekly sessions of up to 60 minutes. The participants could access treatment in their home via a laptop. -It was found that the group significantly reduced their stuttering in terms of frequency and severity. The majority of the data suggested that participants showed a preference in utilising therapy services via a laptop or electronic device.	1, 6
Oral Reading for Language in Aphasia (ORLA): Evaluating the Efficacy of Computer-Delivered Therapy in Chronic Nonfluent Aphasia	Cherney, L. (2010)	-Compared the ORLA delivered by computer to individuals with chronic nonfluent aphasia to delivery via a speech-language pathologist. -It was found that low intensity ORLA delivered to these individuals via computer is efficacious and warrants further research	5, 3
Tele-rehabilitation, Virtual Therapists, and Acquired Neurologic Speech and Language Disorders	Cherney, L., & van Vuuren, S. (2012).	-This article reviewed evidence linked to acquired neurological speech and language disorders in adults and concentrated on studies that had been published since 2000. Articles included in the review contained research studies that have used tele-rehab approaches to evaluate and treat disorders including dysarthria, apraxia of speech, aphasia, and mild Alzheimer's disease. -The articles demonstrated that tele-rehab is a valid method for providing speech and language services and signified a development of technological progression.	3, 5
Home-based speech treatment for Parkinson's disease delivered remotely: a case report	Constantinescu, G. A., Theodoros, D. G., Russell, T. G., Ward, E. C., Wilson, S.	-A video conferencing system delivered the Lee Silverman Voice Treatment to 1 participant who lived 90km from the speech-language pathologist -The patient felt and achieved an overall improvement in vocal sound, reading and conversational monologue. The patient	1, 2, 3, 6

	J., & Wootton, R. (2009)	additionally reported a preference for online sessions rather than face-to-face therapy. Family member input is critical in motivating and encouraging patients	
Treating disordered speech and voice in Parkinson's disease online: a randomized controlled non-inferiority trial	Constantinescu, G., Theodoros, D., Russell, T., Ward, E., Wilson, S., & Wootton, R. (2011)	-34 adults with Parkinson's disease received the Lee Silverman Voice Treatment (LVST) either online or face-to-face. Participants were required to engage in therapy for 1 hour per day, for four days over a four-week period. -Participant satisfaction was high for this study. This study found that implementing the LSVT online is an effective way in improving the voice and speech of people with Parkinson's disease.	1, 3
Assessing disordered speech and voice in Parkinson's disease: a telerehabilitation application	Constantinescu, G., Theodoros, D., Russell, T., Ward, E., Wilson, S., & Wootton, R. (2010)	-This study investigated the validity and dependability of a tele-rehabilitation application for assessing the speech and voice disorder associated with Parkinson's disease. The study included sixty-one participants with Parkinson's disease and hypokinetic dysarthria, who were assessed online which were delivered through a personal computer-based videoconferencing and face-to-face setting by two speech-language pathologists. -Results showed that majority of parameters, comparable levels of agreement were achieved among online and face-to-face environments and concluded that online assessment of disordered speech and voice in Parkinson's disease seems to be validity and dependable.	1, 3
Online Parent Training to Support Children with Complex Communication Needs	Douglas, S., Nordquist, E., Kammes, R., & Gerde, H. (2017).	-This single-subject study was performed with four parents and their children with developmental disabilities and complex communication needs to establish the efficacy of online parent training in communication partner strategies. Parent participants finished an interactive online training and then participated in live sessions to demonstrate trained skills. -Findings indicated higher score of communication opportunities provided by parents to their children with complex communication needs via online parent training. Increased level was also observed in child communication and responses provided by parents to child communication but varied among participants regarding immediacy, magnitude, maintenance, and generalization of behaviours.	1, 3, 4

Expanding Use of Telepractice in Speech Language Pathology and Audiology	Edwards, M., Stredler-Brown, A., & Todd Houston, K. (2012)	-This review highlights the relevant articles which discuss the effects telepractice has on speech-language pathology and audiology -It was found that the studies all represented telepractice as an effective way to diagnose and treat adults and children. There is need for further research as highlighted by many articles	1, 2, 3, 4, 5
Standalone Internet speech restructuring treatment for adults who stutter: A phase I study	Erickson, S., Block, S., Menzies, R., O'Brian, S., Packman, A., & Onslow, M. (2016)	-Based loosely on the Camperdown Project (see O'Brian et. al), This study recruited individuals who stutter. The nine phases, clinician-free program was implemented entirely via the internet -It was found that participants could complete all nine phases via telehealth and were satisfied with receiving this intervention at a distance	3, 5
Speech-language pathology teletherapy in rural and remote educational settings: Decreasing service inequities	Fairweather, G. C., Lincoln, M. A., & Ramsden, R. (2016)	-This article focused on children in rural New South Wales, receiving speech-language pathology via video-conferencing techniques such as FaceTime, Skype and Adobe Connect. It aimed to decrease the inequities experienced by those living in rural and remote areas. -It was found that parents of participants found teletherapy feasible. Using low-bandwidth video conferencing can improve the speech and language skills of children.	1, 2, 4
Clinicians' perspectives of therapeutic alliance in face-to-face and telepractice speech–language pathology sessions	Freckmann, A., Hines, M., & Lincoln, M. (2017)	-Rated the perception of clinicians' rapport with clients using the Therapeutic Alliance Scales for Children- Revised (TASC-r) and their comfort with using technology. -No significant difference was found between TASC-r scores for telepractice and face to face therapy, nor their confidence when using unfamiliar or familiar technology	4, 5
Delivery of Intensive Voice Therapy for Vocal Fold Nodules Via Telepractice: A Pilot Feasibility and Efficacy Study	Fu, S., Theodoros, D. G., & Ward, E. C. (2015)	-Participants (10 women) who were diagnosed with bilateral vocal fold nodules received intensive voice treatment via the computer/mobile based application Skype, for 8 sessions over 3 weeks. -It was found that telepractice was effective in improving perceptual, vocal fold function, acoustic and physiological parameters. In addition, participants stated that their voice-related quality of life post-treatment was also improved. Comparison to traditional treatment is still being	1, 3, 6

		investigated	
Successful remote delivery of a treatment for phonological alexia via telerehab	Getz, H., Snider, S., Brennan, D., & Friedman, R. (2016)	-Two participants who had phonological alexia following from a stroke were required to partake in telerehabilitation three times per week for approximately 45-60 minutes. The study used a paired-associate design to train reading of problematic words. -It was found that both participants improved significantly of their reading of trained words and reported satisfaction with telerehabilitation,	1, 3, 6
Technology assisted speech and language therapy	Glykas, M., & Chytas, P. (2004)	-The telelogos system, based on the concepts of public awareness, reference and evaluation, aimed to develop speech-language therapists' abilities and creativity when implementing new communication methods. -The telelogos system contributes to the improvement of health services quality, speech and language therapy quality and information technology advancements.	3, 4, 5
A pilot study comparing the effectiveness of speech-language therapy provided by telemedicine with conventional on-site therapy	Grogan-Johnson, S., Alvares, R., Rowan, L., & Creaghead, N. (2010)	-Two groups of 17 children participated in this experiment. One group received four months of telemedicine treatment, then four months of traditional treatment and the other group received four months of traditional therapy and then four months of telemedicine treatment. This study looked to compare the two types of intervention in order to identify the benefits of teletherapy. -There was no significant difference in the results, however, video conferencing seems to be a feasible alternative method of therapy.	1, 4
A Pilot Exploration of Speech Sound Disorder Intervention Delivered by Telehealth to School–Age Children	Grogan Johnson, S., Gabel, R. M., […] Schenker, J. (2011)	-13 children aged 6-11 with speech sound impairment participated in this study. Speech-language pathologists implemented a traditional approach and an e-helper assisted the children navigating their way through the computer based intervention. -Students within the telehealth group received greater mastery in their Individual Education Plan goals, however, both groups improved significantly with regards to speech and sound production. In a rural and remote area, videoconferencing appears feasible.	1, 4
A Comparison of Speech Sound Intervention	Grogan-Johnson, S., Schmidt, A.	-14 children aged 6-10 with speech sound impairment were required to have 30-minute individual side-by-side or	1, 4

Delivered by Telepractice and Side-by-Side Service Delivery Models	M., Schenker, J., Alvares, R., Rowan, L. E. & Taylor, J. (2013)	telepractice therapy sessions twice a week over five weeks -The participants improved their speech sound production through traditional therapy regardless of how it was delivered (via face to face or via telepractice). No significant differences were found in performance, however, technology used in the intervention was found to be adequate in treating participants.	
Assessment of Aphasia Across the International Classification of Functioning, Disability and Health Using an iPad-Based Application	Guo, Y. E., Togher, L., Power, E., Hutomo, E., Yang, Y., Tay, A., Yen, S., & Koh, G. C. (2017)	-Access2Aphasia, an iPad-based application allows individuals with Aphasia to communicate in real time with speech-language pathologists. This study aimed to identify Access2Aphasia's reliability and compare it to face to face intervention. 30 individuals with Aphasia participated and were assigned to two different groups; one group utilised the Access2Aphasia application and the second group received face-to-face intervention. -Consumer satisfaction for the application was high and warrants further investigation into the reliability of telehealth services	1, 3, 4, 6
The Lee Silverman voice treatment delivered via distance therapy	Harrington, K. (2012)	-Using teletherapy, this study aimed to identify the efficacy of the Lee Silverman Voice Treatment (LSVT) on improving the vocal loudness in individuals with Parkinson's Disease. Two participants received distance treatment via Skype and three participants received face-to-face treatment. The treatment lasted for 60-minutes per daty, four days a week over a four-week period. The LSVT aims to increase the vocal fold adduction in order to improve vocal loudness and quality -Results differed among all participants especially between the two who received distance therapy. One of the participants made no improvement in vocal loudness and conversational loudness. In the future, a larger sample size is needed in order to effectively assess the efficacy of distance treatment.	1, 3
Expanding Access to Telespeech in Clinical Settings: Inroads and Challenges	Hart, J. (2009)	-This paper discussed the background of telehealth and its current challenges faced, the benefits telehealth provides in a clinical setting and also provided an insight for the future of telehealth. -A major challenge for telehealth services is reimbursement; to implement these services with little to no out-of-pocket cost	5

		to the consumer is a major goal which is seriously under supported.	
Research into telehealth applications in speech-language pathology	Hill, A. & Theodoros, D. (2002)	-This review highlighted the extent to which telehealth has been researched within speech-language pathology. -The cost-effectiveness of many of these studies has gone undiscussed, however, telehealth services indicated positive outcomes for patients.	5
An Internet-Based Telerehabilitation System for the Assessment of Motor Speech Disorders- A Pilot Study	Hill, A. J., Theodoros, D. G., Russell, T. G., Cahill, L. M., Ward, E. C., & Clark, K. M. (2006)	-This study explored the feasibility and effectiveness of an internet-based telerehabilitation application for individuals with acquired neurological impairment who have motor speech disorders -Perceptual assessment battery can be administered reliably through telehealth services.	1, 3
The Redesign and Re-evaluation of an Internet-Based Telerehabilitation System for the Assessment of Dysarthria in Adults	Hill, A. J., Theodoros, D. G., Russell, T. G., & Ward, E. C. (2009)	-Upon results of their previous study, Hill et al. decided to reassess and redesign their original, feasible system. 24 adults were involved in this study. Videoconferencing was used as means of communication with participants and Speech-language pathologists. -It was found overall that assessments of dysarthria in adults is possible through telehealth.	1, 3, 5
Using telerehabilitation to assess apraxia of speech in adults	Hill, A. J., Theodoros, D. G., Russell, T. G., & Ward, E. C. (2009)	-This study aimed to determine whether using a standardised assessment tool via telehealth was feasible in the assessment of apraxia of speech. 11 adults with apraxia were assessed using the Apraxia Battery for Adults-2 (ABA-2) in either a face-to-face setting or through videoconferencing. -It was found that patient satisfaction was generally positive in terms of telehealth being a viable method for assessment. A larger sample size was needed in order to confirm the reliability of the study.	1, 3
Refining an Asynchronous Telerehabilitation Platform for Speech-Language Pathology: Engaging End-Users in the Process	Hill, A. J., & Breslin, H. M. (2016)	-This study utilised the eSALT system, an application which allows speech-language pathologists to design and individualise therapy tasks which are transferable to patients' mobile devices. Patients used the eSALT program for three weeks and then engaged in interviews relating to the satisfaction and usability of the platform -It was found that the eSALT system is an effective way for speech-language pathologists to implement and manage	3, 5, 6

		their clients programs at a distance through technology	
Speech pathologists' perspectives on transitioning to telepractice: What factors promote acceptance?	Hines, M, Lincoln, M., Ramsden, R., Martinovich, J., & Fairweather, C. (2015)	-15 speech-language pathologists were interviewed about their transition to telepractice and their overall opinion of alternate methods of therapy -Participants were initially cautious about telecommunications being unable to create rapport with their clients, especially children, however, concluded that telepractice is feasible, reliable and effective within their field.	5
Provision of Speech-Language Pathology Telepractice Services Using Apple iPads	Isaki, E., & Farrell, C. F. (2015).	-A total of nine participants (5 children, 4 adults) with communication difficulties were provided with technological services within a university setting, over two study semesters. -Many difficulties, such as freezing or skipping images on the iPad made it difficult to confirm the feasibility of this research. It was found, however, that many participants did in fact meet the majority of their goals.	3, 4, 6
Telehealth Technology Applicant ions in Speech-Language Pathology	Keck, C. S., & Doarn, C. R. (2014).	-This literature review focussed on articles based on telehealth in speech-language pathology settings, ranging across a five-year period (2008-2013). It explored the challenges, benefits and areas for improvement with regards to telehealth services and speech-language pathology outcomes. -It was found that telehealth is a rapidly growing service which largely benefits those living in rural and remote areas by enabling access to services	1, 2, 3, 4, 5
Effectiveness of delivering speech and language services via telehealth	Labute, J. (2011).	-The Camperdown Program, the Lidcombe Program, the ISTAR program and other voice assessments were all investigated to determine the overall effectiveness of telehealth delivery in speech-language pathology -The review highlighted six key articles which all explore the effectiveness of telehealth within speech-language pathology outcomes. Most articles highlighted the benefits of telehealth services and all recommended that telehealth needs further investigation when evaluating its effectiveness in speech-language pathology settings	5
A Phase II Trial of Telehealth Delivery of the Lidcombe	Lewis, C., Packman, A., Onslow, M.,	-This study compared The Lidcombe Program (a program which had been altered in order to be delivered	1, 2, 4, 6

Program of Early Stuttering Intervention	Simpson, J. M., & Jones, M. (2008)	electronically) with a control group who received the therapy face-to-face -Telehealth delivery of this program requires around 3 times more resources than standard intervention. Delivery of The Lidcombe Program via telehealth was effective in treating stuttering.	
Review of Telehealth Stuttering Management	Lowe, R., O'Brian, S., & Onslow, M. (2013)	-This review explored the management of stuttering via telehealth services -The review concluded that further research about telehealth and stuttering is needed. This further research would help to improve the efficacy of assessment procedures using telehealth	5
Evaluating the Benefits of Aphasia Intervention Delivered in Virtual Reality: Results of a Quasi-Randomised Study	Marshall, J., Booth, T., Devane, N., Galliers, J., Greenwood, H., Hilari, K. […] Woolf, C. (2016)	-This study utilised a virtual reality platform called EVA Park. Twenty adults with Aphasia participated in this study. The study aimed to stimulate conversation via a virtual reality platform where participants were able to communicate with each other at any time. -It was found that all participants showed compliance to this study, however, confidence in communication did not differ between those who did and did not receive the treatment. The full potential of virtual reality studies needs to be explored.	3
Telehealth: Voice Therapy Using Telecommunications Technology	Mashima, P. A., Birkmire-Peters, D. P., Syms, M. J., Holtel, M. R., Burgess, L. P., & Peters, L. J. (2003)	-72 adults with voice disorders participated in individual voice therapy. They were placed in either the conventional group or the remote video teleconference (VTC) group -No significant difference was found when comparing the two groups. There were differences in participants' abilities pre- and post-treatment	1, 3
Overview of Telehealth Activities in Speech-Language Pathology	Mashima, P. A., & Doarn, C. R. (2008).	-This literature review explored the current evidence of the application of telehealth to a clinical speech-language pathology setting. 40 key articles were found and a discussion of the key themes were addressed. -It was found that whilst telehealth in speech-language pathology is favourable, more clinical trials are needed in order to validate the clinical efficacy and outcomes, as well as evaluating the cost of different services.	5
Remote Management of Voice and Swallowing Disorders	Mashima, P. A., & Brown, J. E. (2011)	-This article highlighted the importance telehealth has on voice disorders on those living in rural and remote areas. The shortage of Speech-Language Pathologists (SLPs) in rural areas implies that individuals residing in these areas are not	2, 5

		receiving the appropriate treatment needed. -It was found that telehealth is a feasible option for those living in rural and remote areas, however, many factors such as cost, shortages and technical requirements need to be considered before implementing specific telehealth programs.	
The Use of Video Teleconferencing to Deliver Voice Therapy At-A-Distance	Mashima, P. A. (2011)	-There were 31 participants involved in this study. 19 participants received voice therapy via video teleconferencing and 12 participants received voice therapy at an urban medical centre in person. -It was found that the telehealth service appears to be feasible based upon qualitative analysis of data. However, successful operation of this program is met with multiple barriers such as personnel, equipment, technical issues and workflow issues.	1, 3
Computer based treatment of post stroke language disorders: a non-inferiority study of tele-rehabilitation compared to in-person service delivery	Meltzer, J. A., Baird, A. J., Steel, R. D., & Harvey, S. J. (2017)	-44 participants with aphasia or cognitive-linguistic communication disorder were required to participate in 1 hour, weekly sessions with a speech therapist over 10 weeks. Both groups had homework to complete throughout this study -Equivalent gains for those who received face-to-face treatment compared with those who received telehealth therapy were achieved. Computer-based treatment is seen as effective in improve speech-language outcomes for those who have had a stroke.	1, 3
Talking to Teo: Video game supported speech therapy	Navarro-Newball, A., Loaiza, D., Oviedo, C., Castillo, A., Portilla, A., Linares, D., & Alvarez, G. (2014)	-This study explored a video game as means to improve communication, as games are more interactive and engaging for children than traditional therapy. The game evaluated voice production and provided feedback. In addition, the game allowed therapists to understand the child's progress and administer exercises accordingly. -The game had positive response from children and one mother and therapist and also implied that it is a suitable tool to encourage therapy. Further evaluation of this program is needed in order to address its clinical implications	4, 5
Telehealth Delivery of the Camperdown Program for Adults Who Stutter: A Phase I Trial	O'Brian, S., Packman, A., & Onslow, M. (2008)	-The Camperdown Program is an initiative which involves speech restructuring. This study aimed to deliver the camperdown program via videoconferencing, to 10 adults who stuttered. -The treating therapist never met any of the 10 participants face to face throughout	1, 3, 5, 6

		the program. It was found that the group as a whole had an 82% reduction in stuttering frequency from pre-treatment to post-treatment and 74% reduction in stuttering 6 months post-treatment. The telehealth delivery of the Camperdown Program can reduce stuttering, however, further research is needed	
Webcam Delivery of the Lidcombe Program for Early Stuttering: A Phase I Clinical Trial	O'Brian, S., Smith, K.., & Onslow, M. (2014)	-3 preschool children who stuttered received speech treatment via webcam in their homes. They received this treatment via videoconferencing as they were unable to attend clinics due to their geographical location -This study showed that the Lidcombe Program when delivered via teletherapy was efficacious, practical and viable, however further testing is needed.	1, 2, 4
Features and Quality of a Mobile Application Employed in a Speech-Language Therapy	Orehočki, T., Vukovac, D. P, Stapić, Z., & Novosel-Herceg, T. (2017)	-mLogoped, a mobile application for delivering remote speech-language pathology therapies was introduced in this paper. Participants were parents of children diagnosed with speech-language disorders. mLogoped is a platform that enables speech therapists to deliver therapy to their patients via video. -9 parents were involved in this study. 77.78% of participants found that mLogoped is designed appropriately for its target audience and 66.67% of participants would recommend mLogoped to other people who may benefit from its use. Further research should be carried out in order to identify mLogoped's full potential	1, 3, 4, 6
Technology and the evolution of clinical methods for stuttering	Packman, A., & Meredith, G. (2011)	-This article explored how new practices and technologies are being accepted into speech-language pathology practice and service delivery. Additionally, it discussed how people who can experience stuttering can retrieve information about stuttering on the internet and outline the principles and practice of telehealth delivery of services for people who stutter and their families. -Telehealth is a rapidly growing practice which, with the help of future studies can become feasible and affordable in the future.	2, 5
Investigating optimal intervention intensity with the Lidcombe Program of early stuttering intervention	Packman, A., & Onslow, M. (2012)	-This article focussed on optimal intervention intensity in stuttering in regard to the Lidcombe Program of early stuttering intervention. This is a program in which parents delivered the treatment for a period of time each day.	3, 4

		-Results showed that telehealth delivery was equally effective as the face to face delivery but required three hours of the clinician's time. Delivery in groups was also equally effective and used three hours less of the clinician's time.	
Equivalence of functional communication assessment in speech pathology using videoconferencing	Palsbo, S. E. (2007)	-This study assessed the We examined the equality of videoconferencing assessment of communication by SLPs. twenty-four post-stroke patients were randomized to a remote or face-to-face delivery of the Boston Diagnostic Aphasia Examination and to remote or face-to-face assessment of speech comprehension, speech expression and motor speech. -The findings revealed that assessment of a person's communication via videoconferencing is equal to face-to-face encounter.	1, 3
Secure Telemonitoring System for Delivering Telerehabilitation Therapy to Enhance Children's Communication Function to Home	Parmanto, B., Saptono, A., Murthi, R., Safos, C., & Lathan, C. E. (2008).	-In this article, a secure telemonitoring system was developed to transform CosmoBot system, a stand-alone speech-language therapy software, into a telerehabilitation system. The system is made to increase children's communication skills and prompt verbal interaction during the stages of remediation and also enables the therapist to remotely monitor the therapy sessions of the child and give feedback for the next sessions. -This article can lead to the opportunity for tele-rehabilitation to be implemented in the environment of a home for children in the future.	4, 5, 6
Evaluating a Speech-Language Pathology Technology	Pulga, M. J., Spinardi-Panes, A. C., Lopes-Herrera, S. A., & Maximino, L. P. (2014)	-This study assessed a speech-language pathology technology produced for distance learning. Sixty participants were recruited from three public universities in the state of Sao Paulo, Brazil. Ten students made up the experimental group and the remainder were allocated to the control group. -Results showed that the control group's performance declined compared to participants in the experimental group, who demonstrated improvement in performance. Thus, this study concluded that speech-language pathology technology can complement traditional teaching	3

Telemedicine in Primary Progressive Aphasia	Raiser, T., Croot, K., Nickels, L., Taylor, C., & Danek, A. (2014)	-This article focused on the approaches aimed at reducing and managing the language impairments and communication challenges. -As telemedicine can be shown to produce positive impacts for people with primary progressive aphasia, the approach can be quickly and inexpensively available to many people.	5
Telepractice Versus In-Person Delivery of Voice Therapy for Primary Muscle Tension Dysphonia	Rangarathnam, B., McCullough, G. H., Pickett, H., Zraick, R. I., Tulunary-Ugur, O., & McCullough, K. C (2015)	-This study explored the utility of telepractice for delivering flow phonation exercises to persons with primary muscle tension dysphonia (MTD). the study included fourteen participants with a diagnosis of primary MTD. the participants underwent seven on and remote locations sessions throughout the span of six weeks of flow phonation voice therapy exercises, auditory perceptual, acoustic, aerodynamic, and quality-of-life measures were conducted pre-and post-treatment. -Results revealed perceptual and quality-of-life were significantly improved post treatment and were equal throughout groups. Improvement was also shown in acoustic and aerodynamic, but change was not statistically significant.	3
Telehealth applications in speech-language pathology: a modified narrative review	Reynolds, A., Vick, J. L., & Haak, N. J. (2009)	-This narrative reviewed literature on telehealth applications used in speech-language pathology assessment and treatment. Sixty-two articles were retrieved and five deeming relevant. -The results from the five studies revealed that the service delivery of telehealth was equal to the conventional face-to-face results. Although, telehealth was not a complete replacement for face-to-face service delivery and further research is required.	5
An Exploratory Investigation of e-REST: Teletherapy for Chronically Aphasic Speakers	Ruiter, M. B., Rietveld, T. C. M., Hoskam, V., & van Beers, M. M. (2016)	-This subject study is explored if a teletherapy application called e-REST meets the criteria of accessibility, user-friendliness, as well as effectiveness. e-REST, teaches Dutch chronic aphasic speakers of who struggle with challenges in sentence production to portray their messages in a telegraphic style. -It was concluded by results that it is justifiable to produce a larger study addressing the user-friendliness, accessibility, effectiveness, and cost-effectiveness of e-REST.	5

Efficacy of Using Telepractice Via the Internet to Assess Children's Language Abilities	Salvo, L. (2013)	-This thesis detailed a study on the CELF-4 Screening Test, which is used to assess the general language abilities of children. This was administered via an internet-based telepractice. -Ultimately, telepractice was found to be a viable alternate method of therapy	1, 4
Service Evaluation of the Use of Assistive Technology to Deliver Speech and Language Therapy to People with Aphasia in Buckinghamshire	Sarhan, F., & Nayoan, J. (2013)	-This report assessed the feasibility of teletherapy in the provision of speech and language therapy (SLT) for clients with aphasia who live in Buckinghamshire in their own homes; complementary to the traditional service of face to face therapy, the speech and language therapists identified that teletherapy allowed independence and provided individuals with control over their own SLT. -The intensive tele-therapies were provided the client's home and so the service ultimately decreased hospital appointments and thus decreased travel costs.	1, 6
Tabby Talks: An automated tool for the assessment of childhood apraxia of speech	Shahin, M., Ahmed, B. Parnandi, A., Karappa, V., McKechnie, J., Ballard, K. J., & Gutierrez-Osuna, R. (2015)	-"Tabby Talks," is a multi-tier system for remote delivery of speech therapy. This paper described speech processing pipeline to automatically identify frequent errors related such as pronunciation errors with childhood apraxia of speech. These errors measured can be given therapist through a web interface, to allow the therapist to alter the child's therapy program remotely. -When evaluated on a dataset the approach achieves a pronunciation verification accuracy of 88.2% at the phoneme level and 80.7% at the utterance level, and lexical stress classification rate of 83.3%.	4, 5
Assessing Swallowing Disorders Online: A Pilot Tele-rehabilitation Study	Sharma, S., Ward, E. C., Burns, C., Theodoros, D., & Russell, T. (2011)	-This article provided information on the basic usefulness and validity of performing dysphagia assessments via tele-rehabilitation. Ten actors participated in the study depicting patients with a spectrum of swallowing difficulties to reduce possible risks from unidentified aspiration. -Dysphagia was assessed by a face-to-face (FTF) and tele-rehabilitation speech pathologist and results showed significant levels of agreement between the telerehabilitation speech pathologist and face to face across all parameters of the clinical swallowing examination (CSE). This study indicated that administering a CSE through telerehabilitation has potential to be a feasible and valid method	1, 3

		for the remote assessment of swallowing disorders.	
Feasibility and outcome evaluation of a telemedicine application in speech-language pathology	Sicotte, C. Lehoux, P., Fortier-Blanc, J., & Leblanc, Y. (2003)	-This evaluative study examined the usefulness and outcome of delivering speech–language services in stuttering children and adolescents. The findings showed that interactive videoconferencing provided a valid and effective delivery model. -Participants demonstrated improved fluency, initially stuttering ranged from 13% to 36% pre-treatment and 2% to 26% post-treatment. Each participant preserved part of their improved fluency at the six-month follow up.	1, 4
An Examination of Quality of Life and Communication Confidence in Aphasia through Telehealth Communication Groups	Sparacino, G. (2017)	-This research paper explored the implementation of web-based communication groups to increase quality of life and confidence surrounding communication for people with aphasia via a videoconferencing medium named Zoom. -A paired samples t-test with the use of descriptive statistics showed that significant improvement to overall Communication Confidence Rating Scale for Aphasia (CCRSA) to assess for communication confidence and the American Speech-Language-Hearing Association Quality of Communication Life Scale (ASHA QCL).	1
Combining Teletherapy and On-line Language Exercises in the Treatment of Chronic Aphasia: An Outcome Study	Steele, R. D., Baird, A., McCall, D., & Haynes, L. (2014)	-This 12-week outcome study involved nine participants with long-term chronic aphasia participated in individual and group speech-language tele-therapy services, on-line language exercises to partake in from home in between therapy sessions. -Findings of scores demonstrated that means improved on most measures following treatment, specifically significantly western Aphasia Battery improved, Communicative Effectiveness Index, and Confidence Rating Scale for Aphasia. Independent work increased with time, and user satisfaction following participation was high.	1, 2, 3, 6
Telehealth language assessments using consumer grade equipment in rural and urban settings: Feasible, reliable and well tolerated	Sutherland, R, Trembath, D., Hodge, A., Drevensek, S., Lee, S., Silove, N., & Roberts, J. (2017)	-This study examined the reliability and feasibility of performing language assessments with school-aged children with present or suspected language impairment via a telehealth application using consumer grade computer equipment.	1, 2, 4

		-The results showed support of the use of telehealth regarding language assessment of school-aged children using a web application and commercially available computer equipment. Thus, this service delivered has potential to be utilized by speech pathologists to provide assessments to children in remote communities.	
A review of the efficacy and effectiveness of using telehealth for paediatric speech and language assessment	Taylor, O. D., Armfield, N. R., Dodrill, P. & Smith, A. C. (2014)	-This review reviewed literature relating to the use of telehealth for paediatric speech and language assessment comparison studies and investigated the validity and/or reliability of speech and language assessment via telehealth, when compared with face-to-face assessment. -The papers reviewed presented some evidence that telehealth can be used to make valid assessments of oral motor function, speech intelligibility and language. Articulation screening through telehealth was found to be valid, but there was conflicting evidence about full articulation assessment.	1, 4
Telerehabilitation for service delivery in speech-language pathology	Theodoros, D. G. (2008)	This study presented further development of tele-rehabilitation as such applications and other computer-based therapies as it provided the opportunity to optimize outcomes however to achieve this, the study proposed that cost-benefit and cost-effectiveness analyses, and professional education are needed if tele-rehabilitation is to play a fundamental role in speech-language pathology practice.	5
Telehealth delivery of Rapid Syllable Transitions (ReST) treatment for childhood apraxia of speech	Thomas, D. C., McCabe, P., Ballard, K. J., & Lincoln, M. (2016)	-Five children aged 5-11 with childhood apraxia of speech were required to receive Rapid Syllable Transitions (ReST) treatment four times a week over three weeks via video conferencing. All participants used a home-based computer for therapy -It was found that all children significantly improved their production of speech. Four children maintained their treatment gains for up to four months post-treatment. Telehealth delivery when compared with face-to-face therapy is considered similar.	1, 4, 6
Voice Therapy Telepractice; Voice Care For The 21st Century	Towey, M. (2013)	-This article described three distinct applications of voice tele-practice that broadens the traditional thinking regarding voice therapy and voice therapy tele-practice this article presented examples that demonstrated the efficacy of voice tele-practice that assessed and fit a device for a laryngectomy; complete virtual	3, 5

		musculoskeletal assessment of a voice patient; and provide virtual simultaneous co-treatment in voice therapy. -It was found that telehealth worked will with voice therapy and can be a feasible treatment option in the future.	
Efficacy of language assessment in Alzheimer's disease: comparing in-person examination and telemedicine	Vestal, L., Smith-Olinde, L., Hicks, G., Hutton, T., & Hart, J. (2006)	-This study assessed the effectiveness of language assessment in mild Alzheimer's patients using telemedicine in comparison with conventional in person assessment. -It was found that telehealth can improve voice loudness and communication in individuals with mild Alzheimer's	1, 2, 3
Employing Educational Video in Speech-Language Telerehabilitation with Children: Insights from Interviews with Parents	Vukovac, D. P. (2016)	-This paper discussed the make of educational videos for tele-rehabilitation of paediatric speech disorder (dyslalia) and provided findings of a qualitative section of the pilot study. -The Quantitative data about the quality of the video design were collected from the parents by means of the post-use questionnaire and in this paper, are briefly reported.	1, 4, 5
Inspecting the Quality of Educational Video Artefacts Employed in Speech-Language Pathology Telerehabilitation: A Pilot Study	Vukovac, D. P., Orehovački, T., & Novosel-Herceg, T. (2016)	-This paper described how video artefacts have been designed in relation with the principles of multimedia learning and subsequently employed in tele-rehabilitation of paediatric speech disorder (dyslalia). -Also, it proposed a set of characteristics which greatly affect the successfulness of the practice of educational video artefacts in speech-language pathology online therapies. Lastly it presented and discussed the findings of a pilot study undertaken with the objective to examine the perceived quality of educational video artefacts applied in SLP tele-rehabilitation.	1, 3, 4
Internet-Based Telehealth Assessment of Language Using the Celf-4	Waite, M. C., Theodoros, D. G., Russell, T., & Cahill, L. M. (2010)	-This study constituted an Internet-based telehealth system for assessing childhood language disorders. Twenty-five children ages 5 to 9 years were assessed, every participant was assessed online and in person. -No significant difference was found between the online and face to face total raw scores and scaled scores for each subtest. The results of this study supported the validity and reliability of scoring the core language subtests of the CELF–4 through telehealth.	1, 4
Assessing children's speech intelligibility and oral structures, and functions via	Waite, M. C., Theodoros, D. G., Russell, T.,	-This study assessed the validity and reliability of an Internet-based telehealth system for screening speech intelligibility and oral-motor structure, and function in	1,4

and Internet-based telehealth system	& Cahill, L. M. (2012)	children with speech disorders. Participants included twenty children aged 4-9 year who were assessed by a clinician in the traditional, face-to-face setting additionally, they were assessed by a clinician via the videoconferencing system. -The findings of the investigation supported the effectiveness of screening children with a developmental speech disorder via an Internet-based telehealth system.	
The Efficacy of Telehealth-Delivered Speech and Language Intervention for Primary School-Age Children: A Systematic Review	Wales, D., Skinner, L., & Hayman, M. (2017)	-The purpose of this article is to conclude if telehealth delivered speech-language pathology interventions are as effective as face to face executions in primary school-aged children with speech and/or language challenges. -Results demonstrated both face to face and telehealth and in-person participants showed significant and similar improvements when treatment effects were measured through five of the six outcome measures. Additionally, findings highlighted there is restricted but promising presented evidence to support the delivery of speech-language pathology intervention services to school-age children via telehealth.	4
Validity of Conducting Clinical Dysphagia Assessments for Patients with Normal to Mild Cognitive Impairment via Tele-rehabilitation	Ward, E. C., Sharma, S., Burns, C., Theodoros, D., & Russell, T. (2012)	-This study aimed to examine the validity of performing clinical dysphagia assessments via tele- rehabilitation. Participants included 40 individuals with dysphagia from varying aetiologies were assessed simultaneously in person by a speech-language pathologist and a tele-rehabilitation speech-language pathologist via an Internet-based videoconferencing tele- rehabilitation system. -Results showed that an examination by tele-rehabilitation can produce reliable and accurate outcomes comparable to clinical decisions made in the face to face environment.	1,3
Telemedicine as a Means of Effective Speech Evaluation for Cleft Palate Patients	Whitehead, E., Dorfman, V., Tremper, G., Kramer, A., Sigler, A., & Gosman, A. (2012)	-This study aimed to explore telemedicine to evaluate speech in patients with cleft lip/palate and also determining if a speech evaluation applied by a Speech-Language Pathologist (SLP) using telemedicine would be equal in comparison to an in-person speech evaluation set between in Tijuana, Mexico and San Diego, California. -The results concluded that there was minimal difference between the two for oral muscle tone, resonance, lingual lateralization, oral pressure, and dentition	1, 2, 4

References

Allen, C. R. (2011). The use of email as a component of adult stammering therapy: a preliminary report. *Journal of Telemedicine and Telecare, 17*(4), 163-167. doi:10.1258/jtt.2010.100114

Anderson, A. (2014). *Web-based Telerehabilitation Assessment of Receptive Language* (Master thesis, Washington State University). Retrieved from https://s3.wp.wsu.edu/uploads/sites/867/2015/08/Anderson_2014.pdf

Anderson, K. L., Balandin, S., & Stancliffe, R. J. (2015). Alternative service delivery models for families with a new speech generating device: Perspectives of parents and therapists. *International Journal of Speech-Language Pathology, 17*(2), 185-195. doi: 10.3109/17549507.2014.979876

Australian Government Department of Health (AGDOH). (2015). Telehealth. Canberra: Commonwealth of Australia. Retrieved from http://www.health.gov.au/internet/main/publishing.nsf/content/e-health-telehealth

Barkmeier-Kraemer, J. M., & Patel, R. R. (2016). *The Next 10 Years in Voice Evaluation and Treatment.* Paper presented at the Seminars in Speech and Language. doi: 10.1055/s-0036-1583547

Baron, C., Hatfield, B., & Georgeadis, A. (2005). Management of communication disorders using family member input, group treatment, and telerehabilitation. *Topics in Stroke Rehabilitation, 12*(2), 49-56.

Behl, D. D., Blaiser, K., Cook, G., Barrett, T., Callow-Heusser, C., Brooks, B. M., . . . White, K. R. (2017). A multisite study evaluating the benefits of early intervention via telepractice. *Infants & Young Children, 30*(2), 147-161.

Beijer, L. J., Rietveld, T. C., Hoskam, V., Geurts, A. C., & de Swart, B. J. (2010). Evaluating the feasibility and the potential efficacy of e-learning-based speech therapy (EST) as a web application for speech training in dysarthric patients with Parkinson's disease: a case study. *Telemedicine and e-Health, 16*(6), 732-738.

Burns, C. L., Ward, E. C., Hill, A. J., Malcolme, K., Bassett, L., Kenny, L. M., & Greenup, P. (2012). A pilot trial of a speech pathology telehealth service for head and neck cancer patients. *Journal of Telemedicine and Telecare, 18*(8), 443-446.

Carey, B., O'Brian, S., Lowe, R., & Onslow, M. (2014). Webcam delivery of the Camperdown Program for adolescents who stutter: A Phase II trial. *Language, Speech, and Hearing Services in schools, 45*(4), 314-324.

Carey, B., O'Brian, S., Onslow, M., Block, S., Jones, M., & Packman, A. (2010). Randomized controlled non-inferiority trial of a telehealth treatment for chronic stuttering: The Camperdown Program. *International Journal of Language & Communication Disorders, 45*(1), 108-120.

Cherney, L. R. (2010). Oral reading for language in aphasia (ORLA): Evaluating the efficacy of computer-delivered therapy in chronic nonfluent aphasia. *Topics in Stroke Rehabilitation, 17*(6), 423-431.

Cherney, L. R., & Van Vuuren, S. (2012). *Telerehabilitation, virtual therapists, and acquired neurologic speech and language disorders.* Paper presented at the Seminars in Speech and Language.

Constantinescu, G., Theodoros, D., Russell, T., Ward, E., Wilson, S., & Wootton, R. (2010). Assessing disordered speech and voice in Parkinson's disease: A telerehabilitation application. *International Journal of Language & Communication Disorders, 45*(6), 630-644.

Constantinescu, G., Theodoros, D., Russell, T., Ward, E., Wilson, S., & Wootton, R. (2011). Treating disordered speech and voice in Parkinson's disease online: a randomized controlled non-inferiority trial. *International journal of language & communication disorders, 46*(1), 1-16.

Constantinescu, G. A., Theodoros, D. G., Russell, T. G., Ward, E. C., Wilson, S. J., & Wootton, R. (2010). Home-based speech treatment for Parkinson's disease delivered remotely: a case report.

Douglas, S. N., Nordquist, E., Kammes, R., & Gerde, H. (2017). Online Parent Training to Support Children With Complex Communication Needs. *Infants & Young Children, 30*(4), 288-303.

Erickson, S., Block, S., Menzies, R., Onslow, M., O'Brian, S., & Packman, A. (2011). Stand-alone Internet speech restructuring treatment for adults who stutter. *Journal of Clinical Practice in Speech-Language Pathology, 13*(1), 118.

Fairweather, G. C., Lincoln, M. A., & Ramsden, R. (2016). Speech-language pathology teletherapy in rural and remote educational settings: Decreasing service inequities. *International Journal of Speech-Language Pathology, 18*(6), 592-602.

Freckmann, A., Hines, M., & Lincoln, M. (2017). Clinicians' perspectives of therapeutic alliance in face-to-face and telepractice speech–language pathology sessions. *International Journal of Speech-Language Pathology, 19*(3), 287-296.

Fu, S., Theodoros, D. G., & Ward, E. C. (2015). Delivery of intensive voice therapy for vocal fold nodules via telepractice: A pilot feasibility and efficacy study. *Journal of Voice, 29*(6), 696-706.

Getz, H., Snider, S., Brennan, D., & Friedman, R. (2016). Successful remote delivery of a treatment for phonological alexia via telerehab. *Neuropsychological rehabilitation, 26*(4), 584-609.

Glykas, M., & Chytas, P. (2004). Technology assisted speech and language therapy. *International Journal of Medical Informatics, 73*(6), 529-541.

Grogan-Johnson, S., Alvares, R., Rowan, L., & Creaghead, N. (2010). A pilot study comparing the effectiveness of speech-language therapy provided by telemedicine with conventional on-site therapy. *Journal of Telemedicine and Telecare, 16*(3), 134-139.

Grogan-Johnson, S., Gabel, R. M., Taylor, J., Rowan, L. E., Alvares, R., & Schenker, J. (2011). A pilot exploration of speech sound disorder intervention delivered by telehealth to school–age children. *International Journal of Telerehabilitation, 3*(1), 31.

Grogan-Johnson, S., Schmidt, A. M., Schenker, J., Alvares, R., Rowan, L. E., & Taylor, J. (2013). A comparison of speech sound intervention delivered by telepractice and side-by-side service delivery models. *Communication Disorders Quarterly, 34*(4), 210-220.

Guo, Y. E., Togher, L., Power, E., Hutomo, E., Yang, Y.-F., Tay, A., . . . Koh, G. C.-H. (2017). Assessment of Aphasia Across the International Classification of Functioning, Disability and Health Using an iPad-Based Application. *Telemedicine and e-Health, 23*(4), 313-326.

Harrington, K. (2012). The Lee Silverman voice treatment delivered via distance therapy (Master thesis) Retrieved from http://thekeep.eiu.edu/cgi/viewcontent.cgi?article=1752&context=theses

Hart, J. (2010). Expanding access to telespeech in clinical settings: inroads and challenges. *Telemedcine Journal and E-Health, 16*(9), 922-924.

Hill, A., & Theodoros, D. (2002). Research into telehealth applications in speech-language pathology. *Journal of Telemedicine and Telecare, 8*(4), 187-196.

Hill, A. J., & Breslin, H. M. (2016). Refining an Asynchronous Telerehabilitation Platform for Speech-Language Pathology: Engaging End-Users in the Process. *Frontiers in Human Neuroscience, 10*.

Hill, A. J., Theodoros, D., Russell, T., & Ward, E. (2009). Using telerehabilitation to assess apraxia of speech in adults. *International Journal of Language & Communication Disorders, 44*(5), 731-747.

Hill, A. J., Theodoros, D. G., Russell, T. G., Cahill, L. M., Ward, E. C., & Clark, K. M. (2006). An Internet-based telerehabilitation system for the assessment of motor speech disorders: A pilot study. *American journal of speech-language pathology, 15*(1), 45-56.

Hill, A. J., Theodoros, D. G., Russell, T. G., & Ward, E. C. (2009). The redesign and re-evaluation of an internet-based telerehabilitation system for the assessment of dysarthria in adults. *Telemedicine and e-Health, 15*(9), 840-850.

Hines, M., Lincoln, M., Ramsden, R., Martinovich, J., & Fairweather, C. (2015). Speech pathologists' perspectives on transitioning to telepractice: What factors promote acceptance? *Journal of Telemedicine and Telecare, 21*(8), 469-473.

Isaki, E., & Farrell, C. F. (2015). Provision of speech-language pathology telepractice services using apple iPads. *Telemedicine and e-Health, 21*(7), 538-549.

Keck, C. S., & Doarn, C. R. (2014). Telehealth technology applications in speech-language pathology. *Telemedicine and e-Health, 20*(7), 653-659.

Kully, D. (2000). Telehealth in speech pathology: Applications to the treatment of stuttering. *Journal of Telemedicine and Telecare,* 6 (2 Suppl.), 39-41.

Labute, J. (2011). Effectiveness of delivering speech and language services via telehealth. Retreived from https://www.uwo.ca/fhs/lwm/teaching/EBP/2010_11/Labute.pdf

Lewis, C., Packman, A., Onslow, M., Simpson, J. M., & Jones, M. (2008). A phase II trial of telehealth delivery of the Lidcombe Program of Early Stuttering Intervention. *American Journal of Speech-Language Pathology, 17*(2), 139-149.

Lowe, R., O'Brian, S., & Onslow, M. (2013). Review of Telehealth Stuttering Management. *Folia Phoniatrica et Logopaedica, 65*(5), 223-238.

Marshall, J., Booth, T., Devane, N., Galliers, J., Greenwood, H., Hilari, K., . . . Woolf, C. (2016). Evaluating the benefits of aphasia intervention delivered in virtual reality: Results of a quasi-randomised study. *Public Library of Science one, 11*(8), e0160381, 1-18.

Mashima, P. A. (2011). *The Use of Video-Teleconferencing to Deliver Voice Therapy At-A-Distance* (Doctoral thesis). Retrieved from http://libguides.library.usyd.edu.au/ld.php?content_id=22193083.

Mashima, P. A., Birkmire-Peters, D. P., Syms, M. J., Holtel, M. R., Burgess, L. P., & Peters, L. J. (2003). Telehealth: Voice therapy using telecommunications technology. *American Journal of Speech-Language Pathology, 12*(4), 432-439.

Mashima, P. A., & Brown, J. E. (2011). Remote management of voice and swallowing disorders. *Otolaryngologic Clinics of North America, 44*(6), 1305-1316. doi: 10.1016/j.otc.2011.08.007

Mashima, P. A., & Doarn, C. R. (2008). Overview of telehealth activities in speech-language pathology. *Telemedicine and e-Health, 14*(10), 1101-1117.

Meltzer, J. A., Baird, A. J., Steele, R. D., & Harvey, S. J. (2017). Computer-based treatment of poststroke language disorders: a non-inferiority study of telerehabilitation compared to in-person service delivery. *Aphasiology*, 1-22.

Navarro-Newball, A., Loaiza, D., Oviedo, C., Castillo, A., Portilla, A., Linares, D., & Álvarez, G. (2014). Talking to Teo: Video game supported speech therapy. *Entertainment Computing, 5*(4), 401-412.

O'Brian, S., Packman, A., & Onslow, M. (2008). Telehealth delivery of the Camperdown Program for adults who stutter: A phase I trial. *Journal of Speech, Language, and Hearing Research, 51*(1), 184-195.

O'Brian, S., Smith, K., & Onslow, M. (2014). Webcam delivery of the Lidcombe Program for early stuttering: A Phase I clinical trial. *Journal of Speech, Language, and Hearing Research, 57*(3), 825-830.

Orehovački, T., Vukovac, D. P., Stapić, Z., & Novosel-Herceg, T. (2017). *Features and Quality of a Mobile Application Employed in a Speech-Language Therapy.* Paper presented at the International Conference on Human-Computer Interaction. Retrieved from: https://link-springer-com.ez.library.latrobe.edu.au/chapter/10.1007%2F978-3-319-58077-7_20

Packman, A., & Meredith, G. (2011). Technology and the evolution of clinical methods for stuttering. *Journal of Fluency Disorders, 36*(2), 75-85.

Packman, A., & Onslow, M. (2012). Investigating optimal intervention intensity with the Lidcombe Program of early stuttering intervention. *International Journal of Speech-Language Pathology, 14*(5), 467-470.

Palsbo, S. E. (2007). Equivalence of functional communication assessment in speech pathology using videoconferencing. *Journal of Telemedicine and Telecare, 13*(1), 40-43.

Parmanto, B., Saptono, A., Murthi, R., Safos, C., & Lathan, C. E. (2008). Secure Telemonitoring System for Delivering Telerehabilitation Therapy to Enhance Children's Communication Function to Home. *Telemedicine and e-Health, 14*(9), 905-911. doi: 10.1089/tmj.2008.0003

Pulga, M. J., Spinardi-Panes, A. C., Lopes-Herrera, S. A., & Maximino, L. P. (2014). Evaluating a speech-language pathology technology. *Telemedicine and e-Health, 20*(3), 269-271

Raiser, T., Croot, K., Nickels, L., Taylor, C., & Danek, A. Telemedicine in Primary Progressive Aphasia. *Aphasie und verwandte Gebiete et domaines associes, 42*(ISSN 1664-8595), 37-40.

Rangarathnam, B., McCullough, G. H., Pickett, H., Zraick, R. I., Tulunay-Ugur, O., & McCullough, K. C. (2015). Telepractice versus in-person delivery of voice therapy for primary muscle tension dysphonia. *American Journal of Speech-Language Pathology, 24*(3), 386-399.

Reynolds, A. L., Vick, J. L., & Haak, N. J. (2009). Telehealth applications in speech-language pathology: A modified narrative review. *Journal of Telemedicine and Telecare, 15*(6), 310-316.

Ruiter, M. B., Rietveld, T. C., Hoskam, V., & van Beers, M. M. (2016). An exploratory investigation of e-REST: Teletherapy for chronically aphasic speakers. *International Journal of Telerehabilitation, 8*(1), 21.

Salvo, L. (2013). *Efficacy of Using Telepractice Via the Internet to Assess Children's Language Abilities (Master thesis).*Retrieved from https://search.proquest.com/docview/1418799006?pq-origsite=gscholar

Sarhan, F., & Nayoan, J. (2013). Service Evaluation of the Use of Assistive Technology to Deliver Speech and Language Therapy to People with Aphasia in Buckinghamshire.

Shahin, M., Ahmed, B., Parnandi, A., Karappa, V., McKechnie, J., Ballard, K. J., & Gutierrez-Osuna, R. (2015). Tabby Talks: An automated tool for the assessment of childhood apraxia of speech. *Speech Communication, 70*(Supplement C), 49-64. doi:10.1016/j.specom.2015.04.002

Sharma, S., Ward, E. C., Burns, C., Theodoros, D., & Russell, T. (2011). Assessing swallowing disorders online: a pilot telerehabilitation study. *Telemedicine and e-Health, 17*(9), 688-695. doi:10.1089/tmj.2011.0034

Sicotte, C., Lehoux, P., Fortier-Blanc, J., & Leblanc, Y. (2003). Feasibility and outcome evaluation of a telemedicine application in speech–language pathology. *Journal of Telemedicine and Telecare, 9*(5), 253-258.

Sparacino, G. (2017). *An Examination of Quality of Life and Communication Confidence in Aphasia through Telehealth Communication Groups.* Available from https://search.proquest.com/docview/1925928089?pq-origsite=gscholar

Steele, R. D., Baird, A., McCall, D., & Haynes, L. (2014). Combining teletherapy and on-line language exercises in the treatment of chronic aphasia: An outcome study. *International Journal of Telerehabilitation, 6*(2), 3.

Stredler-Brown, A. (2012). Expanding use of telepractice in speech-language pathology and audiology. *The Volta Review, 112*(3), 227.

Sutherland, R., Trembath, D., Hodge, A., Drevensek, S., Lee, S., Silove, N., & Roberts, J. (2017). Telehealth language assessments using consumer grade equipment in rural and urban settings: Feasible, reliable and well tolerated. *Journal of Telemedicine and Telecare, 23*(1), 106-115.

Taylor, O. D., Armfield, N. R., Dodrill, P., & Smith, A. C. (2014). A review of the efficacy and effectiveness of using telehealth for paediatric speech and language assessment. *Journal of Telemedicine and Telecare, 20*(7), 405-412.

Theodoros, D. G. (2008). Telerehabilitation for service delivery in speech-language pathology. *Journal of Telemedicine and Telecare, 14*(5), 221-224.

Theodoros, D. G., Hill, A. J., & Russell, T. G. (2016). Clinical and Quality of Life Outcomes of Speech Treatment for Parkinson's Disease Delivered to the Home Via Telerehabilitation: A Noninferiority Randomized Controlled Trial. *American Journal of Speech-Language Pathology, 25*(2), 214-232.

Thomas, D. C., McCabe, P., Ballard, K. J., & Lincoln, M. (2016). Telehealth delivery of Rapid Syllable Transitions (ReST) treatment for childhood apraxia of speech. *International journal of language & communication disorders, 51*(6), 654-671.

Tindall, L. R. (2013). Initiating and sustaining a telepractice program for individuals with aphasia. In. Todd, K.T. *Telepractice in Speech-Language Pathology*. (p. 165-170). San Diego, CA: Plural Publishing.

Towey, M. (2013). Voice Therapy Telepractice; Voice Care For The 21st Century. *Perspectives on Voice and Voice Disorders, 23*(3), 74-81.

Vestal, L., Smith-Olinde, L., Hicks, G., Hutton, T., & Hart Jr, J. (2006). Efficacy of language assessment in Alzheimer's disease: comparing in-person examination and telemedicine. *Clinical Interventions in Aging, 1*(4), 467. doi:10.1089/tmj.2011.0034

Vukovac, D. P. (2016). *Employing Educational Video in Speech-Language Telerehabilitation with Children: Insights from Interviews with Parents.* Paper presented at the 8th International Conference on Education and New Learning Technologies. Retrieved from https://www.researchgate.net/publication/305209498

Vukovac, D. P., Orehovački, T., & Novosel-Herceg, T. (2016). *Inspecting the Quality of Educational Video Artefacts Employed in Speech-Language Pathology Telerehabilitation: A Pilot Study.* Paper presented at the International Conference on Universal Access in Human-Computer Interaction. Retrieved from https://link-springer-com.ez.library.latrobe.edu.au/chapter/10.1007%2F978-3-319-40238-3_46

Waite, M. C., Theodoros, D. G., Russell, T. G., & Cahill, L. M. (2010). Internet-based telehealth assessment of language using the CELF–4. *Language, Speech, and Hearing Services in Schools, 41*(4), 445-458.

Waite, M. C., Theodoros, D. G., Russell, T. G., & Cahill, L. M. (2012). Assessing children's speech intelligibility and oral structures, and functions via an Internet-based telehealth system. *Journal of Telemedicine and Telecare, 18*(4), 198-203.

Wales, D., Skinner, L., & Hayman, M. (2017). The efficacy of telehealth-delivered speech and language intervention for primary school-age children: A systematic review. *International Journal of Telerehabilitation, 9*(1), 55.

Ward, E. C., Sharma, S., Burns, C., Theodoros, D., & Russell, T. (2012). Validity of conducting clinical dysphagia assessments for patients with normal to mild cognitive impairment via telerehabilitation. *Dysphagia, 27*(4), 460-472.

Whitehead, E., Dorfman, V., Tremper, G., Kramer, A., Sigler, A., & Gosman, A. (2012). Telemedicine as a Means of Effective Speech Evaluation for Cleft Palate Patients. *Annals of Plastic Surgery, 68*(4), 415. doi: 10.1097/SAP.0b013e31823b6897