SUBJECT REVIEW

Telepractice in the assessment and treatment of individuals with autism spectrum disorders: A systematic review

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Abstract

Objective: Studies involving the use of telepractice in the delivery of services to individuals with autism spectrum disorders (ASD) were reviewed with the intent to inform practice and identify areas for future research.

Methods: Systematic searches of electronic databases, reference lists and journals identified eight studies that met predetermined inclusion criteria. These studies were analysed and summarized in terms of: (a) characteristics of the participants, (b) technology utilized, (c) services delivered via telepractice, (d) research methodology and (e) results of the study.

Results: Telepractice was used by university-based researchers, behaviour analysts, psychiatrists and psychologists to assist caretakers and educators in the delivery of services to 46 participants with ASD. The services delivered included behavioural and diagnostic assessments, educational consulting, guidance and supervision of behavioural interventions and coaching/training in the implementation of a comprehensive early intervention programme.

Conclusions: Results suggests telepractice is a promising service delivery approach in the treatment of individuals with ASD that warrants additional research. Guidelines for practitioners and potential directions for future research are discussed.

Keywords: telepractice, telemedicine, telediagnostic, telehealth, videoconferencing, distance education, autism, ASD, Asperger’s, PDD-NOS

Introduction

The number of children in the US diagnosed with an autism spectrum disorder (ASD) has increased and is now reported to be as high as three-to-six cases per 1000 children [1]. Research has shown that early intervention using evidence-based practices...
is effective in improving long-term outcomes for children with ASD [2,3]. Implementation of evidenced-based practice often requires a specialist (e.g. speech language pathologist, behaviour analyst, special educator or psychologist). Therefore, as the number of individuals diagnosed with ASD increases, so does the need for specialists trained to provide evidence-based practices.

The World Health Organization (WHO) identified a lack of trained specialists as a primary obstacle in providing adequate services to individuals with intellectual disabilities [4]. The shortage is most pronounced in rural and geographically isolated areas [4–6]. Within the US, there are documented shortages of speech language pathologists [7] and special educators [8]. In terms of Board Certified Behavior Analysts (BCBA), Florida, California, Massachusetts and New York each have between 200–400 BCBA and, many states have fewer than 10 [9]. Therefore, given the prevalence of individuals with ASD in these states, the shortage of BCBA in the US is apparent.

The Individuals with Disabilities Education Act [10] and the No Child Left Behind Act [11] require that schools implement evidenced-based practices. However, due to the shortage of specialists, students with ASD are often evaluated and treated by less qualified or uncertified personnel (e.g. teaching assistants), particularly in rural communities where access to specialists is most limited [4]. When intervention is implemented by individuals who have insufficient training, to the extent the fidelity of implementation is reduced, intervention outcomes for children with ASD suffer [2,6,8]. However, it is not always logistically or fiscally possible to routinely travel the distances it would require to link trained specialists to children with ASD who require their services. Further, analysis of current trends in the recruitment and training of future specialists suggests the need for additional specialists may not soon be met [7].

Telepractice (also called ‘telehealth’ and ‘telemedicine’) involves the application of communication technologies (e.g. computer-based video-conferencing software and the internet) to enable specialists to consult and deliver services in real-time over a geographical distance [13]. A large body of literature supports the use of telepractice to deliver health care services to other populations in need of specialized services [14,15]. For example, telepractice has been used to connect doctors in hospitals to home-bound patients recovering from chronic heart disease [16] and stroke [17,18]. Given this success, it is possible that telepractice may also be useful in connecting specialists in the field of ASD to individuals with ASD in need of services. Although the use of telepractice in the assessment and treatment of individuals with ASD has been evaluated in a number of studies, no systematic review of this research has been published. Given the unique characteristics of individuals with ASD and the services they require, such a review is warranted.

To facilitate evidence-based practice in this important area, this review provides a systematic analysis of studies in which telepractice procedures were used in the assessment or treatment of individuals with ASD. Each included study is described in terms of the (a) characteristics of the participants, (b) technology and equipment utilized, (c) services delivered via telepractice, (d) research methodology and (e) results of the study. This review has two main aims. First, this review is intended to help guide and inform practitioners and agencies involved in the assessment and treatment of individuals with ASD in the development and implementation of telepractice-based services. Second, this review is intended to identify areas within the existing database in need of future research. Ultimately, it aims to contribute to the larger effort to improve the availability and quality of services for individuals with ASD.

Method

Search procedures

A five step systematic search procedure was used to identify studies for possible inclusion in this review. First, searches were conducted in five electronic databases: Education Resources Information Center (ERIC), Academic Search Premier, Google Scholar, MEDLINE and PsycINFO. Publication year was not restricted, but the search was limited to studies written in the English language and appearing in peer-reviewed journals. Searches were conducted on each database using combinations of the keywords ‘Asperger’, ‘Autism’, ‘PDD-NOS’, ‘Developmental Disability’, ‘Syndrome’, ‘Telediagnostic’, ‘Telemedicine’, ‘Telepractice’, ‘Teleconference’, ‘Skype’, ‘iChat’, ‘videoconferencing’, ‘distance education’, ‘telehealth’ and ‘Teletherapy’. This process identified 21 studies for possible inclusion. The abstracts of these studies were reviewed to identify studies meeting the inclusion criteria (see Inclusion Criteria below). Second, reference lists of studies meeting these criteria were then reviewed to identify additional articles for possible inclusion. Third, the surname of the first author of each of the included studies was then searched to identify additional work by that author to be considered for inclusion. Fourth, to identify more recent studies not yet listed in the aforementioned databases, hand searches of the two most recent issues of the journals...
that had published at least one of the included studies were conducted. Finally, the author listed as the primary contact for each of the included studies was sent an E-mail with the list of included studies and asked to identify any additional work meeting the inclusion criteria that did not appear on the list. This systematic multi-step search procedure occurred between February and April 2010.

**Inclusion criteria**

To be included in this review, studies had to meet three inclusion criteria. First, the study had to contain at least one participant with an ASD diagnosis (i.e. autism, Asperger's or PDD-NOS). Second, at least one dependent measure had to involve the individual with ASD and the results of an assessment, evaluation of changes in behaviour (e.g. learning a new skill or decreasing challenging behaviour) and/or the fidelity of implementation of an assessment, intervention or educational programme. Finally, some form of telepractice had to be used to deliver one of the above services from a specialist or expert (e.g. researcher, psychiatrist, behaviour analyst or speech language pathologist) at one location to participants with ASD at a second location. For example, a psychiatrist’s could conduct a psychiatric evaluation from a city hospital with a child with ASD in a rural setting [19].

In order to ensure the accuracy of the systematic search and the application of the inclusion criteria, the authors of this review independently ran the first step of the multi-step search procedure and made an initial determination as to whether each study identified met inclusion criteria. Agreement as to whether a study should be included or excluded was 89% (i.e. agreement was obtained on eight of the nine studies). Zahn and Buchanan’s [21] study was identified for inclusion by some authors and not by others. After discussion, this study was excluded because the focus of that study was on a university-based distance education programme for in-service teachers and few details regarding the participants with ASD were reported.

**Data extraction**

Each identified study was first assessed for inclusion. Then, each included study was read and summarized by the first author of this review. The first author used a coding sheet designed specifically for this review (available upon request) to extract data describing the: (a) characteristics of the participants with ASD, (b) technology and supports utilized to facilitate telepractice, (c) type of services delivered via telepractice, (d) research design employed and (e) results and conclusions of the study. Various procedural aspects were also noted, including the settings involved in the telepractice and the obstacles to implementation.

**Inter-coder agreement**

The accuracy of the summaries was independently checked by one of the remaining co-authors using a checklist that included the initial summary of the study and five questions regarding various details of the study. Specifically, (a) is this an accurate description of the participants?, (b) Is this an accurate description of the technology?, (c) Is this an accurate summary of the services delivered?, (d) Is this an accurate description of the research design?, and (e) Is this an accurate summary of the results and conclusions? Co-authors were asked to read the study and the summary and then complete the checklist. In cases where the summary was not considered accurate, the co-authors were asked to edit the summary to improve its accuracy. The resulting summaries were then agreed upon and used to create Table I.

This approach was intended to ensure accuracy of the study summaries and to provide a measure of inter-coder agreement on data extraction and analysis. There were 40 items on which there could be agreement or disagreement (i.e. eight studies with five questions per study). Agreement was obtained on 34 items (85%). In the six instances where aspects of the summaries were initially considered inaccurate, changes were made to more accurately summarize the studies. The summaries were repeatedly evaluated by the co-authors until 100% agreement was reached.

**Results**

Table I summarizes the (a) participants, (b) technology utilized, (c) services delivered via telepractice, (d) research design and (e) results of each of the eight included studies.

**Participant characteristics**

Collectively, the eight studies provided telepractice services to a total of 46 participants. The sample size of individual studies ranged from one-to-29 participants with ASD. Three studies included only one participant and one included 29. Across the eight studies, nine (20%) of the participants were male and four (9%) were female. The sex of the remaining 33 (69%) was not reported. The most common diagnosis was autism (n = 42; 91%). The participants ranged in age from 2–11 years old (M = 3.75). The specialists who provided services included university-based researchers, behaviour analysts/consultants, education specialists, psychiatrists and
<table>
<thead>
<tr>
<th>Reference</th>
<th>Participant characteristics</th>
<th>Technology</th>
<th>Services delivered</th>
<th>Research design and outcomes</th>
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<tbody>
<tr>
<td>Barretto et al. [20]</td>
<td>1 male, 5 years old, autism</td>
<td>Iowa Communications Network (ICN), a 2800 mile fibre-optic telecommunications system connects a host hospital to rural communities using a television monitor, a camera for transmitting and recording, microphone and multimedia projector. A microphone and the multimedia projector were placed in a classroom. Teachers were coached via video and audio transmitted from the experts.</td>
<td>A brief functional analysis [25] was conducted in a school classroom by consulting clinicians located at university-based hospital who guided the actions of local service teams in rural areas.</td>
<td>Research design: The brief functional analysis was conducted within a multi-element design. Results: The functional analysis was successfully conducted. The results of the functional analysis differed from the results of an interview assessment done without the use of telemedicine.</td>
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<td>Gibson et al. [27]</td>
<td>1 male, 4 years old, autism</td>
<td>Two Dell Latitude D820 notebook computers with an internal microphone, 1.83 GHz processor and 504 MB of RAM were used to run the desktop videoconferencing application Skype. A high-speed Internet connection was available via Ethernet cable. A Logitech Quickcam Pro USB camera was hung from the ceiling of the classroom. Video was transmitted at 15 fps. The experts’ feedback was transmitted to the teacher’s ear bud via an Azden UHF wireless microphone.</td>
<td>University-based behavioural consultants conducted a FBA, developed an intervention, trained teaching staff to implement FCT, collected data on target behaviour and provided ongoing feedback to teachers in the school.</td>
<td>Research design: ABAB design was used to evaluate the effectiveness of FCT in reducing challenging behaviour. Results: Teachers accurately implemented the intervention and challenging behaviour was significantly reduced. This suggests that the services provided via videoconferencing were effective. Teachers rated the remote consultation as acceptable on the BIRS-R.</td>
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<td>Machalicek et al. [23]</td>
<td>2 females, 7 and 11 years old, autism</td>
<td>Two Mac-Book laptop computers with 2 GHz processors, external iSight cameras, internal microphones and broadband internet connection were used to run iChat video conferencing software. A high speed internet connection was available via FireWire 400 (IEEE 1394a) cable. Video was transmitted at 30 fps.</td>
<td>University-based behaviour analysts guided the teachers’ implementation of a functional analysis and collected data on challenging behaviour in the school.</td>
<td>Research design: The functional analysis was conducted within a multi-element design. An intervention created from the functional analysis was evaluated in an alternating treatment design for each student. Results: The intervention created based on the results of the functional analysis was successful in reducing challenging behaviour and increasing on task behaviour. This suggests that the functional analysis conducted via videoconferencing was accurate.</td>
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<tr>
<td>Study</td>
<td>Participants</td>
<td>Technical Setup</td>
<td>Notes</td>
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<td>Machalicek et al. [30]</td>
<td>2 males, 5 and 7 years old, autism; 1 male, age 34 months with PDD-NOS</td>
<td>Two Mac-Book laptop computers with 2 GHz processors, external iSight cameras, internal microphones and broadband internet connection were used to run iChat video conferencing software. A high speed internet connection was available via WiFi. Video was transmitted at 30 fps.</td>
<td>University-based behaviour analysts guided the pre-service teachers' implementation of a paired-choice preference assessment [29] and collected assessment data in the school. Research design: Interventions created from the results of these preference assessments were evaluated in alternating treatment designs. Results: The intervention based on the result of the preference assessment was successful in increasing desirable behaviour. This suggests that the preference assessment conducted via videoconferencing was accurate.</td>
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<tr>
<td>Machalicek et al. [24]</td>
<td>4 males, 2 females, $M$ years old $= 5.9$, autism</td>
<td>Two Mac-Book laptop computers with 2 GHz processors, external iSight cameras, internal microphones and broadband internet connection were used to run iChat video conferencing software. A high speed internet connection was available via Ethernet network cable and WiFi. Video was transmitted at 30 fps.</td>
<td>University-based behaviour analysts guided the teachers' implementation of a functional analysis and collected data on challenging behaviour and implementation fidelity in the school. Research design: The teachers' fidelity of implementation of functional analysis procedures was evaluated in a multiple baseline design across teacher–student dyads. Results: With performance feedback, teachers learned to implement the functional analysis procedure. This skill was maintained without expert guidance across teachers for a $M$ of 5 weeks following videoconferencing. Teachers rated the videoconferencing as satisfactory and effective with a $M$ of 5.4 on a 6-pt Likert scale.</td>
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<td>Rule et al. [31]</td>
<td>1 preschool age child with autism</td>
<td>An unspecified Polycom system was connected to the internet via a T-1 line.</td>
<td>University-based researchers and educational consultants attempted to interact with teachers to develop and implement an IEP in a school. Research design: Pilot testing, research design not reported. Results: Technology and logistical-programmatic challenges were never overcome and videoconferencing was considered unsuccessful. The introduction of the Polycom system in the schools networked created bandwidth issues and limitations. Insufficient tech-support personnel were available to address technology problems.</td>
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<td>Savin et al. [19]</td>
<td>3 children with autism or pervasive developmental disorder out of a larger group of 21 children with other diagnoses</td>
<td>A videoconferencing unit was connected to an integrated services digital network (ISDN) circuit in which six bonded channels transmit at 384 kilobits per second. Video was transmitted at 30 fps.</td>
<td>Psychologists and psychiatrists provided psychiatric and psychological evaluations and consulting to Native American children living in rural areas. Research design: Research design was not reported. Results: Patients and parents reported feeling comfortable with the technology and satisfied with the services. Specialists reported it took longer to establish rapport with the patients but believed they were able to make accurate diagnoses and treatment recommendations.</td>
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<td>Vismara et al. [28]</td>
<td>29 children, 2–4 years old, autism</td>
<td>The system was referred to as ‘telehealth technology’, but the specific technology or equipment utilized was not reported in the study.</td>
<td>University-based researchers taught community-based early intervention specialists and parents to implement the Early Start Denver Model, a comprehensive early life intervention programme in children’s homes.</td>
<td>Research design: 10 therapists were assigned to one of two groups. One group received training via live in-person instruction and a second group received instruction via telepractice technology. Changes in child social-communicative behaviours, therapist implementation fidelity and satisfaction with services were measured for both groups. Results: Although both groups (live instruction and telepractice instruction) made significant improvements in fidelity of implementation overtime ($F_{(3, 24)} = 8.85, p &lt; 0.001$), no difference between groups in child outcome, therapist/parent implementation of the intervention or therapist/parent satisfaction with services was found. This suggests that distance education technology was as effective as live instruction.</td>
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  * Behavioral Intervention Rating Scale–Revised;  
  * Frames per second;  
  * Skype is publicly available web-based software [38];  
  * Functional Communication Training [39];  
  * iChat is publicly available web-based software [40];  
  * Functional Behavioral Assessment [41].
psychologists. These specialists delivered training and supervision to teachers, therapists and parents located in schools, homes and rural community-based clinics.

Technology used

The majority of the studies included in this review used widely available technology to implement telepractice. This included laptop computers with both internal or peripherally connected microphones and web cameras connected to the Internet via high-speed Internet connections. Video was transmitted at a rate of either 15 or 30 frames per second (fps). Skype® and iChat® videoconferencing software programs were used. Skype and iChat both allow video and voice calling over a variety of different mobile internet devices and are currently available for free download. Two studies used more sophisticated and permanent telecommunications technologies. Barretto et al. (2006) used the Iowa Communications Network (ICN). The ICN involves 2800 miles of fibre-optics that directly connect over 700 classrooms. ICN services include full-motion video, video over IP, voice, data, WAN connections, remotely controlled cameras and high-speed Internet [21]. Savin et al. [19] used an integrated services network circuit in which six bonded channels (the equivalent to six aggregated telephone lines) were able to transmit 384 kilobits per second (kps).

Services delivered

Telepractice was used to deliver a variety of services. In three studies [22–24] behaviour analysts located at university-based clinics collected data on challenging behaviour and guided the implementation of functional analysis procedures [25,26]. In two studies researchers trained teachers, therapists or parents to implement multi-step behavioural interventions, functional communication training [27] and the Early Start Denver Model [28]. In one study psychologists and psychiatrists from an urban clinic provided consulting and evaluations to a clinic serving Native American youth on their reservation [19]. In another study behaviour analysts collected data and guided the implementation of preference assessments [29] in a special education classroom [30]. Finally, one study attempted to set up a more permanent consulting relationship between university-based specialists and a school located in a rural area for the purpose of consulting on the development of individualized education plans [31].

Research designs

The most common research design utilized to evaluate the efficacy of services delivered via telepractice was a single-subject experimental design. For example, when the service provided via telepractice was a behavioural assessment (e.g. functional analysis or preference assessment), the accuracy of this assessment was evaluated by designing a behavioural intervention or educational programme based on the assessment results and then determining if the assessment-based intervention/programme was effective in either a multi-element, multiple baseline or ABAB design. This approach was used in five studies [22–24,27,30]. Vismara et al. [28] taught 10 therapists to implement the Early Start Denver Model of early intervention in a quasi-experimental group research design. Five therapists received face-to-face in person instruction and the other five received instruction via telepractice technology. Assignment to these groups was based on distance from the university delivering training and was therefore not random. The remaining studies did not identify a research design and were considered pilot testing [19,31].

Outcomes

Seven of the eight studies included in this review reported successful implementation of telepractice to deliver the intended services. Rule et al. [31] was the only study in which the researchers stated that ‘technological and programmatic challenges were never fully overcome’ (p. 1). However, despite the obstacles, the researchers stated that the child involved in the case study still ‘clearly benefited from the services’ provided via telepractice.

Discussion

This review summarized and analysed eight studies involving the use of telepractice to allow university-based researchers, behaviour analysts, psychiatrists and psychologists to deliver services to 46 participants with ASD and their caregivers or educators. A variety of services were delivered including behavioural and diagnostic assessments, educational consulting, guidance and supervision of behavioural interventions and coaching/training in the implementation of a comprehensive early intervention programme. Seven of the eight reviewed studies reported successful implementation and positive outcomes of services delivered via telepractice (see Table I).

Nonetheless, the existing literature base is perhaps best described as limited with respect to the overall
connection (T-1 line) sufficient for the transmission involved in that study had a high-speed Internet required. For example, even though the school existing infrastructure to support the technology is initial obstacles. First, a comprehensive analysis of the checklist does emerge that may help prevent potential obstacles. Although technological and programmatic challenges were never fully overcome, the following checklist does emerge that may help prevent potential obstacles. First, a comprehensive analysis of the existing infrastructure to support the technology is required. For example, even though the school involved in that study had a high-speed Internet connection (T-1 line) sufficient for the transmission of video and audio, the addition of the teleconferencing equipment to the system introduced bandwidth restrictions that reduced the quality of the transmissions and hindered procedures. Similar problems might be encountered with firewall settings and lower speed internet connections. Second, technical support personnel familiar with the aims of the study and the equipment being utilized may be required at both locations. The support personnel should have a pre-established troubleshooting plan and a back-up means for communication (e.g. cell phone) in the event communication via the telepractice equipment is not immediately possible. Third, evaluation of the expenses associated with the implementation of telepractice must include not only the cost of the equipment, but also the technical support personnel and other associated maintenance and material costs.

Several unique ethical and legal issues exist when delivering services via telepractice [12,33]. First, the Health Insurance Portability and Accountability Act of 1996 (HIPPA) requires safeguards to ensure the privacy of information transmitted electronically [34]. One manner to protect privacy during telepractice procedures is to use a virtual private network (VPN). A VPN can provide several types of data protection, including confidentiality, integrity, data origin authentication, replay protection and access control. The National Institute of Standards and Technology has a manual currently available as a free download from the HIPPA website that provides specific recommendations concerning VPNs and telepractice [35,36].

A second legal and ethical consideration involves informed consent. When providing informed consent it is necessary to provide the involved parties with information regarding how services may be different if delivered via telepractice as opposed to face-to-face, describe risks and benefits specifically associated with telepractice and how breeches in confidentiality may be difficult to remedy [12,31]. Depending on the nature of the service being delivered and the professional organization or certifying agency associated with that service (e.g. American Psychological Association, American Speech-Language-Hearing Association or Behavior Analyst Certification Board) additional ethical and legal considerations may be required prior to implementing telepractice.

The results of this review suggest telepractice is a promising service delivery model and highlights the need for future research. The American Speech Language Hearing Association (ASHA) has recommended directions for future research in the delivery of speech language pathology services that are also relevant to the delivery of other services often sought by individuals with ASD. Specifically, ASHA...
recommends that future research should address: (a) technological requirements to support diagnostic protocols and intervention procedures; (b) further analysis of clinical efficacy and effectiveness; (c) client, clinician and caregiver satisfaction (i.e. social validity measures); (d) a system for determination of client candidacy for telepractice; (e) cost-benefit analyses; and (f) practical implementation issues (e.g. scheduling, workflow and organizational readiness) [37]. Moreover, future research studies utilizing telepractice should be conducted across a range of service delivery locations including controlled trials in laboratory settings and real-world locations such as clinics, schools and client homes in both rural and urban areas. Future studies should address the provision of telepractice services across various disciplines, including behavioural analysis, speech and language pathology, audiology, special education and psychology.

Among the areas warranting future research, perhaps foremost is the need to evaluate telepractice using more rigorous experimental methods that offer the potential for providing a greater certainty of evidence. Single-subject designs (e.g. multiple baseline, ABABA or multi-element) were the most commonly used approach. In the studies reviewed, it was assumed that the assessment or coaching delivered via telepractice was effective if the services delivered resulted in positive behaviour change. Although this methodology does provide some evidence that the services provided via telepractice were effective, conclusions are limited because a direct comparison between the outcomes of services delivered via telepractice and the outcomes of onsite implementation were not made. Therefore, questions regarding the relative efficacy of telepractice vs services provided onsite remain unanswered.

Given the shortage of specialists and the rising rates of ASD diagnosis, the need for further research regarding the capabilities and limitations of telepractice as a service delivery model is apparent. If current development trends are sustained, technology advances will result in more powerful, less expensive and more compact equipment. Consequently, telepractice will likely become increasingly more efficient, effective, versatile and, potentially, an even more viable means to address the need for improved access to treatment for individuals with ASD.

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