Review Article

Telepractice for Adult Speech-Language Pathology Services: A Systematic Review

Kristen Weidner[a] and Joneen Lowman[a]

Purpose: We conducted a systematic review of the literature regarding adult telepractice services (screening, assessment, and treatment) from approximately 2014 to 2019.
Method: Thirty-one relevant studies were identified from a literature search, assessed for quality, and reported.
Results: Included studies illustrated feasibility, efficacy, diagnostic accuracy, and noninferiority of various speech-language pathology services across adult populations, including chronic aphasia, Parkinson's disease, dysphagia, and primary progressive aphasia. Technical aspects of the equipment and software used to deliver services were discussed. Some general themes were noted as areas for future research.
Conclusion: Overall, results of the review continue to support the use of telepractice as an appropriate service delivery model in speech-language pathology for adults. Strong research designs, including experimental control, across multiple well-described settings are still needed to definitively determine effectiveness of telepractice services.

Telehealth has life-changing potential to connect Americans with necessary care, and it continues to grow at a rapid pace. In the United States, telehealth is uniquely positioned to meet future health care goals. The Affordable Care Act and the U.S. Department of Health and Human Services' (2010) Healthy People 2020 initiative have emphasized access to health care and reduction of disparities as priorities in American health care, which provides a unique opportunity for telehealth applications to bridge service gaps (Ahn et al., 2016; Institute of Medicine, 2012). Healthy People 2030 is under development, but its framework holds elimination of health disparities and promotion of health equity among its key goals (U.S. Department of Health and Human Services, 2019). Telehealth is already being used successfully to promote health care access across medical specialties and settings in a variety of configurations. Forms of telehealth can include synchronous (live, interactive video), asynchronous (or store-and-forward, in which data such as patient information or images are transmitted, but not in real time), remote patient monitoring (transmission of patient data such as physical measurements for a remote health care professional to analyze and monitor), and mHealth (such as health-promoting apps; The Office of the National Coordinator for Health Information Technology, 2018). A number of federal health care delivery systems, such as those within the Department of Veterans Affairs, Department of Defense, and Indian Health Service, currently use telehealth (Elliot, 2016).

Within telehealth is the field of telerehabilitation. Within telerehabilitation is *telepractice*, a term used by the American Speech-Language-Hearing Association (ASHA) to include remote services outside the health care settings and defined as "the application of telecommunications technology to the delivery of speech language pathology and audiology professional services at a distance by linking clinician to client or clinician to clinician for assessment, intervention, and/or consultation" (ASHA, 2019b). Speech-language pathology services are uniquely suited to telehealth delivery, given the audiovisual nature of clinical interactions and techniques (Theodoros, 2013). Telepractice has enormous potential for speech-language pathologists (SLPs): not only in overcoming access barriers such as distance, provider shortages, or patient mobility issues but also in providing unique opportunities to connect with patients in their natural environments or during travel (Cason & Cohn, 2014). ASHA recognizes telepractice as an appropriate service delivery model, provided that clinicians have adequate knowledge of the technologies utilized, appropriately adapt assessment or intervention materials for telepractice delivery, and competently select clients

[a]Department of Rehabilitation Sciences, College of Health Sciences, University of Kentucky, Lexington
Correspondence to Kristen Weidner: kristen.weidner@uky.edu
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appropriate for remote service delivery; further information and guidance can be found at ASHA's Practice Portal on telepractice (ASHA, 2019b). Telepractice is currently being used to fill service gaps in educational settings and in some adult health care settings.

The literature supporting the use of telepractice in the adult health care environment is emerging. Various systematic reviews, which are helpful in synthesizing information for clinicians, have investigated different facets of telepractice for communication and swallowing in adults. In 2013, a Cochrane review examined the effectiveness of telerehabilitation in general for individuals with stroke but did not find enough evidence to make firm conclusions (Laver et al., 2013). Another 2013 systematic review by Hall et al. supported effectiveness and viability of telepractice for aphasia. Differences in these conclusions are likely related to the broader scope of the Cochrane review and types of studies accepted: Cochrane included only randomized controlled trials, whereas Hall et al. (2013) did not restrict results by study design. Keck and Doarn (2014) completed an extensive literature review on telehealth technologies applicable to SLPs, concluding that technical feasibility had been achieved for telepractice. In 2015, Molini-Avejonas et al. reviewed the literature on the use of telehealth in a variety of communication or swallowing disorders, including audiology. Results were largely positive, with preliminary evidence for feasibility, cost-effectiveness, and patient satisfaction (Molini-Avejonas et al., 2015). Also, Coleman et al. (2015) reviewed telehealth literature on assessment and intervention for cognitive or communication impairments in adults with acquired brain injury. More recently, reviews have been conducted for populations such as dementia (Cotelli et al., 2017), dysphagia (Nordio et al., 2018), and stuttering (McGill et al., 2018). Although evidence base for telepractice service continues to broaden and deepen, challenges remain. Nordio et al. (2018) concluded there was insufficient evidence for the efficacy of telerehabilitation for dysphagia, given the lack of controlled trials. Similarly, Politis and Norman (2016) also found insufficient evidence for the efficacy of computer-based cognitive rehabilitation for individuals with traumatic brain injury (two of the 13 included studies involved telehealth), due to lack of controlled trials.

Since Molini-Avejonas et al. (2015), a systematic review has not investigated the literature for telepractice across disorders. This review will build upon their results by considering publications from 2014 forward and will focus specifically on adult speech-language pathology services. The view across disorders is fitting for the emergent state of literature in this area and reflective of heterogeneous adult populations served by health care facilities or medical SLPs. Additionally, while disorder-specific reviews strengthen the literature base for specific interventions or groups, a broader systematic review can identify themes and gaps across the full topic of adult telepractice. This is useful for practicing clinicians considering telepractice as a future tool, or speech-language and hearing science researchers broadly interested in investigating telepractice.

Overall, the primary aim of this review is to examine current evidence for feasibility and efficacy of speech-language pathology services (screening, assessment, or treatment) delivered via telepractice for adult populations from 2014 to 2019. Secondarily, in addition to investigation of remotely delivered treatments and assessments themselves, we wished to collect and present descriptive information regarding equipment utilized for telepractice and regarding service delivery setting (e.g., at home, remotely between clinics). Given that telepractice is a service delivery model, contextual information such as equipment or setting is important for two reasons: First, these details help the clinician to decide whether he or she will be able to implement a similar configuration with clients, and second, it identifies areas for future research regarding setting and tool variables. Telepractice, such as telemedicine, may be considered a "bundle" of variables, including setting and equipment, that may affect whether interventions work and are practical (Bashshur et al., 2011). As a note on terminology, we will refer to telepractice as telehealth or remote delivery. Any traditional, on-site delivery involving the physical presence of the clinician will be referred to as in-person (Cason, 2017).

Method

Information is presented in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (Moher et al., 2009). This review did not have a registered protocol.

Literature Search

Databases searched for relevant literature were EBSCOHost, CINAHL, PubMed, Scopus, and Web of Science. An example search strategy is listed in Table 1. Searches were conducted in March 2019 and included all results from January 1, 2014, forward. This date was chosen to include studies published since Molini-Avejonas et al. (2015), with an additional year to capture articles in press at time of publication. Google Scholar was searched with similar terms to identify further articles. Reference lists of included studies and pertinent journals were hand searched.

Table 1. Example search strategy.

Databases	Search string
EBSCOHost, CINAHL, PubMed, Scopus, Web of Science	(telehealth OR telepractice OR telerehabilitation OR telemedicine) AND ("speech language pathology" OR "SLP" OR "speech therapy" OR "speech pathology") AND (aphasia OR dysphagia OR swallowing OR apraxia OR voice OR language OR speech OR fluency OR stuttering OR brain injury OR TBI OR cognitive OR AAC) AND adult

Table 2. Inclusion criteria.

- All participants ≥ 18 years of age
- English language
- Published, peer-reviewed papers
- Original data (excludes reviews)
- Specific to speech-language pathology
- Addresses screening, assessment, or intervention via telepractice (excludes service outcomes)

Inclusion Criteria

Table 2 lists inclusion criteria. Studies were included if they examined evidence of feasibility, acceptability, efficacy, and/or effectiveness of telehealth for speech-language pathology screening, assessment, or intervention. We did not examine service outcomes such as cost-effectiveness or efficiency. We defined telepractice as the use of synchronous, asynchronous, or hybrid delivery of skilled services and excluded studies examining remote patient monitoring, mobile health only, or computer-based interventions that did not involve telecommunications to facilitate interaction with the clinician. Only adult populations (≥ 18 years of age) were included. Articles in which age was not clearly stated for all participants were excluded. Questions of inclusion were resolved through discussion with the second author.

The first author screened search results for eligibility by title and abstract, assessed each article in full for eligibility, and extracted data. Data extracted included study design, participant characteristics, treatment setting, telecommunications technology characteristics, intervention characteristics, primary and secondary outcomes, overall results, and conclusions. Methodological quality of included studies was assessed via the Joanna Briggs Institute critical appraisal tools, which include checklists to assess quality of a variety of study designs in health care literature (Joanna Briggs Institute, n.d.). Single-subject design studies were assessed via the National Technical Assistance Center on Transition (n.d.) quality checklist for single-case designs.

Results

The literature search identified 125 articles in total, with additional articles identified via Google Scholar and hand searching. After screening and assessment, 31 articles were included for qualitative review. See Figure 1 for a flowchart illustrating this process. Meta-analysis was determined inappropriate given heterogeneity of populations and outcomes in the identified studies, so results were analyzed qualitatively and summarized. Characteristics of included studies are provided in Table 3. Excluded studies, with reasons for exclusion, are listed in Table 4.

Participant Characteristics

About half (48%) of the studies focused on individuals with aphasia. Types (e.g., Broca's, Wernicke's) and severities varied across studies. Most participants were at least 6 months postonset of stroke, a time period at which aphasia is considered chronic in the literature (Johnson et al., 2019). The next most common disorder population in our included studies, following aphasia, was Parkinson's disease (PD; 16%). Other disorder populations included dysphagia (13%), primary progressive aphasia (PPA; 10%), traumatic brain injury (6%), voice, and mixed populations (3% each; percentages are approximate). Participant ages ranged from 18 to 112 years (as reported). Typical age ranges were approximately 40–80 years. Sample sizes ranged from two to 100 participants. Further participant details can be found in Table 3.

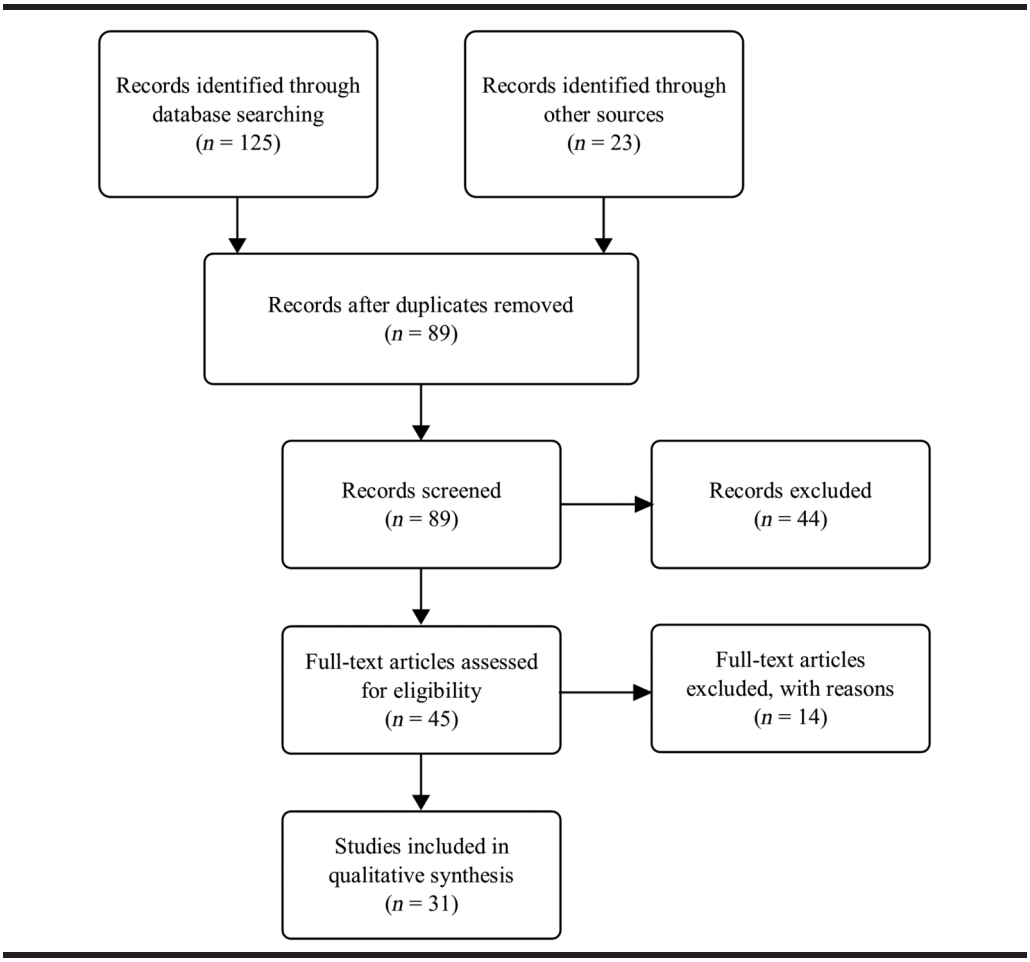
Methodological Characteristics

Studies were most frequently quasi-experimental (45%), meaning researchers experimentally tested an intervention, but often did not have a control group and/or randomization. This weakens the evidence strength. Two randomized controlled trials were included: one on session attendance rates for individuals with PD (Covert et al., 2018) and a randomized controlled noninferiority trial with individuals with aphasia or cognitive-communication disorders (Meltzer et al., 2017). Noninferiority studies seek to determine whether an alternative intervention is not inferior to an established intervention (based on a preset margin of clinically acceptable difference), particularly when the new intervention costs less or is more convenient (Kumbhare et al., 2019). Wade et al. (2017) suggest noninferiority may be one of the most appropriate telehealth study designs, since the typical clinical question involves determining whether telehealth is inferior to another intervention model, such as in-person speech-language pathology service delivery. Other study designs included diagnostic accuracy, single-subject designs, case series, and case reports. Commonly encountered sources of bias identified during quality assessment were lack of a control group, inadequate description of procedures, and inadequate avoidance of case-control design for diagnostic studies. Avoidance of case-control design means that diagnostic studies should not test the accuracy of an instrument on individuals already diagnosed with the disorder of interest by some other means, because this can bias results (BMJ Publishing Group Limited, 2019; Joanna Briggs Institute, 2019). Strengths included good follow-up on participants, selection of valid and appropriate measures, and clear descriptions of independent and dependent variables.

Primary Outcomes

Studies commonly used a combination of standardized or formal measures and investigator-developed measures such as satisfaction questionnaires. Outcomes for treatment feasibility or efficacy varied by disorder group and are listed in Table 3. Studies involving Lee Silverman Voice Treatment (LSVT LOUD) had the most consistently reported outcomes for vocal intensity in decibel (Covert

Figure 1. Article selection process.



et al., 2018; Griffin et al., 2018; Quinn et al., 2018; Theodoros et al., 2016). The consistency might be expected given the treatment program's standardized set of measures. However, Dias, Limongi, Barbosa, et al. (2016) studied an extended version of LSVT, LSVT-X, and measured outcomes with the Grade, Roughness, Breathiness, Asthenia, Strain, and Instability scale (Dejonckere et al., 1996). In aphasia and PPA studies, common outcomes included naming, reading accuracy, or functional communication. Studies that examined feasibility as a primary outcome used a wide variety of measures, including clinician logs, recruitment data, attrition counts, treatment fidelity, and participant report. Further detail on primary outcomes for each study is located in Table 3.

Diagnostic Accuracy

Diagnostic studies measured agreement between evaluations completed in person versus remotely. Five studies examined accuracy of telepractice assessment in dysphagia or aphasia. Three diagnostic studies involved dysphagia assessment, either via videofluoroscopy or clinical swallow evaluations, via telepractice (Burns et al., 2016; Morrell et al., 2017; Ward et al., 2014). All authors found high agreement between remote and in-person conditions, whether using instrumental or noninstrumental evaluations. Despite these overall positive results, there were some issues assessing individuals with severe dysphagia in the studies on clinical swallow evaluations. In Ward et al. (2014), upon completion of the study, clinicians assigned to telepractice reported feeling "an optimal assessment was not as easily achieved because of increased patient complexity" (p. 302); interestingly, this perception was despite acceptable levels of agreement across telepractice/in-person conditions and dysphagia severity levels (Ward et al., 2014). In Morrell et al. (2017), there were lower levels of agreement across clinicians when assessing individuals with severe stroke; however, disagreement did not appear worse in the telepractice versus in-person assessment condition. These results suggest possible nuances in assessment of patients with complex or severe conditions, independent of the telepractice service delivery model.

Two studies involved screening or assessment of aphasia. Aphasia screening via a mobile tablet version of the Frenchay Aphasia Screening Test and store-and-forward technology was found to be reliable (Choi et al., 2015). Also on a tablet,

Table 3. Characteristics of included studies.

Study	*n*	Age (range, years)	Diagnosis	Intervention (I)/screening (S)/ assessment (A)	Primary outcome
Agostini et al. (2014)	5	57–70	Chronic aphasia, anomia	(I) Naming treatment	Outcome: Naming accuracy Measure: Percent correct
Choi et al. (2016)	8	37–62	Chronic aphasia	(I) Comprehensive home program	Outcome: Various language skills Measure: K-WAB scores
Choi et al. (2015)	60	21–79	Aphasia	(S) Online version of the K-FAST	Diagnostic accuracy; equivalence of K-FAST and mobile version
Furnas & Edmonds (2014)	2	54–55	Aphasia	(I) Computerized version of V-NeST	Outcome: Lexical retrieval Measure: Accuracy in various retrieval tasks
Getz et al. (2016)	2	44–51	Phonological alexia	(I) Custom treatment program (Semantic Mediation)	Outcome: Oral reading Measure: Accuracy reading single words
Guo et al. (2017)	30	35–79	Aphasia	(A) Custom assessment software (Access2Aphasia)	Diagnostic accuracy; agreement between online and face-to-face versions of assessment
Kurland et al. (2018)	21	47.3–81	Chronic aphasia	(I) Tailored naming home practice program	Outcome: Naming accuracy Measure: Percent correct
Macoir et al. (2017)	20	49–78	Chronic aphasia	(I) Modification of PACE treatment	Outcome: Functional communication Measure: PACE communication effectiveness scores
Pitt et al. (2017)	2	41–78	Chronic aphasia	(I) Constraint-induced language therapy delivered online via custom software	Outcome: Feasibility Measure: Various, including log and notes
Pitt et al. (2018)	19	21–79[c]	Chronic aphasia	(I) Group aphasia sessions	Outcome: Communication-related quality of life Measure: ALA
Pitt et al. (2019)	4	41–78	Aphasia	(I) Group aphasia sessions	Outcome: Feasibility and acceptability Measure: Various, including log and notes
Rhodes & Isaki (2018)	2	37–66	Chronic aphasia with apraxia of speech	(I) Script training	Outcome: Communication effectiveness listed as first aim Measure: CETI
Steele et al. (2014)	9	43–77	Chronic aphasia	(I) Remote individual and group treatment, online practice exercises	Outcome: Various Measures: WAB-R, CETI, ASHA NOMS, CCRSA, survey of satisfaction
Walker et al. (2018)	6	39–87	Mild chronic aphasia	(I) Group aphasia sessions	Outcome: Social connections Measure: Friendship Scale
Woolf et al. (2016)	20	53–67.2[a]	Aphasia	(I) Naming treatment, home practice tasks	Outcome: Feasibility Measures: Various, including recruitment and retention
Covert et al. (2018)	36	54–87	Idiopathic Parkinson's disease	(I) LSVT LOUD	Outcome: Number of missed appointments[b] Measure: Number of completed sessions
Dias, Limongi, Barbosa, et al. (2016)	20	42–78	Idiopathic Parkinson's disease	(I) Extended LSVT	Outcome: Vocal quality measure: GRBASI scale
Griffin et al. (2018)	29	67[a]	Idiopathic Parkinson's disease, moderate hypokinetic dysarthria	(I) LSVT LOUD	Outcome: Vocal loudness, pitch Measures: Various vocal intensity/ pitch tasks
Quinn et al. (2018)	8	61–81	Parkinson's disease, hypokinetic dysarthria	(I) Modification of "Loud and Proud" group treatment program for individuals post-LSVT LOUD	Outcome: Feasibility Measures: Vocal intensity tasks, pitch range
Theodoros et al. (2016)	31	50–87	Parkinson's disease, hypokinetic dysarthria	(I) LSVT LOUD	Outcome: Noninferiority (vocal loudness) Measure: Change in SPL (dB) in monologue task
Burns et al. (2016)	20	18–87	Referral for assessment (cancer, trauma, respiratory, neuro)	(A) Simultaneous face-to-face and remote videofluoroscopy	Diagnostic accuracy; levels of agreement in clinical decision-making, swallowing feature ratings
Cassel (2016)	3	59–74	Dysphagia	(I) Provision of cueing for compensatory strategies during mealtime	Outcome: Swallowing strategy use Measure: Percent accuracy

(*table continues*)

Table 3. *(Continued).*

Study	*n*	Age (range, years)	Diagnosis	Intervention (I)/screening (S)/ assessment (A)	Primary outcome
Morrell et al. (2017)	99	67.5[a]	Referral for assessment (stroke)	(A) Bedside swallow evaluation	Diagnostic accuracy; agreement between evaluation conditions
Ward et al. (2014)	100	21–112	Dysphagia	(A) Clinical swallow evaluation	Diagnostic accuracy; agreement between evaluation conditions
Riegler et al. (2017)	24	20–45	Mild TBI	(I) Web-based program with weekly remote SLP sessions	Outcome: Feasibility, cognitive functioning Measures: BRIEF-A, TOMAL-2
Williamson & Isaki (2015)	2	44–53	Moderate-to-severe chronic TBI	(I) Modification of Facial Affect Recognition training	Outcome: Emotion identification Measure: Accuracy identifying facial expressions
Dial et al. (2019)	31	61–68.9[a]	PPA	(I) LRT or VISTA	Outcome: Various (feasibility, naming, script accuracy) Measures: Various
Meyer et al. (2016)	3	48–69	PPA	(I) Phonological and orthographic treatment, practice sessions	Outcome: Naming Measure: Number of correctly named words
Rogalski et al. (2016)	31	56–83	PPA	(I) Web-based treatment via customized website	Outcome: Feasibility Measures: ASHA FCMs, CCRSA
Fu et al. (2015)	10	19–49	Vocal fold nodules	(I) Vocal hygiene, modified LMRVT, vocal function exercises	Outcome: Various (feasibility, various vocal outcomes) Measures: Various
Meltzer et al. (2017)	44	60.8–66.8[a]	Aphasia or cognitive-communication disorder	(I) Communication partner training, individualized treatment, and home practice	Outcomes: Aphasia severity or cognitive functioning Measures: WAB-R AQ, CLQT

Note. K-WAB = Korean version of the Western Aphasia Battery; K-FAST = Korean version of the Frenchay Aphasia Screening Test; VNeST = Verb Network Strengthening Treatment; PACE = Promoting Aphasics' Communication Effectiveness; ALA = Assessment for Living with Aphasia; CETI = Communication Effectiveness Index; WAB-R = Western Aphasia Battery–Revised; ASHA NOMS = American Speech-Language-Hearing Association National Outcomes Measurement System; CCRSA = Communication Confidence Rating Scale for Aphasia; LSVT = Lee Silverman Voice Treatment; GRBASI = Grade, Roughness, Breathiness, Asthenia, Strain, and Instability scale; GRBAS = Grade, Roughness, Breathiness, Asthenia, and Strain scale; TBI = traumatic brain injury; STAI = State-Trait Anxiety Inventory; CES-D = Center for Epidemiologic Studies Depression Scale; BRIEF-A = Behavior Rating Inventory of Executive Function—Adult version; TOMAL-2 = Test of Memory and Learning—2nd edition; PPA = primary progressive aphasia; LRT = lexical retrieval treatment; VISTA = video-implemented script training in aphasia; WAB-AQ = Western Aphasia Battery–Aphasia Quotient; NAT = Northwestern Anagram Test; BNT = Boston Naming Test; ASHA FCMs = American Speech-Language-Hearing Association Functional Communication Measures; WAB-R AQ = Western Aphasia Battery—Revised Aphasia Quotient; CLQT = Cognitive Linguistic Quick Test.

[a]Several studies did not provide an age range for participants; rather, mean ages for treatment groups were reported. In this case, group age mean (or range of group mean ages) is stated here. [b]One patient did not report age; however, all participants were required to be > 18 years old. [c]Secondary outcomes included changes in vocal intensity.

aphasia assessment using videoconferencing had good agreement with in-person aphasia evaluation results, and comparable intrarater and interrater reliability (Guo et al., 2017). Guo et al. (2017) used a custom application to allow an SLP to administer the Assessment for Living with Aphasia (Kagan et al., 2013) and portions of the Psycholinguistic Assessments of Language Processing in Aphasia (Kay et al., 1992) to individuals with aphasia in their homes.

Intervention

Twenty-six studies investigated interventions delivered via telepractice, five of which used group interventions. As stated above, most of the studies involved individuals with chronic aphasia. A variety of common aphasia treatment techniques were used. Two studies used progressive cueing hierarchies to target word retrieval, finding similar results for remote and in-person delivery (Agostini et al., 2014; Woolf et al., 2016). Independent home practice of word retrieval, intended to sustain gains from a separate intensive aphasia program, was integrated with informal weekly videoconferencing check-ins; results suggested the practice helped maintain naming skills (Kurland et al., 2016, 2018). Four studies used videoconferencing to administer group therapy to individuals with chronic aphasia, demonstrating feasibility and potential benefits (Pitt et al., 2018, 2019; Steele et al., 2014; Walker et al., 2018). Steele et al. (2014) supplemented group intervention with individual videoconferencing sessions, as well as home practice tasks on a proprietary software. In the aphasia intervention studies, specific interventions investigated were script training (Rhodes & Isaki, 2018), constraint-induced language therapy (Pitt et al., 2017), Promoting Aphasics' Communication Effectiveness (Macoir et al., 2017), Verb Network Strengthening Treatment (Furnas & Edmonds, 2014), and Semantic Mediation (Getz et al., 2016). Choi et al. (2016) used an asynchronous model that allowed participants to practice various expressive and receptive language tasks on a tablet, with feedback and guidance provided by a remote SLP. Studies generally had positive results demonstrating feasibility and/or potential benefits.

Table 4. Excluded studies.

Study	Diagnosis	Reason for exclusion
Burns et al. (2017)	Dysphagia, head and neck cancer	Service outcomes
Collins et al. (2017)	Dysphagia, head and neck cancer	Service outcomes
Curtis (2014)	Cerebral palsy, ALS (AAC)	Ages not specifically stated
DeBelly et al. (2018)	Stuttering	Some participants under 18 years of age
Dias, Limongi, Hsing, et al. (2016)	Parkinson's disease	Patient perspectives
Hill & Breslin (2016)	Aphasia	Software usability only
Isaki & Fangman Farrell (2015)	TBI, aphasia	Some participants under 18 years of age
Kantarcigil & Malandraki (2017)	Dysphagia	Usability of form only
Rangarathnam et al. (2015)	Muscle tension dysphonia	Some participants under 18 years of age
Rietdijk et al. (2017)	Severe TBI	Ages not specifically stated
Simic et al. (2016)	Aphasia	Software usability only
Utianski et al. (2019)	Dysarthria	Measurement/speech science
Wall et al. (2016)	Dysphagia, head and neck cancer	Computerized screener only
Wall et al. (2017)	Dysphagia, head and neck cancer	Service outcomes (adherence)

Note. ALS = amyotrophic lateral sclerosis; AAC = augmentative and alternative communication; TBI = traumatic brain injury.

Five studies examined telepractice for individuals with PD, and all involved delivery or maintenance of LSVT LOUD. Covert et al. (2018) used a commercially produced teleconferencing system to achieve comparable results for telepractice and face-to-face conditions on nearly all treatment outcomes. The only outcome with unequal results was vocal intensity while reading; the reasons for which were unclear (Covert et al., 2018). Theodoros et al. (2016) used a custom telerehabilitation system to deliver services to the home, and results suggested noninferiority of the telepractice condition. Griffin et al. (2018) established noninferiority of some outcomes (e.g., vocal intensity during reading, monologue, and describing a task), but not others, when delivering LSVT LOUD via tablet-based videoconferencing. Technical difficulty with the tablet as a measurement tool compelled the researchers to remove measures of vocal pitch (Griffin et al., 2018, p. 210). Quinn et al. (2018) successfully conducted group intervention sessions to help participants maintain their gains after completing LSVT LOUD. Dias, Limongi, Barbosa, et al. (2016) found potential benefit of remotely administering the extended version of LSVT LOUD (LSVT-X), in which sessions are distributed over a longer time period.

Three studies examined telepractice specifically for intervention for PPA (Dial et al., 2019; Meyer et al., 2016; Rogalski et al., 2016). Meyer et al. (2016) demonstrated feasibility of telepractice delivery of phonological and orthographic treatment of naming impairments. Dial et al. (2019) retrospectively found positive results for the use of computers, iPads, and videoconferencing software to deliver lexical retrieval therapy or video-implemented script training in aphasia. Rogalski et al. (2016) developed an online web portal application to connect participants with a variety of features, including education, independent home practice, and SLP videoconferencing sessions applying techniques such as script training and compensatory strategy training, with good results for feasibility.

Two studies examined intervention for traumatic brain injury. Williamson and Isaki (2015) demonstrated the feasibility of delivering a version of Facial Affect Recognition intervention via telepractice. Riegler et al. (2017) demonstrated feasibility and preliminary efficacy of a program including online independent education and periodic SLP videoconferencing for cognitive rehabilitation for veterans with mild traumatic brain injury. Participants completed premade, web-based modules on topics such as compensatory strategies for attention and memory, self-monitoring and self-regulation, and problem-solving, and participated in remotely delivered online sessions with an SLP (Riegler et al., 2017).

The remainder of the studies explored telepractice delivery for dysphagia, voice, and mixed disorder populations. Interestingly, although three studies investigated swallowing assessment, only one included study reported on intervention for individuals with dysphagia. Cassel (2016) presented three cases in which individuals with various swallowing impairments were observed during mealtimes and provided cues for use of postural/compensatory strategies. Fu et al. (2015) exhibited the feasibility of telepractice delivery of intensive voice intervention for vocal nodules after an initial in-person session for vocal hygiene training. Meltzer et al. (2017) successfully demonstrated noninferiority of tablet or computer delivery of intervention and home programming for individuals with aphasia, using various treatment techniques, including communication partner training and structured conversations. In the same study, authors achieved similar results with individuals with poststroke cognitive-communication impairments, but the group was too small to complete formal noninferiority testing (Meltzer et al., 2017).

Technology

Studies generally offered a thorough description of their chosen telepractice technology. Regarding the type of telepractice, all but two studies (Choi et al., 2015, 2016) employed live (synchronous) videoconferencing. SLPs typically communicated with participants in real time using a videoconferencing software, either commercially produced

(e.g., Skype, Zoom, Adobe Connect) or custom made for research purposes. In 10 studies, research teams developed their own software programs (Agostini et al., 2014; Furnas & Edmonds, 2014; Getz et al., 2016; Guo et al., 2017; Macoir et al., 2017; Meyer et al., 2016; Pitt et al., 2017; Rogalski et al., 2016; Theodoros et al., 2016; Ward et al., 2014). Although design of multiple programs may seem redundant, researchers customize software "to overcome some of the limitations of off-the-shelf technology" (Theodoros, 2013, p. 315) and to add features specific to intervention needs. For example, Macoir et al. (2017) created customized software to integrate Promoting Aphasics' Communication Effectiveness (Davis & Wilcox, 1985) techniques into the videoconferencing interface, such as images of objects and tools to enable the written communication modality.

Five studies took a hybrid approach, which ASHA (2019b) defines as "applications of telepractice that include combinations of synchronous, asynchronous, and/or in-person services." Authors included, for example, the integration of electronic home practice assignments, recorded educational materials, or in-person sessions (Fu et al., 2015; Riegler et al., 2017; Steele et al., 2014). Ward et al. (2014) used live videoconferencing for clinical swallow evaluation but included store-and-forward capability for review of swallowing trials in the event of technical failure. Burns et al. (2016) employed a variation of hybrid methodology, in which the telepractitioner could review postprocedure recorded videofluoroscopy while videoconferencing with a radiologist.

Commonly used hardware included computers, tablets, or commercially produced comprehensive teleconferencing systems. In some studies, clinicians and patients utilized the same hardware, such as computers (Agostini et al., 2014; Dias, Limongi, Barbosa, et al., 2016; Fu et al., 2015; Getz et al., 2016; Rhodes & Isaki, 2018; Ward et al., 2014; Williamson & Isaki, 2015), tablets (Griffin et al., 2018; Guo et al., 2017), commercial systems (Burns et al., 2016; Covert et al., 2018), or custom-designed system (Theodoros et al., 2016). In other studies, clinicians and patients utilized different hardware; still, further studies were unclear about hardware used on one or both sides of the clinical interaction. Some studies allowed participants' choice between devices; for example, in Woolf et al. (2016), clinicians and participants used either tablets or computers for aphasia treatment. Beyond the main telecommunication device, researchers often supplemented with peripheral devices such as a microphone (Getz et al., 2016), lighted webcam (Fu et al., 2015), or headset (Pitt et al., 2017). Researchers displayed ingenuity in the selection of peripheral devices. Ward et al. (2014) supplemented remote clinical swallow evaluation with a microphone attached to the participant's lapel to record vocal quality, remote-controlled cameras for use by the telepractitioner, a pulse oximeter, and "a strip of white surgical tape positioned over the patient's thyroid notch to enhance visualization of laryngeal movement during the swallow" (p. 298). Meyer et al. (2016), studying telepractice in PPA, provided participants with an electronic signature pad (such as those used to confirm credit card purchases) to record written responses. The studies investigating LSVT LOUD typically used calibrated microphones and software (Covert et al., 2018; Quinn et al., 2018; Theodoros et al., 2016) to obtain measurements during vocal tasks. In Griffin et al. (2018), where LSVT was delivered via tablet videoconferencing, each participant kept a sound pressure level meter within camera view for the clinician, and the clinician operated an orchestral tuner.

Several studies mentioned technical difficulties encountered during service provision. The most commonly reported difficulty involved interrupted, delayed, or inconsistent quality audio or video (Fu et al., 2015; Rogalski et al., 2016; Ward et al., 2014), which may be due to connection issues or user error. Some studies found it was necessary to provide extended training upon initiation of telepractice services in order for participants to successfully utilize the technology (Griffin et al., 2018; Kurland et al., 2018). In studies reporting technical difficulties, the issues were typically quickly resolved. Publication bias may occlude trials in which technical difficulties were insurmountable, but our results suggested most problems were easily remedied. To avoid technical difficulty, some studies took advantage of trained staff or caregivers, which may be referred to as *eHelpers* (Towey, 2013), to assist patients in using technology or completing tasks. Further detail on individuals facilitating telepractice is found in the Future Directions section below.

Setting

The setting in which telepractice services were delivered, both on clinician and client end, was inconsistently described. Some studies offered thorough descriptions of the setting; for example, Ward et al. (2014) described the rooms in which both the patient and the remote SLP were located: "standard clinical consulting rooms with no special lighting or sound dampening modifications" (p. 298), both within the same department. Quinn et al. (2018) offered group intervention for LSVT LOUD maintenance to individuals in their homes from a clinician in a "sound-attenuated telerehabilitation studio" (p. 5). Studies that were unclear on the setting were either vague overall or described only one end of the clinician interaction. For example, some authors reported interventions were delivered online via videoconferencing without further detail as to where the patient accessed the service. Other studies stated the patient received services at home but did not delineate where or how remote clinicians were situated.

Discussion

This review of the literature from 2014 to 2019 found evidence of feasibility and preliminary efficacy of telepractice delivery of speech-language pathology services for adults. Most of the included studies focused on services for individuals with aphasia and typically for chronic aphasia. Reasons for the relative preponderance of aphasia studies could include reimbursement- or location-related barriers

to SLP services for individuals with chronic aphasia, as several studies cited. Getz et al. (2016) also suggested aphasia treatments are well suited for telepractice given their audiovisual nature (Brennan et al., 2002). The type of telepractice most commonly used was synchronous, specifically videoconferencing. Some of the most promising evidence came from well-designed noninferiority trials suggesting adequate treatment outcomes can be achieved with telepractice. However, based on this approximately five-year sample of recent literature, some issues remain for resolution before strong conclusions can be made regarding telepractice's effectiveness with adults.

An important issue identified by this review is the lack of control groups. Only 34% of reviewed intervention studies included controls. Inclusion of control conditions is crucial for establishing treatment efficacy, because it helps eliminate the possibility of other factors causing treatment effects; this can be achieved with a control group such as in a randomized controlled trial, or controlled conditions in single-case experimental design (Lemoncello & Ness, 2013). Earlier reviews (Hall et al., 2013; McGill et al., 2018; Ward & Burns, 2014) similarly made calls for greater use of controls in telepractice research. Methodological strength (including control) is incredibly important in light of the weight with which evidence strength is considered by policymakers and payers, stakeholders with formidable control over future growth and development of telepractice (ASHA, 2019a). SLPs and speech-language-hearing scientists continue to push forward in the development of stronger studies of telepractice's effect.

Terminological inconsistency was found in the ways studies reported their aims or results, considering phases of clinical research. Phased models of clinical research generally progress from exploratory studies (feasibility or pilot studies) on to efficacy and effectiveness studies (randomized controlled trials). According to Orsmond and Cohn (2015), feasibility studies involve examination of study recruitment and sampling, measures and procedures, acceptability, required resources and management needs, and preliminary participant intervention responses, and pilot studies have a greater focus on intervention outcomes. In this review, Pitt et al. (2019) completed a feasibility study with thorough description of the investigation process. However, some authors aimed to examine feasibility but selected outcomes more appropriate to efficacy studies, focusing more on measuring benefits from treatment than the process of conducting investigation. Some papers employed efficacy study methodology (in which research conditions are not reflective of the larger population), yet concluded the study had demonstrated effectiveness. Reflecting upon our included studies within the Gitlin (2013) framework of interventions, we found noteworthy ambiguity regarding studies' research phases. There are several possible reasons for this lack of clarity: Speech-language pathology interventions or assessments do not always fit neatly into the phases of clinical research, phases can be overlapping or iterative, and the study of service delivery models (such as telepractice) may proceed differently than that of the typical clinical intervention research pathway. However, ambiguity leads to conflicting findings in the literature. Importantly, concordance with accepted medical language for clinical trials can strengthen our arguments for intervention effectiveness when communicating with interdisciplinary audiences. Agreement with one another on these terms can help clarify next steps in telepractice research.

Another area of growth is a need for greater detail in describing treatment setting: both the setting in which services are received and the setting from which services are provided. First, description of environment enables judgment of whether interventions can be generalized to other clinical or patient settings. Sites of service are also important to consider when determining appropriate technology and technology support, compliance to state licensure requirements, and privacy/confidentiality safeguards (ASHA, 2019b). However, setting was often only briefly mentioned in the literature here. Both provider and patient setting in medical telepractice is important with regard to patient safety, liability, and billing. As an example, Medicare currently only reimburses telehealth services occurring between a provider and a patient at certain medical facilities located in specifically designated geographic areas (Center for Connected Health Policy, 2019). In-home services are excluded except for dialysis in end-stage renal disease (Centers for Medicare & Medicaid Services, 2019). Many of the studies in this review provided services to the home. In-home services take advantage of telepractice's inherent "potential for greater ecological validity since therapy is provided in more natural communication environments than a clinic" (Rhodes & Isaki, 2018), but adult medical SLP research may benefit from more studies reflecting potential future reimbursement requirements (e.g., remote services are provided to a patient located in a medical facility) in the event SLPs become eligible providers of telehealth services under Medicare. Overall, when medical services occur from beyond the typical clinic room, describing the environment in which intervention takes place on both ends of the encounter is critical.

Limitations

This review investigated a broad research question. Evidence was included from multiple populations and across the continuum of care. Narrower research questions allow for stronger statements about specific interventions or disorders. However, as stated in our aim, we found this appropriate for the state of the evidence in telepractice and for our goal of identifying patterns in the current body of evidence. Next, results are subject to publication bias. It is certainly possible that unsuccessful telehealth or telepractice interventions were not submitted for publication. Then, our literature search was conducted as thoroughly as possible, but we may have excluded relevant studies. Finally, data extraction and quality assessments were completed by a single author, introducing bias. This was mitigated by review and discussion between authors. It is hoped many authors will revise and expand upon the results presented here with further telepractice literature reviews.

Future Directions

Telepractice is a developing field, and there are many exciting opportunities for research. First, while we have evidence for feasibility and preliminary evidence for adult telepractice efficacy, convincing arguments for treatment effectiveness require studies with stronger methodology and the investigation of outcomes under typical clinical conditions. Further research in these conditions is needed to elucidate the relationship between telepractice service delivery models and communication and swallowing outcomes. Careful implementation of experimental controls can help produce stronger results and more definite conclusions about the use of telepractice in medical populations.

Beyond this, the review suggested some adult disorder populations for further, up-to-date investigation of telepractice service delivery. Our review considered about a five-year time period and found literature primarily on aphasia, dysphagia, PD, and PPA. Apraxia of speech was often noted as a comorbidity in the aphasia studies (Furnas & Edmonds, 2014; Kurland et al., 2018; Pitt et al., 2017; Rhodes & Isaki, 2018; Walker et al., 2018) but not investigated specifically. Telepractice service delivery for motor speech disorders, augmentative and alternative communication, and dementia are all excellent opportunities for study. Some of these populations have been studied in papers that were not applicable to our review criteria and therefore excluded from this review. For example, Utianski et al. (2019) explored the effects of audio processing on listener's judgments of dysarthric speech but was not included here as it did not involve a specific assessment or intervention. The reader is encouraged to find these papers in Table 4. Motor speech has been examined in the past (e.g., Hill et al., 2009) but may benefit from updated investigation.

Additionally, future research can illuminate the role and impact of eHelpers in telepractice services. These individuals may provide technical or practical assistance to their patient or help facilitate aspects of the intervention requiring "hands-on" interaction. In this review, about a third of the studies specifically mentioned inclusion of such assistance. Individuals filling the "eHelper" role included allied health assistants, feeders, nurses, or certified nursing assistants supporting dysphagia evaluation (Burns et al., 2016; Morrell et al., 2017; Ward et al., 2014) or LSVT LOUD (Covert et al., 2018), speech-language pathology assistants supporting group intervention (Steele et al., 2014), or family members or communication partners assisting with home intervention (Meltzer et al., 2017; Pitt et al., 2017, 2018, 2019; Walker et al., 2018; Woolf et al., 2016). ASHA (2019b) has also identified the use of trained facilitators as an important consideration in telepractice. Although beyond the scope of this review, there is great opportunity to investigate this area in detail.

Conclusion

Consistent with many reviews in the field of telerehabilitation, our review found overall positive evidence with relatively low or moderate methodological strength (Russell & Theodoros, 2017). This is similar to Molini-Avejonas et al. (2015), whose findings suggested positive results of telepractice service delivery but also suggested a need for stronger studies in order to generalize results or determine best practice. Feasibility of telepractice delivery of speech-language pathology has been demonstrated across a variety of adult populations, in both assessment and intervention, and efficacy is at least preliminarily demonstrated. Finally, we identified and described possible opportunities for growth in the literature, such as including controls in research designs, detailed reporting of the settings in which telepractice occurs, and examination of telepractice in further disorder populations.

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