

# Guidelines for Developing Telehealth Services and Troubleshooting Problems with Telehealth Technology When Coaching Parents to Conduct Functional Analyses and Functional Communication Training in Their Homes

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**Abstract** The researchers in the project used telehealth to conduct functional analyses and functional communication training in homes of children diagnosed with autism who displayed problem behavior. Parents conducted all assessment and treatment procedures within their homes while receiving coaching from applied behavior analysts located approximately 200 miles away from them. In this article, the researchers summarize the technical systems they used to develop a telehealth service and the concerns and problems they have encountered using telehealth and provide some guidelines for how to troubleshoot those problems.

**Keywords** Telehealth · Autism · Functional analysis · Functional communication training

The State of Iowa was an early provider of telehealth services, primarily because of the establishment of the Iowa Communications Network (ICN) in 1987. The ICN is a 2800-mile fiber-optic telecommunication system that connected most hospitals and high schools in Iowa (Barretto et al. 2006). The original purpose of the ICN was educational, but in 1994, the use of the ICN was extended to health care

facilities including The University of Iowa Hospitals and Clinics. In 1996, The University of Iowa's National Laboratory for the Study of Rural Telemedicine received a grant from the US National Library of Medicine (NLM) to fund projects that evaluated the effects of telehealth on access to health care (Kienzle 2000). One of the projects initiated in pediatrics with partial funding from the NLM was behavioral consultation, assessment, and treatment of severe problem behavior displayed by children with developmental disabilities (Barretto et al. 2006). This project was conducted via the biobehavioral outpatient clinic (Northup et al. 1991) and was restricted to sites connected by the ICN.

In 2009, Lindgren and Wacker received funding from the National Institute of Mental Health (NIMH) to increase telehealth services to those same outpatient clinics with an emphasis on direct observation. Wacker et al. (2013a, b) provided the outcomes of conducting functional analyses (FA; based on Iwata et al. 1982/1994) and functional communication training (FCT; based on Carr and Durand 1985) via telehealth with young children with autism. Approximately 20 families received coaching from applied behavior analysts who were located approximately 200 miles from the families' homes. The families traveled to regional pediatric outpatient clinics that were located within 50 miles of the families' homes. The clinic sites all had accessible and reliable high-speed Internet with preexisting videoconferencing capabilities. A secure connection existed between each clinic and the hospital-based telehealth center, which housed the applied behavior analysts.

The success of this project (average reduction of problem behavior was 93.5 %) led Lindgren and Wacker (2009) to then apply the same telehealth technology and the same function-based assessment and treatment approach directly into the homes of parents of children with autism. The preliminary

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results of this project have been positive (Suess et al. 2014). However, moving from secure outpatient clinic sites to home sites has raised two sets of issues and concerns that previously were not present in the clinic-to-clinic project. The first set of these issues and concerns was related to the technical aspects of delivering applied behavior analysis services directly into home settings. The second set of concerns had to do with variations in the assessment and treatment procedures. In this article, the researchers describe the first set of concerns dealing with technology. Guidelines are then provided for addressing these concerns when the service team has, or does not have, technical expertise as part of their team. The researchers' goal in this article is to acquaint applied behavior analysts with telehealth and to assist them in developing these services for their clients.

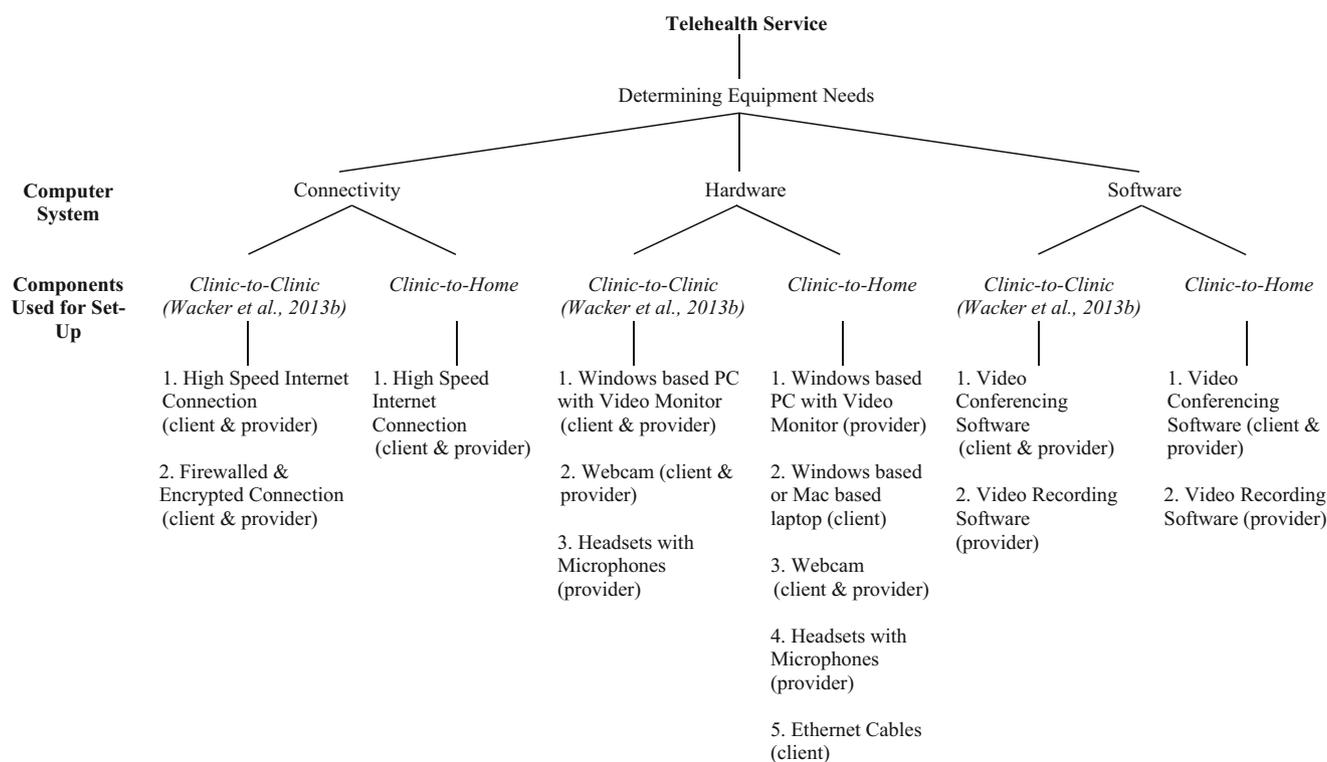
### Where We've Been: Clinic-to-Clinic

In the clinic-to-clinic project (Wacker et al. 2013a, b), the focus was only on service delivery since the telehealth system between the clinic sites was already established. Therefore, the researchers did not have to determine the majority of equipment needs. As depicted in Fig. 1, the equipment components were related to three computer systems: connectivity, hardware, and software. The equipment components previously in place and used in the clinic-to-clinic project were a high-speed Internet connection, firewalled and encrypted

connection, Windows-based PCs with video monitors, webcams, and videoconferencing software. The only equipment that the hospital-based telehealth center needed for the purposes of the previous project were (a) headsets with microphones to minimize the breach of confidentiality in an office space with multiple workstations and (b) video recording software to record the telehealth sessions for subsequent data collection. This established telehealth system allowed the researchers to focus on determining the feasibility of conducting behavior analytic assessments and treatments remotely without the added considerations of the technology needed for remote care.

### Where We've Gone: Clinic-to-Home

Following the success of the clinic-to-clinic project (Wacker et al. 2013a, b), the current clinic-to-home project (Lindgren and Wacker 2011) set out to determine the feasibility of coaching parents via telehealth to conduct the same behavior assessment and treatment package directly in their homes. With this change, the researchers not only had to focus on service delivery but also on the technology aspects of telehealth as each home had different equipment needs. As depicted in Fig. 1, the components used to establish telehealth in the home environment were similar to the clinic-to-clinic project with the largest differences being the inability to secure a firewalled and encrypted connection, additional hardware



**Fig. 1** Comparison of telehealth equipment needs between the clinic-to-clinic and clinic-to-home projects

needs such as laptops and Ethernet cables being sent to the majority of families, and the need to install antivirus software on the laptops sent to the families. To determine the equipment needs for each family, the researchers needed to know something about the following three computer systems: connectivity, hardware, and software, which are discussed individually below and summarized in Table 1. The researchers' decisions about the equipment needs for each computer system were based on determining (a) what options would work best for two-way audio and video transmission; (b) how to keep costs as low as possible while maintaining acceptable audio-video quality; (c) what systems would be simple, secure, and reliable to use; and (d) what equipment would offer the best practical options for scalability so that behavioral telehealth services could be spread as widely as possible across the state of Iowa.

### Connectivity

The researchers' primary concern when developing the clinic-to-home telehealth service was taking the technology they knew from the clinic-to-clinic project, which worked on an internal, intranet (closed, secure, fast, directly connected) system to a broader Internet (open, unsecured, variable speed, web of connections) system. This was a challenge for both the telehealth service providers and hospital IT specialists because a few things remain unique to the practice of applied behavior analysis conducted via telehealth. The main difference between videoconferencing and behavioral teleconsultation is that rather than interacting face-to-face, one side (provider) is presented as just a face with moving lips while the other side (client) appears more like a movie. This presents a challenge on two levels, one from a consultation perspective and the other from a technology perspective. For consultation, the client sees the provider's face much more closely, which may help to build rapport and often supports close relationships between the client and provider; however, the typically greater distance from the camera to the client and the rapid movement displayed on the video can make it difficult for the provider to discern cues from the facial expressions of the client.

Differences in the client's distance from the webcam also make the technology configuration relating to Internet speed more demanding than is typical for routine video chats using Skype™ or FaceTime. For example, if the purpose of the telehealth session requires transmission of increased activity levels such as the child running across the room, higher connection speeds may be needed to obtain acceptable video quality. In contrast, if the purpose of the telehealth session requires transmission of minimal activity, such as interviewing the child or parent, lower connection speeds may provide sufficient video quality. Internet connections are affected by the download speed, upload speed, and latency to transmission speed. The download speed refers to the amount of audio-

video data received per second. This is the speed that is most often reported by the Internet service provider (ISP), and the researchers requested a minimum download speed of 1 megabit per second (Mbps). The upload speed refers to the amount of audio-video data sent by one party to another party per second. This is the speed that is the most frequent source of telehealth connection problems. Therefore, the researchers requested a minimum upload speed of 1 Mbps. The latency to transmission speed (also known as "ping") is the latency or lag between the sending of a signal and receiving a return response, which reflects the amount of time it takes the data to transmit from the telehealth provider to the client and back. The smaller this number, the shorter the delay between the transmission of a behavior and a response. Thus, the researchers requested a minimum latency to transmission speed of 300 milliseconds (ms).

To achieve optimal speeds for videoconferencing, there are numerous types of Internet connection options available to consumers. These services include dial-up (via phone line), coaxial cable (via cable TV line), digital subscriber line (DSL; via phone-line), local-to-dish microwave transmission, satellite, T1-T3 lines (multiple phone-like lines), fiber optic service (FiOS), and cellular. Throughout their project, the researchers have evaluated the use of cable, DSL, local-to-dish microwave transmission, and satellite connection options. These options were evaluated on a case-by-case basis with the project's participants in order to achieve a sufficient video quality that allowed for accurate data collection of the occurrence of severe challenging behaviors. The Internet connection option that achieved the most consistent video quality for the purposes of the researchers' project was cable. Cable-based Internet that was wired from a modem to the computer through an Ethernet cable offered a direct continuous connection to the Internet, which was less likely to result in signal interruptions or interference. However, other wired and wireless options have been effective for individual cases, with dial-up and satellite connections having been the most difficult to implement successfully.

### Hardware

*Computers* To maintain reasonable costs, it was not possible to purchase traditional teleconferencing equipment for the clinic site and for multiple family homes. Instead, the researchers used widely available desktop computers at the clinic site and created a "lending pool" of mid-priced laptop computers for family use. To allow the laptops to function well using the range of networks available to families living in small communities, the researchers had to be sure that non-essential memory or bandwidth-intensive programs (e.g., torrent software and unused browser windows) were removed from the laptops before they could be used by families in the project. For participants who did not have home computers or

**Table 1** Specific equipment and the rationales for their use in the clinic-to-home telehealth project

Computer system	Component	Equipment specifications	Rationale
Connectivity	Internet connection speeds (client and provider)	<ol style="list-style-type: none"> <li>1. Download speed: minimum of 1 Mbps</li> <li>2. Upload speed: minimum of 1 Mbps</li> <li>3. Latency to transmission speed: minimum of 300 ms</li> </ol>	1-3. Necessary specifications for adequate video quality
	Type of Internet connection (client and provider)	<ol style="list-style-type: none"> <li>1. Wired-cable Internet connection</li> </ol>	<ol style="list-style-type: none"> <li>1. Provided the most direct continuous connection and consistent video quality for the purposes of our project that was least likely to result in signal interruptions or interference</li> </ol>
Hardware	Computer	<ol style="list-style-type: none"> <li>1. Laptop with i5® Intel processor, 4 GB of RAM, integrated graphics, 250 GB of hard disc drive storage, 15-in. screen, and open USB 2.0 ports (client)</li> <li>2. Desktop with Intel® Core™ 2 Duo 3.16 GHz processor, 4 GB of RAM, integrated graphics, 250 GB of hard disc storage, 19-in. monitor, and open USB 2.0 ports (provider)</li> </ol>	1-2. Met the minimum requirements for the use of Skype™, and the USB ports accommodated the webcam and headset
	A/V capture	<ol style="list-style-type: none"> <li>1. Logitech c910 or c920 external webcam (client)</li> <li>2. Microsoft Life Cam external webcam (provider)</li> <li>3. Logitech headsets (provider)</li> </ol>	<ol style="list-style-type: none"> <li>1. Camera's autofocus, field of vision, gain, and direction of the microphone placement were important and it provided a wide diagonal field of view, quality video compression, built-in microphone, cross-platform capability, and flexible placement options</li> <li>2. Small size combined with high-quality resolution</li> <li>3. Provided both speakers and microphone in each unit and protected client confidentiality</li> </ol>
Software	Other	<ol style="list-style-type: none"> <li>1. Telephones, cellular phones, Bluetooth headsets (client and provider)</li> <li>2. Ethernet cable (client)</li> </ol>	<ol style="list-style-type: none"> <li>1. Communication without the participant hearing the conversation and emergency communication such as troubleshooting a telehealth problem</li> <li>2. Provided a more direct Internet connection</li> </ol>
	Computer OS (client and provider) Videoconferencing software (client and provider) Video recording software (provider) Antivirus software (client)	<ol style="list-style-type: none"> <li>1. Windows XP or Windows 7</li> <li>1. Skype™</li> <li>1. Debut Video Capture Software Professional</li> <li>1. Bit-Defender and AVG</li> </ol>	<ol style="list-style-type: none"> <li>1. Provided the most up-to-date computer operating system</li> <li>1. Cost-effective</li> <li>1. Saved videos in a small file size without lengthy post-recording processing</li> <li>1. Free and provided the ability to temporarily disable scans and/or shields</li> </ol>

had home computers that were older than 2 years old at the start of the project, the researchers provided them with laptop computers that were equipped with a minimum of an i5<sup>®</sup> Intel processor, 4 gigabytes (GB) of RAM, integrated graphics, 250 GB of hard disc drive storage, 15-in. screen, and open universal serial bus (USB) 2.0 ports. Participant-owned computers used to conduct telehealth sessions included Apple Macintosh laptops, iPads, and desktop computers that were 2 years old or less.

Providers in the project used desktop computers that were equipped with a minimum of an Intel<sup>®</sup> Core<sup>™</sup> 2 Duo 3.16 gigahertz (GHz) processor, 4 GB of RAM, integrated graphics, 250 GB of hard disc drive storage, 19-in. (or larger) monitor, and open USB 2.0 ports. Although computers with lower processing speed and memory capacity may perform at an acceptable level under ideal conditions, the researchers have not tested these options extensively.

*Audio and Visual Hardware* The researchers had participants use external webcams because the camera's autofocus, field of vision, gain, and direction of the microphone placement were important given that the distance of the client from the computer changed during sessions. Participants were provided with Logitech c910 or c920 external webcams because of the wide diagonal field of view (i.e., 78°), quality video compression, built-in microphone, cross platform capability (Mac, Windows, etc.), and flexible placement options. To achieve optimal camera views, some participants were given a 16-ft USB extension cord. On occasion, participants and providers used the integrated webcam on the computer; however, integrated webcams were not typically recommended because of the limited field of view, reduced video quality, and the possibility that the integrated speakers and microphones would automatically mute the audio signal, causing missed information during the telehealth sessions.

To capture audio/video (A/V) data, providers used a Microsoft Life Cam (external webcam) due to its small size combined with high-quality resolution. Webcams were placed on either the top of the computer monitor or on a mini tripod. Using the mini tripod allowed the provider to manipulate the location of the webcam. For example, to appear as though the provider was directly looking at the participant, the webcam and tripod were placed in the middle of the computer monitor at eye level. Other A/V capture hardware used by the providers was Logitech ClearChat Stereo Headsets, which provided both speakers and microphones in each unit. The benefit of these headsets was that noise going to the participant as well as participant sounds that might be heard by others in the clinic environment was minimized. Headsets were connected to the providers' computers using either 3.5-mm mini audio or USB connectors.

*Additional Hardware* In addition to the A/V capture hardware, both the providers and participants used telephones, cellular phones, and Plantronics M50 Bluetooth Headsets when necessary. These were most often used when the provider wanted to communicate with the parent without the participant hearing the conversation or for emergency communication such as troubleshooting a telehealth problem.

Ethernet cables ranging in length from 15 to 50 ft were used for connecting the laptop directly to the cable modem or router in the home where sessions were conducted. Using an Ethernet cable allowed the participants to have a more direct Internet connection, which often improved the video quality when compared to a wireless connection.

## Software

*Computer Operating Systems* Because the researchers decided to use standard desktop and laptop computers rather than expensive dedicated teleconferencing systems, they relied on a software solution to provide telehealth capabilities. For their project, the researchers used either Windows XP or Windows 7 operating systems (OS). Although the researchers did not test other OS, any modern OS (e.g., MAC OSX, UNIX, Chrome, etc.) capable of running videoconferencing software should be sufficient for telehealth.

With OS and software, there are frequent updates to maintain each program's performance. It is important for providers and clients to have OS and software updates installed prior to conducting telehealth sessions because failure to do so may disrupt telehealth sessions (e.g., lost connections).

*Videoconferencing Software* The researchers tested several possible videoconferencing software options and determined that Skype<sup>™</sup> offered the best price-performance ratio of any of the videoconferencing software options available at the time the clinic-to-home project started. Although Skype<sup>™</sup> is one of the most widely used teleconferencing software and uses high levels of encryption to protect user privacy, it does not claim the Health Insurance Portability and Accountability Act (HIPAA) compliance, which has created potential concerns for the use of Skype<sup>™</sup> in health care environments. In the researchers' project, participants signed consent to use Skype<sup>™</sup>, but other telehealth providers may prefer to use alternative software (e.g., Vidyo<sup>®</sup>, Adobe<sup>®</sup> Connect<sup>™</sup>, vSee, etc.) if Skype<sup>™</sup> is not an acceptable option. For example, as an alternative to Skype<sup>™</sup>, the researchers have used Google Hangout in other projects. Google Hangout is run within a web browser (e.g., Internet Explorer, Chrome), requires users to be in a Google+ circle, does not require separate software installation, and appears to provide good video quality. Both Skype<sup>™</sup> and Google Hangout have been practical options for conducting telehealth when traditional videoconferencing hardware and software solutions have been

too expensive to support widespread use. A number of other software-based videoconferencing options may also work effectively, as long as users are able to avoid software that produces long delays in transmission, uses large amounts of system processing capacity, or uses proprietary software/hardware interfaces that adversely impact its ability to provide a quick and consistent connection directly between the provider and the client.

*Video Recording Software* Video recording software can also be used to record the A/V input from telehealth sessions. In their project, the researchers recorded telehealth sessions for subsequent data collection and data analysis using Debut Video Capture Software Professional (Debut). Debut allowed the provider to capture the video feed from his or her computer screen as well as the audio input from both the provider and the participant in a small file size (e.g., less than 10 MB per min of recorded video) using the default settings. Debut instantly saved video files without lengthy post-recording processing that would delay the start of the next session. Other video recording software may also be effective as long as they do not take too long to process the videos, produce too large of a saved file size, or fail to capture both audio sources (provider and client).

*Antivirus Software* Antivirus software is needed on the computers of both the provider and client to prevent malicious viruses from stealing bandwidth, system resources, or private information. Many free antivirus and malware programs exist. For their project, the researchers most commonly used Bit-Defender (free edition) and AVG (free edition) for participant computers. When choosing an antivirus or malware program, it is important to have the ability to temporarily disable scans and/or shields if they are interfering with troubleshooting a telehealth session.

#### IT Support

Any provider is likely to need technology support when delivering services via telehealth. The degree to which technology support is needed will likely depend on the provider's knowledge of technology and on how the provider structures the telehealth services. The researchers initially believed that they would need local technical experts to go into each home to help parents set up their computers and webcams. However, after internal preparation and testing, the providers became relatively conversant with the majority of technological issues that may be encountered and the most common fixes, which are discussed in the next section of this article. This made it easier for the providers to provide technical support for laptops the researchers sent out; similar problems existed for participant-owned computers, which required similar technical support. Most of the technical advice and modifications

can be provided initially over the phone and then over Skype™ once connected.

When enrolling participants, the researchers used technology support to determine the specific equipment the participants needed, prepare the equipment to be sent to the participants, and assist the participants in setting up their equipment. These tasks were conducted across several days with each participant and are represented in Table 2. After the participants received the needed equipment, a technology meeting via telehealth was held with a technology support person (usually the participant's telehealth provider or the first author) to set up and test the equipment prior to conducting telehealth sessions. The first author provided all technology support that could not be provided by the provider, and the researchers highly recommend that each team of providers include one staff member who has these skills. If no one is available on the team, then consider hiring an outside IT specialist. Technology support was used most often at the beginning of the participation in the project and faded across time as the provider and participants became more familiar with the setup needed and the use of effective strategies for troubleshooting problems.

#### What We've Learned: Troubleshooting During Telehealth Sessions

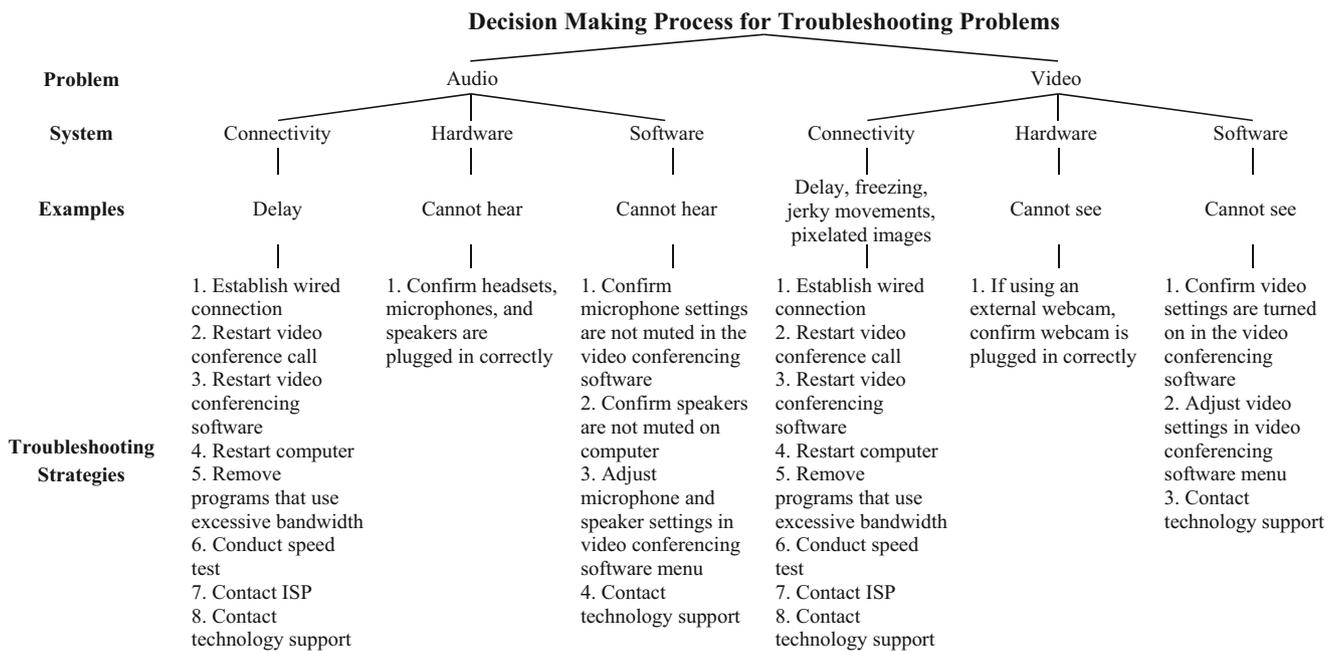
When delivering services via telehealth, providers are likely to encounter some problems with the technology. The most common technology problems that the researchers have encountered have been related to audio transmission or video transmission. These problems are related to connectivity, hardware, software, or a combination of these three computer systems. The decision-making process for troubleshooting problems related to audio and video transmission is provided in Fig. 2. In each section below, the researchers provide two examples of the common audio and video problems they have encountered while conducting telehealth sessions and the step-by-step procedures they used to resolve these problems. These problems are most often easily resolved by the provider after trying one or two basic troubleshooting strategies (see Tables 3 and 4). If the problems persist, additional technology support may be required.

#### Audio Problems

One common problem related to the audio transmission has been the delay in the exchange of audio information. For example, as the provider is conducting a telehealth session, he or she notices that the audio heard in the headset is not synchronized with the client's lip movements on video, which suggests a problem with connectivity. The provider wants to troubleshoot this problem because the delay may affect the

**Table 2** Specific tasks and steps for determining client equipment needs for telehealth services

Computer system	Task	Specific questions to ask or steps to take	Preferred specifications	Video examples and tutorials
Connectivity	Determining client's Internet service connection	<ol style="list-style-type: none"> <li>1. Do you have Internet?</li> <li>2. Who is your ISP?</li> <li>3. Do you have high-speed or dial-up Internet service?</li> <li>4. Is your Internet connected through a cable (cable modem), phone line in a wall (DSL), or dish on your house (satellite)?</li> <li>5. If the client has Internet service but he or she does not know the Internet connection, then he or she needs to contact the ISP to determine what type and tiers of service are currently being provided.</li> <li>6. If the client does not have Internet service, then he or she needs to contact a local ISP to obtain Internet service.</li> </ol>	High-speed Internet through a cable connection	Video comparison between the quality internet connection of cable and satellite service
	Determining both parties' Internet connection speeds	<ol style="list-style-type: none"> <li>1. Go to speedtest.net</li> <li>2. Client chooses city closest to provider's location</li> <li>3. Provider chooses city closest to the client's location</li> <li>4. Begin speed test</li> <li>5. Evaluate results to determine if Internet speeds meet criteria for both parties.</li> </ol>	<ol style="list-style-type: none"> <li>1. Download speed greater than or equal to 1 Mbps</li> <li>2. Upload speed greater than or equal to 1 Mbps</li> <li>3. "ping" delay of less than or equal to 300 ms</li> </ol>	Video demonstration on how to conduct a speed test
Hardware	Determining the client's computer specifications	<ol style="list-style-type: none"> <li>1. Do you own a computer?</li> <li>2. What kind of computer do you own (e.g., laptop, desktop, windows, apple, etc.)?</li> <li>3. How old is your computer?</li> <li>4. What version of Windows is your computer operating?</li> <li>5. How much RAM does your computer have?</li> </ol>	<ol style="list-style-type: none"> <li>1. Computer that is 2 years or newer</li> <li>2. uses Windows 7 or newer</li> <li>3. has at least 4GB of RAM</li> </ol>	Video demonstration on how to determine a computer's specifications
Software	Installing updates for Windows OS and other software	<ol style="list-style-type: none"> <li>1. Go to your Control Panel</li> <li>2. Go to System and Security</li> <li>3. Select Windows update</li> <li>4. Install all important updates</li> <li>5. After updates are complete, restart computer</li> <li>6. Continue to check for important updates until there are no remaining important updates to complete</li> <li>7. Windows may suggest optional updates, installing these should be at the discretion of the user</li> </ol>		Video demonstration on how to check for and complete Windows and other software updates



**Fig. 2** Decision-making process for troubleshooting common telehealth problems

procedural fidelity of the session. To troubleshoot this problem, the provider confirms with the client that the client's computer is running off of a wired connection using an Ethernet cable. The provider then instructs the client to terminate and reestablish the videoconference call. After reestablishing the call, the provider and the client engage in a brief conversation to determine if the audio delay is still occurring. If the provider determines that the delay is still occurring, he or she instructs the client to sign out of the videoconferencing software. The provider confirms that the client has signed out of the videoconferencing software by making sure the client is offline. Following confirmation, the provider also signs out of the videoconferencing software. Next, both parties sign in and reestablish the videoconference call. During a brief conversation, the provider determines that the audio delay has been resolved and resumes the telehealth session.

A second common problem has been that one party is unable to hear the other party. For example, at the beginning of a videoconference call, it is clear that the client cannot hear the provider as demonstrated by the provider talking while the client is shaking his or her head "no," which suggests there may be a problem with either the hardware or software. To troubleshoot this problem, the provider signals to the client by holding up one finger to wait while he or she implements some troubleshooting strategies on his or her computer. First, the provider ensures the hardware is connected properly. Next, the provider evaluates the microphone settings in the videoconferencing software. He or she does not need to test the speaker settings because he or she can hear the client. To test if the provider's adjustments to the microphone settings resolved the problem, the provider speaks to the client but the client

may still respond by shaking his or her head no. The provider thus determines that the problem is not related to his or her settings and is likely related to the client's settings. To adjust the client's settings, the provider calls the client via telephone. The provider instructs the client to check if the computer speakers are turned on. If he or she indicates that the computer speakers are muted, the provider responds by instructing the client to adjust his or her speaker volume. When the client confirms that he or she can hear the provider, the telephone call is ended and they resume the telehealth session.

### Video Problems

Problems with the video transmission (e.g., video delay, freezing video, jerky movements, and tiled or pixelated images) during telehealth sessions may be related to system connectivity. For example, as the provider is conducting a telehealth session, the video transmission may become pixelated and blurry to the point that he or she cannot observe the client's behaviors. The provider needs to troubleshoot this problem because the inability to observe the behaviors compromises the procedural fidelity of the telehealth session. To troubleshoot this problem, the provider confirms that the client's computer is wired directly with an Ethernet cable. Next, the provider and the client restart the videoconference call, videoconferencing software, and their computers, respectively. If the video continues to be pixelated after completing these troubleshooting strategies, the provider may ask the client if there are competing applications running on the client's computer. If the client indicates that he or she has Netflix (or a similar program) running on his or her computer, the provider

**Table 3** Troubleshooting strategies for audio problems

Computer system	Example	Troubleshooting strategy steps	Additional notes
Connectivity	Audio delay	<ol style="list-style-type: none"> <li>1. Establish wired connection</li> <li>2. Restart videoconference call</li> <li>3. Restart videoconferencing software</li> <li>4. Restart computer(s)</li> <li>5. Stop applications that have use too much bandwidth</li> <li>6. Conduct speed test</li> <li>7. Contact ISP</li> <li>8. Contact tech support if audio delay continues</li> </ol>	<p>A. Determine if client is using a wired or wireless connection B. If client is using a wireless connection, plug Ethernet cable into computer</p> <p>A. Both parties need to fully quit, exit, or close videoconferencing software</p> <p>A. Other computer programs i. Unhide all programs in toolbar or click on the double chevrons by the clock. ii. Close unnecessary programs by right clicking on the icon and selecting Close, Quit, or Exit. iii. Leave the following programs running: videoconferencing software, speaker, clock, pointer software, and antivirus protection. B. Other devices using wireless connection (e.g., cellular phones, tablets, etc.) i. Disable the wireless access on other devices using a wireless connection</p> <p>A. Go to speedtest.net B. Client chooses city closest to provider's location C. Provider chooses city closest to the client's location D. Begin speed test E. Evaluate results to determine if Internet speeds meet criteria for both parties</p> <p>A. Call the ISP to check the quality of the signal going to the location. If the quality of the signal is below the tiered service they are subscribed to, ISP needs to resolve this issue</p>
Hardware	Cannot hear	<ol style="list-style-type: none"> <li>1. Confirm that headset, microphone, and speakers are plugged in correctly</li> </ol>	
Software	Cannot hear	<ol style="list-style-type: none"> <li>1. Confirm microphone settings are not muted in the videoconferencing software</li> <li>2. Confirm speakers are not muted on your computer</li> <li>3. Adjust microphone and speaker settings in videoconferencing software menu</li> <li>4. Contact tech support if audio problems continue</li> </ol>	<p>A. In the Skype™ video toolbar, confirm that the microphone icon is on (there should not be a red slash over the microphone icon)</p> <p>A. On the computer toolbar, confirm that the speaker icon is on B. When adjusting the speaker volume, you should hear a sound</p> <p>A. In the Skype™ menu, select Tools—Options—Audio Settings B. Locate the microphone section. Speak into your microphone; if the colored bar moves across your screen, you have the correct microphone source selected. If you do not see the colored bar move across your screen, select an alternative microphone source by clicking on the microphone dropdown menu. Repeat these steps until you see a colored bar move across your screen or until all microphone options have been tested C. Locate the speaker section. Click on the play icon and if you hear the tone, you have the correct speaker source selected. If you do not hear the tone, select an alternative speaker source by clicking on the speaker dropdown menu. Repeat these steps until you hear the tone or until all speaker options have been tested D. After you have your desired settings select, click save before returning to your telehealth session</p>

instructs the client to close Netflix, which improves the video quality of the conference call.

Problems with the video transmission during telehealth sessions may also be related to hardware and software issues.

**Table 4** Troubleshooting strategies for video problems

Computer system	Example	Troubleshooting strategy steps	Additional notes
Connectivity	Video delay, freezing, or pixilated images	<ol style="list-style-type: none"> <li>1. Establish wired connection</li> <li>2. Restart videoconference call</li> <li>3. Restart videoconferencing software</li> <li>4. Restart computer(s)</li> <li>5. Stop applications that have use too much bandwidth</li> <li>6. Conduct speed test</li> <li>7. Contact ISP</li> <li>8. Contact tech support if problems continue</li> </ol>	<ol style="list-style-type: none"> <li>A. Determine if client is using a wired or wireless connection</li> <li>B. If client is using a wireless connection, plug Ethernet cable into computer</li> <li>A. Both parties need to fully quit, exit, or close videoconferencing software</li> <li>A. Other computer programs <ol style="list-style-type: none"> <li>i. Unhide all programs in toolbar or click on the double chevrons by the clock</li> <li>ii. Close unnecessary programs by right clicking on the icon and selecting Close, Quit, or Exit</li> <li>iii. Leave the following programs running: videoconferencing software, speaker, clock, pointer software, and antivirus protection</li> </ol> </li> <li>B. Other devices using wireless connection (e.g., cellular phones, tablets, etc.) <ol style="list-style-type: none"> <li>i. Disable the wireless access on other devices using a wireless connection</li> </ol> </li> <li>A. Go to speedtest.net</li> <li>B. Client chooses city closest to provider's location</li> <li>C. Provider chooses city closest to the client's location</li> <li>D. Begin speed test</li> <li>E. Evaluate results to determine if Internet speeds meet criteria for both parties</li> <li>A. Call the ISP to check the quality of the signal going to the location. If the quality of the signal is below the tiered service they are subscribed to, ISP needs to resolve this issue</li> </ol>
Hardware	Cannot see	<ol style="list-style-type: none"> <li>1. If using an external webcam, confirm that the webcam is plugged in correctly</li> </ol>	
Software	Cannot see	<ol style="list-style-type: none"> <li>1. Confirm video settings are on in the videoconferencing software</li> <li>2. Adjust videos settings in videoconferencing software menu</li> <li>3. Contact tech support if problems continue</li> </ol>	<ol style="list-style-type: none"> <li>A. In the Skype™ video toolbar, confirm that the video icon is on (there should not be a red slash over the video icon)</li> <li>A. In the Skype™ toolbar menu, select Tools—Options—Video Settings</li> <li>B. Cover the webcam you want to use with your hand. If the video screen goes dark, you have the correct webcam selected. If the video screen continues to show a picture when you cover the webcam, select an alternative webcam source by clicking on the webcam dropdown menu. Repeat these steps until your video screen is dark when you cover the webcam you want to use. When you uncover the webcam, you should see your picture on the video screen</li> <li>C. After you have selected your desired settings, click Save before returning to your telehealth session</li> </ol>

For example, if the provider cannot see the client at the beginning of the telehealth session, the provider may determine that this problem is related to the client's webcam. To troubleshoot this problem, the provider confirms that the client's webcam is connected properly. Next, the provider

instructs the client to check the videoconferencing software to confirm that the video feed is on. When the client confirms that the video is on, the provider instructs the client to check the video settings to confirm that the correct webcam source is selected. If problems continue after exhausting these

troubleshooting strategies, the provider contacts tech support for further assistance.

## Conclusion

As applied behavior analysts begin to more fully utilize telehealth options in their service, training, and research programs, they will need access to supports needed to conduct telehealth sessions. The type and level of supports needed will depend on both the interest and skill levels of their team and the goals of the service. If the goals are to (a) conduct real time direct observation of client behavior, (b) coach parents to implement assessment and treatment procedures, and (c) store video and audio files of the observation sessions, then a relatively high level of skill will likely be needed. In this article, the researchers summarized the concerns and problems they encountered and provided guidelines for troubleshooting problems that occurred most frequently.

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## References

Barretto, A., Wacker, D. P., Harding, J., Lee, J., & Berg, W. (2006). Using telemedicine to conduct behavioral assessments. *Journal of Applied Behavior Analysis, 39*(3), 333–340.

- Carr, E. G., & Durand, V. M. (1985). Reducing behavior problems through functional communication training. *Journal of Applied Behavior Analysis, 18*, 111–126.
- Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27*, 197–209. doi:10.1901/jaba.1994.27-197. Reprinted from *Analysis and Intervention in Developmental Disabilities, 2*, 3–20, 1982.
- Kienzle, M (2000). Rural academic integration: Iowa's National Laboratory for the Study of Rural Telemedicine. Retrieved November 3, 2003 from <http://telemed.medicine.uiowa.edu/trcdocs/publications.html>.
- Lindgren, S. D., & Wacker, D. P. (2009) Behavioral treatment for autism in community settings use a telehealth network [Grant # 1 RO1MH089607]. Washington, DC: Department of Health and Human Services, National Institute of Mental Health.
- Lindgren, S. D., & Wacker, D. P. (2011). Behavioral treatment through in-home telehealth for young children with autism [Grant R40MC22644]. Washington, DC: U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau.
- Northup, J., Wacker, D., Sasso, G., Steege, M., Cigrand, K., Cook, J., & DeRaad, A. (1991). A brief functional analysis of aggressive and alternative behavior in an outpatient clinic. *Journal of Applied Behavior Analysis, 24*(3), 509–522.
- Suess, A. N., Romani, P. W., Wacker, D. P., Dyson, S. M., Kuhle, J. L., Lee, J. F., Lindgren, S. D., Kopelman, T. G., Pelzel, K. E., & Waldron, D. B. (2014). Evaluating the treatment fidelity of parents who conduct in-home functional communication training with coaching via telehealth. *Journal of Behavioral Education, 23*, 34–59.
- Wacker, D. P., Lee, J. F., Padilla Dalmau, Y. C., Kopelman, T. G., Lindgren, S. D., Kuhle, J., ...Waldron, D. B. (2013a). Conducting functional communication training via telehealth to reduce the problem behavior of young children with autism. *Journal of Developmental and Physical Disabilities, 25*, 35–48.
- Wacker, D. P., Lee, J. F., Padilla Dalmau, Y. C., Kopelman, T. G., Lindgren, S. D., Kuhle, J., ...Waldron, D. B. (2013b). Conducting functional analyses of problem behavior via telehealth. *Journal of Applied Behavior Analysis, 46*, 1–16.