a white paper on the status of tele-audiology

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Introduction
Tele-audiology has been a developing concept since the 1990s. As in general telehealth practice, the driving force behind tele-audiology has been in response to the key challenges facing health care globally, which include issues of access, equity, quality and cost-effectiveness (WHO, 2010).
This paper will present various salient areas of tele-audiology and the importance of their development toward better hearing health care to all individuals. The areas included in this paper are; Telehealth background, technology, current tele-audiology practices, audiology assistance, licensure/regulation, reimbursement, and priorities for the advancement of tele-audiology.

1. Telehealth background

Telehealth as Part of Health Care Transformation
Telehealth is part of a much larger revolution in health care. The traditional health care model was focused on disease and placed much of the responsibility for managing health care on the patient. It was recognized that this practice model was inefficient, expensive, inequitable, and produced poor outcomes. The evolving health care environment places the patient at the center of health care team.
Health care is personalized. The patient’s care team adapts and customizes the care plan to the patient’s needs, based on the patient’s medical and social history, lifestyle, behavior, and preferences.
Health care is proactive. The care team does not merely react, but rather takes the initiative to anticipate problems. And foremost, health care is patient-driven. The patient is the source of control such that their health care is based in their needs, values, and how the patient wants to live. Health care is also evolving into “connected health” that utilized virtual care, places the patient at the center of
holistic care, focuses of wellness rather than disease, and creates deep partnerships between the patient and the care team, and between the care team and other providers.

In this changing environment, patient engagement will require a command of technology and information. Technology will expand access to care (eliminate face to face visits at the medical center), inform decision making, promote self-management and patient education, enhance patient dialog to foster provider/patient interactions, manage chronic conditions, improve follow up care, improve outcomes and satisfaction, and reduce costs. A key component of connected health is virtual care. Virtual care includes patient access to electronic health records, health information resources, secure messaging between patients and providers, e-consults between primary care providers and specialists, and telepractice.

**Terminology**

The World Health Organization (WHO)(2010) and the American Telemedicine Association (ATA)(2013) have adopted “telemedicine” and “telehealth” as interchangeable concepts. The WHO defines these terms as “The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation and for the continuing education of health care providers, all in the interest of advancing the health of individuals and their communities”.

Many fields of health care have also adopted the prefix “tele” in front of the specific health care practice, i.e., tele-dermatology and tele-psychiatry. For the purposes of this White Paper, the term tele-audiology will be used as a category referring to the practice of audiology using telehealth means.

**Service models**

Providing telehealth services can be classified into two basic models that relate to the timing of the information exchange and the interaction between patient-to-health professional or between health professional-to-health professional (World Health Organization, 2010). The first model has been called “store-and-forward” or asynchronous telehealth involves sharing pre-recorded clinical information from one location to another. The information may be relayed from a patient site (also called the remote or originating site) to a health care provider site (also called the specialist or host site), or between health care providers. Importantly, “store-and-forward” telehealth models do not require a health care
provider to interact with the information in real time. In comparison, “real time” or synchronous telehealth requires that both individuals (e.g., the health care provider and patient) are simultaneously engaging in information exchange.

Both synchronous and asynchronous telehealth models require that information be shared using information and communication technologies (ICTs) which can range from simple technologies including a fax machine, two-way radio or landline telephone, to more advanced technologies such as integrated shared server uploads, video-conferencing and remote desktop-sharing software. In practice, these two telehealth models may also be used in combination and is commonly called a “hybrid” model.

The clinical literature on tele-audiology demonstrates the very real potential of telehealth applications in the practice of audiology. Nevertheless, the practice is not a widespread or mainstream aspect of audiology practice for a variety of reasons. Technical issues, such as connectivity, bandwidth, and equipment, privacy and information security issues, clinician acceptance, and licensure and reimbursement issues have conspired to limit the growth of tele-audiology. The American Academy of Audiology (AAA) resolution on telehealth (2008) stated that telehealth was “emerging” but not validated, and that telehealth services must be validated before being implemented in audiology practice.

More than a decade ago, in 2002, the American Speech-language-Hearing Association (ASHA) surveyed audiologists and speech-language pathologists on telepractice topics, including the use of telepractice, practice settings, telepractice delivery, and barriers to service delivery, among other topics. The survey included 842 audiologists. The survey found that 12 percent of audiologists were engaged in tele-audiology services. Of those who were not providing tele-audiology service, 40 percent expressed an interest in using telehealth. Audiologists delivered tele-audiology services from various locations, including non-residential health care facilities (46 percent), hospitals (26 percent), other settings (16 percent), and the audiologist’s home (14 percent). Patients receiving these services were located primarily at home (78 percent). Audiologists reported a variety of tele-audiology services, including direct patient care (50 percent), consultation (35 percent) education and training (10 percent) and supervision (5 percent). Direct patient care services included counseling (83 percent), follow-up (68 percent), equipment checking (47 percent), prevention (26 percent), screening (15 percent), treatment (14
percent), and assessment 11 percent). Of the audiologists who reported supervision and training via telehealth, 38 percent supervised students, 32 percent supervised paraprofessionals, 56 percent trained students and 32 percent trained paraprofessionals. Areas of audiology practice included amplification devices (89 percent), hearing disorders (79 percent), aural rehabilitation (50 percent), and auditory processing disorders (16 percent).

The survey asked respondents to identify barriers to telehealth. While these responses were not broken out by discipline, cost of technology, lack of professional standards, reimbursement, lack of efficacy, licensure laws, confidentiality, and malpractice were cited as barriers to widespread telehealth practices. For practitioners already using telehealth, time, limitations of patients (technology and disability), preference for face-to-face contact, and lack of equipment and resources were cited as the main deterrents to expansion. In the past 10 years much progress and development has however been made in the practice of tele-audiology (Swanepoel & Hall, 2010).

The barriers to tele-audiology are real, and perhaps insurmountable in the near term in some settings. Technical issues such as equipment and connectivity will always be constraints for any telehealth application. For example clinical video telehealth (CVT) requires video-conferencing-type equipment and software, remotely-controllable peripherals, and remote control software. Connectivity will place limits on where telepractice services can be delivered, and the services that can be effectively delivered. Bandwidth must be sufficient to handle the demands of real-time synchronous data transmission and high-quality video displays. Connecting within hospital networks (for example, between a main hospital and a network clinic) has its own challenges, but the challenges greatly increase when there is different hardware, software, and bandwidth on the patient end.

The U.S. Department of Veterans Affairs (VA) recognized that widespread deployment of telepractice presented many of the challenges for audiologists, as in other health care settings. These challenges include:

- Investment in equipment, information resources, and staff to work effectively.
- Lack of professional standards and the lack of data on efficacy and cost-effectiveness.
- Lack of reimbursement by insurance companies.
- Absence of coverage by practice acts, or prohibited by state professional regulations.
- State laws that restrict the delivery of clinical services across state lines.
• Providers not covered by malpractice liability for telehealth services.
• Credentialing and privileging of practitioners at different facilities.
• Information security and privacy issues.

Practitioner and patient acceptance are major barriers to telehealth, as it is for any major system change. To be accepted in routine practice, audiologists must be confident that tele-audiology will not detrimental to the quality of service, and will be appropriate for the type of services they provide and the patients for whom they care. Audiologists must have confidence in the efficacy of tele-audiology through published studies. Patients must also accept tele-audiology. They must feel that tele-audiology does not degrade the quality of the care they receive or interfere with the rapport and personal interaction they enjoy in face-to-face encounters with their audiologists.

Space and technology pose special challenges. Small outpatient clinics are often not designed for specialized clinical services, and rarely for space demands of an audiology clinic. Tele-audiology requires highly specialized technology, software, and information networks to function seamlessly. It also requires inter-disciplinary collaboration and careful planning. In some facilities, space can be dedicated and designed solely for tele-audiology, but other situations may require sharing space and resources with other disciplines. Consideration must be given to the size and layout of the space, acoustics, lighting, and accessibility. Room design must be consistent with special requirements for tele-conferencing. Persons with expertise in telehealth room design can be helpful in identifying potential problem areas.

In planning tele-audiology, it is also important to assess data transmission lines, adequate bandwidth for videoconferencing connectivity, competing technology during tele-audiology sessions, and the compatibility and characteristics of peripheral devices, e.g., remote control software. While there are many telecommunications and software applications that might be used in tele-audiology, not all are secure. It is imperative that communication systems are secure and protect patient-identifying and protected health information.

The Centers for Medicare and Medicaid Services (CMS) has restrictions on telepractice. At the present time (2014), for example, CMS limits telepractice services to certain originating sites located in a rural health professional shortage area or in a county that is not included in a Metropolitan Statistical Area.
Entities participating in a Federal telemedicine demonstration project may qualify as an eligible originating site, regardless of geographic location. Telepractice is limited to CVT. Asynchronous “store and forward” technology is permitted only in Federal telehealth demonstration programs conducted in Alaska or Hawaii. CMS limits coverage to consultations, outpatient office visits, psychotherapy, pharmacologic management, psychiatric interview, individual health and behavioral assessment, neurobehavioral status exams, end-stage renal disease services, nutrition therapy, and inpatient telehealth consultations and follow-ups by designated telehealth practitioners. Requests to add speech-language pathologists, physical therapists, and occupational therapists were denied because they are not permitted under current law to furnish and receive payment for Medicare telehealth services (42 CFR 410.78).

Despite the barriers that audiology faces, telehealth continues to develop. The clinical literature contains many articles demonstrating tele-audiology applications such as aural rehabilitation (Polovoy, 2009; Yates and Campbell, 2005); cochlear implant programming (Wasowski et al., 2002); hearing aid programming (Campos and Ferrari, 2012; Dennis et al. 2012; Galster and Abrams, 2012); infant hearing screening programs (Krumm et al., 2005, 2007; Lancaster et al., 2008; Hayes et al., 2012); and audiometry (Crowell et al, 2011; Givens and Elangovan, 2003; Givens et al, 2003; Krumm et al. 2007; and Swanepoel, 2012). A systematic review of tele-audiology evidence published in 2010 reported a growing number of papers on audiological services using telehealth (Swanepoel & Hall, 2010). Existing evidence indicated that utilization of telehealth encompassed various areas of audiological services including screening, diagnosis and intervention across infants and adult populations (Swanepoel & Hall, 2010). In general studies demonstrated the feasibility and reliability of audiological services delivered through telehealth means (Swanepoel & Hall, 2010). Current evidence shows that not only is tele-audiology technically feasible; it can also be a natural and integral part of audiology practice.

- The experience of the VA is an example of what can be achieved by the merger of advancements in technology, connectivity, software, and carefully planned and coordinated approach to tele-audiology practice. The VA tele-audiology program is jointly managed by the Office of Telehealth Services, Office of Rehabilitation and Prosthetics Services, and the Audiology and Speech Pathology National Program Office. In 2011, VA established 10 pilot sites to investigate the feasibility of remote hearing aid programming and verification via telehealth, and to take tele-audiology practice from proof of concept to full operational capability. VA
developed a concept of operations; identified a core team comprised of clinicians, technicians, information technology (IT) experts, and biomedical engineering staff; evaluated remote software for effectiveness in audiology applications; and provided the pilot sites with telehealth equipment, compatible audiology peripherals and software, and support staff. VA established a long-range strategic plan for tele-audiology consisting of four phases: remote hearing aid programming, remote audiometry, home-base tele-audiology, and home-based tele-rehabilitation. The goals of the pilot program were to develop and validate telehealth clinical protocols using tele-audiology technology; explore best practices including technology, training, organizations relationships, and clinical procedures; to evaluate the reliability, efficacy, and effectiveness, patient/family and clinician acceptance and satisfaction, quality of care, and cost effectiveness of tele-audiology; to establish minimum technical and equipment specifications for tele-audiology applications; to develop and distribute practice guidelines for tele-audiology; and to build knowledge, clinical practice, and technical infrastructure to expand tele-audiology.

As a result of the pilot project, tele-audiology sites were greatly expanded in FY 2012. As evidence of the success of tele-audiology practice, VA increased tele-audiology encounters from 356 in FY 2010 to over 7,200 in FY 2013, making audiology one of the top 15 VA telehealth programs

Tele-audiology practice may require support personnel. In the typical CVT application, the patient at the originating site (usually a community-based outpatient clinic) must always be accompanied by a technician. Technicians can be health technicians (audiology assistants), registered nurses, licensed practical nurses, or trained telehealth clinical technicians (TCTs). Technicians are responsible for operating telehealth equipment, scheduling appointment for the day, assisting the patient and ensuring patient safety, assisting the audiologist with the evaluation or treatment, operating audiology equipment under the guidance of the audiologist, providing instructions or patient education, documenting and workload data capture, and working with facility telehealth coordinator to work out any process issues, equipment needs/problems, data collection and any other logistical issues.

The VA has evolved the use of two types of support personnel: audiology health technicians (audiology assistants) and telehealth clinical technicians (TCTs) trained in audiology services. Audiology health technicians have been trained in the use of telehealth technology. The advantage of health technicians (audiology assistants) is that they can perform all of the duties of an audiology assistant, as well as supporting telehealth encounters. A telehealth clinical technician (TCT) is trained to support all types of
telehealth and can support multiple clinical specialties at a single location. TCTs can be cross-trained in audiology to perform basic support services. The audiologist at the medical center (distant site) interacts with the patient at the community-based clinic (originating site), remotely controls all of the software from the medical center, and performs all of the services s/he would normally perform in a face-to-face encounter. The patient is accompanied by a telehealth clinical technician (TCT). The technician sets up equipment, connects the hearing aids, assists the audiologist, and provides patient instruction.

3. Examples of tele-audiology services

Tele-audiometry
Remote audiometry may be useful in rural or remote settings when diagnostic audiometry is not feasible. The concept of remote audiometry is attractive since audiologists are used to a certain amount of physical separation during testing, and have computer-based audiometers that may be compatible with remote control software (Givens and Elangovan, 2003 and Givens et al, 2003). Swanepoel (2012) described a tele-audiology project in South Africa using a mobile audiometer that incorporated remote-controlled audiometry, active noise attenuation, and automated testing. Testing outside of a sound suite or booth is a challenge in rural or remote settings where such installations are impractical. Use of noise-attenuating earphones that control sound levels to permissible ambient sound levels is one solution.

The VA is also developing tele-audiometry capability. Like applications in foreign countries, it faces challenges in delivering audiology service in rural and highly rural areas. Over 40 percent of veterans live in rural or highly rural areas where access to advanced audiology clinics is limited. Forty-seven percent of Veterans living in rural areas and 95 percent of veterans living in highly rural areas drive more than two hours to VA facilities for their health care. To address this issue, the VA has de-centralized many of its health care services into 983 small outpatient clinics and community-based outpatient clinics (CBOC). Traditionally, these small outpatient clinics were designed to provide primary care services. Few of them were designed to offer specialty care. Telehealth creates an opportunity to expand specialty care, such as audiology, into these settings. The VA is now using telehealth for dermatology, mental health services, chronic disease management, speech-language pathology, and optometry. Because of its space constraints, audiology poses a special challenge for some clinics. Small outpatient clinics are rarely designed to accommodate sound suites. The VA is investigating ambient noise monitoring software, and
the feasibility noise-attenuating earphones in telehealth applications. The VA is also investigating the feasibility of commercially-available automated audiometry in a veteran population.

**Tele-programming**

Remote fitting and programming of hearing aids has been well described in the telehealth literature. Tele-programming has commonly been completed through desktop sharing applications that remotely control hearing aid software, programming interfaces, and PC-based verification systems. Through a national pilot initiative for tele-audiology services, the VA has been successful in moving tele-programming from proof-of-concept to a viable, effective delivery model (Gladden, 2013). VA has collected over 1,700 International Outcome Inventory-Hearing Aids (IOI-HA) surveys. The feedback data indicate a high level of satisfaction with tele-audiology-based hearing aid fittings and programming and positive patient acceptance of this modality. Comparative data with traditional service delivery also indicate a level of satisfaction as good, if not better, than face-to-face encounters (Table 1).

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
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<td>All Veterans (N=148,396)</td>
<td>4.45</td>
<td>4.09</td>
<td>3.83</td>
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<td>3.8</td>
<td>3.88</td>
<td>4.07</td>
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<td>Telehealth (N=1,750)</td>
<td>4.53</td>
<td>4.17</td>
<td>3.96</td>
<td>4.52</td>
<td>3.98</td>
<td>4.01</td>
<td>4.12</td>
<td>2.38</td>
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</table>

Q1 Use
Q2 Benefit
Q3 Residual activity limitations
Q4 Satisfaction
Q5 Residual participation restrictions
Q6 Impact on others
Q7 Change in quality of life
Q8 Self-perceived hearing difficulty

Scoring: 1=poorest outcome, 5=best outcome

<table>
<thead>
<tr>
<th>Norms</th>
<th>Q1</th>
<th>Q2</th>
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<th>Q7</th>
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<tbody>
<tr>
<td>Mild to moderate*</td>
<td>3.73</td>
<td>3.39</td>
<td>3.40</td>
<td>3.20</td>
<td>3.57</td>
<td>3.79</td>
<td>3.19</td>
</tr>
<tr>
<td>None to moderate+</td>
<td>3.6</td>
<td>3.8</td>
<td>3.9</td>
<td>4.2</td>
<td>4.1</td>
<td>4.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Mod-severe to severe**</td>
<td>4.50</td>
<td>3.52</td>
<td>3.19</td>
<td>3.84</td>
<td>3.38</td>
<td>3.38</td>
<td>3.68</td>
</tr>
<tr>
<td>Mode-severe to severe++</td>
<td>4.2</td>
<td>3.9</td>
<td>3.3</td>
<td>4.3</td>
<td>3.3</td>
<td>3.2</td>
<td>3.9</td>
</tr>
</tbody>
</table>

* Mild to moderate perceived hearing difficulty group data (Cox et al, 2003)
+ None to moderate perceived hearing difficulty group data (Smith et al, 2009)
** Moderately-severe to severe perceived hearing difficulty group data (Cox et al, 2003)
++ Moderately-severe to severe perceived hearing difficulty group data (Smith et al, 2009)
Measuring Success

Ultimately, the measure of success is the patient’s clinical outcome. Success, however, is also measured by the extent to which specialty care moves beyond its traditional disease-focuses, consultative role, to a patient-focused, team-oriented, and virtual care. The following strategies have been shown to lead to success in tele-audiology:

- Support and buy-in from clinical staff and leadership using top-down and bottom-up communication and initiatives;
- Commitment to education and training to ensure sustained health care quality and staff competence;
- Take ownership and be prepared for resistance and challenges;
- Develop a strong partnership with industry and clinical, technical, and administrative staff;
- Adopt an enterprise-approach that will create sustainable, systemic, and transformative change;
- Identify technical and infrastructure needs and issue early, and address them as a team;
- Develop protocols, standards of care, best practices, and toolkits;
- Be flexible and allow for modification of work processes based on experience;
- Standardization, interoperability, and connectivity are key factors for initial success and long term sustainability;
- Ongoing training and education are essential to maintain expertise and currency with rapidly changing technology and evolving health care environment; and
- Careful evaluation of service delivery, focus on clinical outcomes and patient/provider satisfaction and acceptance, adherence to established guidelines and protocols.

**Infant diagnostic evaluation**

Infants needing diagnostic evaluation may benefit from access to remote hearing evaluations. These remote tests are currently performed at a handful of institutions. Infant tele-audiology programs have been developed to reduce high loss to follow up rate observed in geographic regions within a newborn hearing screen program or to provide evaluation in a geographic region where pediatric audiologists are not available (Hayes et al, 2012).

Complete evaluations, or any portion of the infant diagnostic hearing evaluation that is performed in the traditional face to face model, can be provided remotely. This may include immittance measures, otoacoustic emissions, video otoscopy and evoked potentials, as well as counselling.
equipment that is PC based is utilized for remote application. The audiology equipment is at the patient site while at the specialist site the audiologist remotely controls the equipment with desktop sharing software and directs the audiology assistant. Counselling can be provided during the session immediately following the testing.

There is increasing interest by private sector audiologists, government institutions, academia, and industry to develop hearing aid programming capabilities through applications for smartphones and tablets. This would significantly improve convenience and accessibility to hearing care and lend itself well to home-based audiological services that would otherwise not be possible. Development of mobile devices for clinical care will require that various operating systems and platforms be compatible with newer technology. Mobile devices are clearly an exciting area for continued development and would positively expand the service modalities currently in place.

4. Technology
Tele-audiology, as a vital and rapidly growing practice within telehealth service delivery, inextricably links technologic advances and clinical care. Within tele-audiology's on-going development as a service model are both facilitating forces and significant challenges. The challenges generally center on refining clinical practices to meet emerging needs of the hearing impaired individual, addressing technologic complexities, and the integration of sound business/management principles into tele-audiology planning and implementation.

Planning for Technology
Planning, implementing, and sustaining an effective and sound technical environment remains a critical aspect of any viable telehealth delivery system. The technical environment as it related to telemedicine broadly has been discussed in detail in various documents, but less published information exists on the scope and type of tele-audiology technologies that are currently available, promising initiatives and ways in which they can be effectively integrated into the mainstream and emerging infrastructures, and critical aspects of the evaluation process that should precede any rollout of patient care services (Yao et al. 2009, 2009, 2010). The purpose of this section is to more fully address key components of technology and technology environment within the current tele-audiology infrastructure and implications for future development.
Identifying appropriate technology needed for tele-audiology with its related costs and assets - both financial and human resources - is a critical aspect of planning services. A clear business plan and needs assessment of both the patient population and organizational resources are required. The American Telemedicine Association (ATA) provides references related to the core administrative, clinical, and technical standards for services (ATA, Core Standards for Telemedicine Operations, November 2007). Regardless of the setting or environment in which tele-audiology services will be provided, these standards of practice become the broad framework and foundation for care. Within the technological service environment are requirements for on-going support from information technology, biomedical, and key support staff. As important are patient safety practices that include infection control, protection of health information, electronic storage of data, and emergency/contingency plans for critical events.

There are a variety of technologies currently available and integrated within tele-audiology practice. These include various Coder-Decoders (codecs), cameras, peripheral devices, and desktop sharing applications. Standardized use of these technologies is important to maintaining effective connectivity, reducing interruptions in care, and maximizing utilization of costly technology resources. Careful analysis of each piece of technology in terms of its suitability and interface with currently available technology should be completed before purchasing agreements are made.

Software
Ongoing software development is an asset and challenge for clinical and technical staff that support audiology. The technologies that are commonly employed to support tele-audiology and telehealth, in general, are rapidly evolving and converging. Essentially, all audiologic procedures require a software application. This fact undergirds the frustration commonly felt by providers when software release occurs faster than the organization's ability to thoroughly evaluate its value and suitability for use within current systems. Well-developed software has supported the refinement of hearing aid evaluation, diagnostic and screening equipment, cochlear implants, assistive listening devices, and products for aural rehabilitation. However, for each piece of technology that can potentially be used in a tele-audiology environment, there will be an ever increasing number of software products claiming important benefits; all coming with associated requirements for testing and integration with other technologies in use.
For synchronous or real-time applications, desktop sharing software is particularly critical because clinicians need to remotely control PC-based audiologic equipment. This is generally controlled concurrently with the use of video teleconferencing equipment. There are a number of remote desktop and web-based applications available and each should be carefully evaluated on the appropriate LAN or WAN, especially if communicating over significantly long distances. The particular "drag" on the PC or CPU, graphic user interfaces, and color schemes are just a few of the variables that can impact performance. Assessing available bandwidth in relation to total technology demands remains a significant consideration in planning.

**Hardware**

**Video teleconferencing Systems**

The basic components of synchronous tele-audiology systems are the same for both the provider site and patient site. On the sending side, a video camera is connected to a system - known as a CODEC - which "compresses" the video signal and sends it over a telecommunications link to the receiving side. A microphone is used to pick up sound.

On the receiving side, the signal is decompressed; a picture is displayed on a video monitor and sound is amplified by speakers. A camera and microphone also pick up video and sound at the receiving side. The system compresses and sends the signal back to the sending side. Both sides can see and hear each other in "synchronous" communication. In this exchange, there is usually a short delay caused by the compression/decompression process and the time it takes to transmit the signal.

Video teleconferencing (VTC) requires high capacity connections (high bandwidth) because of the volume of data that is exchanged between the two ends. These connections can be over special digital telephone lines known as "ISDN," or over high-speed data network connections, often "IP" networks. Connections using regular telephone lines and analog modems are inadequate for synchronous video teleconferencing, making "IP" the more practical type of connection used in most remote areas.

There are basically two kinds of videoconferencing systems:

1. Dedicated systems have all required components packaged into a single piece of equipment, usually a console with a high quality video camera. Dedicated systems can vary in size from group videoconferencing units to individual devices that can be portable and designed for single
users. The portable devices generally have fixed cameras, microphones, and loudspeakers integrated into the console.

2. Desktop systems are add-ons to normal PCs, transforming them into videoconferencing devices. A range of different cameras and microphones can be used which contains the necessary codec and transmission interfaces. Most of the desktops systems work with the H.323 video teleconferencing standard.

Video teleconferencing is especially useful where moving images contribute to the gathering of information by the audiologist. Tele-audiology systems are often equipped with uniquely-designed diagnostic peripherals which have an integrated video pickup. Common clinical peripherals include otoscopes and general examination cameras.

Video teleconferencing systems are also commonly equipped with a camera that functions for document reading, or in the case of a webcam, can be removed or manipulated from the PC, so that patient education materials, audiometric information, or other static information can be incorporated into the synchronous interaction. Most manufacturers also have a desktop sharing application that allows information to be pulled up and shared directly through the IP connection (webcam or desktop VTC).

Synchronous connections can be used for nearly any consultation, but is especially useful for tele-audiology providers. It is also a common method of communication in business and government settings. Video teleconferencing hardware and software have become standardized and is much less expensive than was previously the case. Telehealth applications using video teleconferencing are generally based on the same standard video teleconferencing equipment and software that is used in business and government, with some adaptation. The adaptations are primarily in the area of accessories.

An integrated telehealth system generally has six major components required on both ends of the video call:
- Video Teleconferencing CODEC
- Video Camera
- Video Monitor (1 or 2)
• Microphone
• Speakers
• Accessories

CODEC
CODEC is the acronym for Coder-Decoder. The CODEC is the heart of the video teleconferencing (VTC) system. It compresses the two-way audio and video communication streams so that they can be sent over the communications link. The CODEC also provides the means to connect all devices used in a Video Teleconferencing system, such as cameras, microphones and other system components. While there are standards for communication between video teleconferencing systems, each CODEC uses different methods to perform its functions with varying outcomes. Each manufacturer also creates unique features and a distinct user interface to make its system attractive to potential users.

CODECs can be dedicated hardware "boxes" running proprietary software, or can be based on a personal computer (PC). Dedicated hardware CODECs are associated with more expensive, traditional video teleconferencing systems. PC-based systems are associated with lower cost, recent generation systems.

New models have blurred the lines between high-end and low-end systems. High quality dedicated video teleconferencing systems are now available in the same price range as PC-based systems. They are often known as "appliances" or "set-top boxes" because of their small size and "all-in-one" which are built into the monitor construction.

Video Camera
The video camera is specially designed for video teleconferencing applications. It offers pan (side to side) and tilt (up and down) controls so that the user can easily point the camera at the appropriate subject. It also offers control of the zoom for a wider or tighter angle of view. (Pan/Tilt/Zoom is often abbreviated P/T/Z.) The focus is automatically adjusted by the camera. Most systems provide connections for two or more video cameras, facilitating the addition of specialized diagnostic cameras.

Camera Control: Many video teleconferencing systems allow control of the camera on the far end of the connection. This is especially useful for group presentations and tele-audiology visits as the audiologist provider has direct control over the view on the near end monitor. This far end camera control ensures that the audiologist can frame the subject as needed, avoiding problems with the subject being "cut
Far end camera control has become a standard feature on newer video teleconferencing systems, but may not be available on older systems or those incompatible with the camera control protocol.

**Video Monitor**
Each endpoint of the video teleconferencing connection has at least one video monitor. Many systems allow connection of two monitors. Systems with a dedicated CODEC most often use a standard video monitor (such as would be used with a VCR or DVD player). PC-based CODECs generally use a computer monitor, although some newer systems use one video monitor and one computer monitor (for data display).

**Microphone**
Each end has at least one microphone to pick up the sound for transmission to the far end.

**Speakers**
Speakers allow the user to hear the sound from the far end.

**Accessories**
Video teleconferencing system accessories are available for virtually any specialized application. Some key accessories are used often in tele-audiology applications:

**Document cameras**
Document cameras are used as a general purpose device to share documents, graphs, and other materials.

**Diagnostic peripherals**
Many common diagnostic scopes and other devices have been adapted for use with video teleconferencing equipment. They generally include a light source and a video pickup. These peripherals are commonly integrated into a "cart-style" setup, but are more commonly used in the audiology community as stand-alone devices driven by a PC or USB interface. Some examples might include a video-otoscope or an ENT scope.
Fax machine
A fax machine is often the least expensive and simplest way to transmit hard copy information such as charts and printed test reports. (see document camera).

Purpose-specific software
PC-based systems have the advantage of being able to run software programs directly. Dedicated, hardware-based videoconferencing systems can usually transmit the display from a PC connected to them, so that software programs can be used during the tele-audiology visit.

Digital Video Disc (DVD) Recorder / Videocassette recorder (VCR)
Recorders can be useful for documenting a patient encounter or for facilitating an asynchronous consultation.

Audiology Hardware
Generally, audiological hardware used in most telehealth clinics are clinic equipment that either has been integrated or ‘home-grown’ for the purposes of providing services to individuals where the need arises. Most studies and reported programs have used PC-based audiological equipment that is ‘taken over’ by a remote audiologist to run and operate. Clearly, there is a growing demand for audiological equipment that is specific to its discipline and takes into account the complexities of providing services from a distance. Considerations that have been, and are currently being addressed by vendors and manufacturers, include the following:

- Integration of voice and serial connections through codec.
- Integration of video teleconferencing capabilities into hardware/software platforms.
- Dedicated or adapted audiometers, immittance bridges, electrophysiologic, ENG/VNG, and PC-based equipment.
- Noise attenuating headphones for testing in locations where sound suites or enclosures are not available.
- Integrated sound level meters to assess background noise and ensure permissible noise levels are met throughout testing process.
- Scanning and images of external ear canal for the purpose of ear mold and hearing aid fabrication.
- Integration of hardware/software and video images into EMR for store-and-forward procedures.
• Home-based products for hearing testing/screening/monitoring, consultation, and rehabilitation.

These are just a few of the technical considerations that other providers have discussed and published in detail. The technologic components and initiatives will continue to grow in correlation to the expanding consumer base.

IT Network Considerations
The Information Technology infrastructure is an essential component of successful tele-audiology services. Availability of bandwidth must be considered at the early stages of planning for implementation. Standard telehealth carts are set to permit IP video teleconferencing at H.323 with a transmission rate of 384 Kbps. This rate is generally adequate for video teleconferencing connectivity; however real-time streaming of high resolution peripheral cameras require a faster transmission rate and as much as twice the bandwidth. Consideration and management of competing internet or bandwidth ascribing services may be needed when providing tele-audiology services (for example a small rural clinic with limited bandwidth). Additional IT network considerations are achievable within the broader organizational network structure such as QoS (Quality of Service) and ACL (Access Control Lists)/firewalls.

Employing highly sophisticated medical technology for patient care across large geographical distances requires a strong commitment from IT, biomedical engineering, and clinical staff. Plans to implementation tele-audiology services must outline organizational objectives and expectations, define requisite roles and responsibilities, and include concurrence from major internal and external parties. Policy and procedures for equipment use, maintenance, and technical support must be consistent with agreed upon roles and responsibilities. Contingency plans and "backup" processes must be developed prior to implementation. For example, the risk of technical malfunctions can be mitigated by having spare equipment readily available. Clinical staff must receive training to enable their comfortable and efficient response to common technical glitches in a manner that represents complete confidence to patients receiving tele-audiology services.

5. Role of Audiology Assistants
The practice of tele-audiology may require audiology assistants at the site of the patient. These individuals provide essential support in preparing the patient for testing by the audiologist. The following issues should be considered when identifying the need for and scope of activities of the audiology assistant.

Qualifications and Personal Attributes

The audiology assistant is typically a member of the originating site community and employed by the partner organization (hospital, healthcare clinic, university or school, etc). He/she may be drawn from a number of occupations, preferably in a healthcare field. These individuals may be licensed or certified healthcare personnel such as a R. EEG. Tech (registered electroencephalography technician) or RN (registered nurses) or a para-professional specifically trained in audiology assistant duties. A developing tele-audiology program may find it useful to use assistants who were previously trained for telehealth visits within a separate field such as tele-dermatology. Qualifications of the audiology assistant for tele-audiology may include:

- Experience with the targeted age group
- Technical knowledge and technology trouble-shooting experience
- Prior experience in telepractice

In addition to work-related qualifications, the audiology assistant should be comfortable communicating with patients/clients and family members, unflustered by unexpected issues or technology breakdowns, able to adhere to his/her responsibilities as delineated in policies and procedures, and reliable.

Registration or licensure for audiology assistants may be required by the state or jurisdictional body. The audiologist is responsible for identifying the registration or licensure requirements for audiology assistants at the site where the patient will be served.

Training and Supervision

The audiologist is responsible for training and supervising the audiology assistant. Both written didactic instruction and practicum opportunities should be offered. Training may be accomplished on-line, by videoconference, and/or in-person.
Training components for the audiology assistant should include:

- Basic understanding of the ear and hearing
- Specific instruction on the activities to be conducted by tele-audiology
- Specific instruction on preparing the patient for the activities to be conducted
- Specific instruction on monitoring the patient during preparation and throughout the tele-audiology session
- Communication expectations with the patient and with the audiologist
- Trouble-shooting equipment and videoconferencing breakdowns
- Responding to an unexpected event or emergency
- Other skills as specific to the tele-audiology practice

Regardless of the training methodology, audiology assistant should have the opportunity to practice his/her skills multiple times and meet a pre-determined baseline before he/she is scheduled for tele-audiology duties. Both on-going assessment and formal performance evaluation should be conducted by the audiologist as defined in policies and procedures.

**Duties and Responsibilities**

Depending on the agreement with the partnering institution, the Audiology Assistant may have both administrative and practice-related duties.

Administrative duties may include:

- Scheduling Patient, audiologist, interpreting services (as needed)
- Patient registration
- Insurance authorization
- Billing
- Ordering supplies and maintaining supply inventory
- Scheduling equipment calibration and safety checks

Practice-related duties prior to the appointment include:

- Setting up and testing all related equipment prior to the scheduled appointment
- Ensuring all supplies are available, cleaned, and ready for patient use

Practice-related duties during the appointment may include:
• Greeting the patient, escorting the patient to the test suite, and ensuring the patient’s comfort
• Using accepted infection control procedures,
• Preparing the patient per the audiologist’s instructions
  o Conducting otoscopy or videotoscopy
  o Placing probes or insert earphones into the patient’s ear
  o Placing bone vibrator or standard earphones on the patient’s head
  o Preparing the patient for evoked potential procedures including skin preparation and electrode application
  o Recording patient responses to speech reception or speech recognition tasks, including oral responses or picture pointing responses
  o Removing probes, insert earphones, bone vibrator, standard headphones, and electrodes from patient at the conclusion of testing
  o Examining site of test-related apparatus on patient’s head for evidence of abrasion or pressure sores
  o Include activities required for hearing aid programming or cochlear implant mapping
• Troubleshooting any technical or videoconferencing breakdowns or interruptions
• On-going surveillance of patient comfort
• Escorting patient out of test suite upon completion of testing and counseling by the audiologist

Practice-related duties following the appointment may include:
• Cleansing and disinfecting equipment per manufacturer instructions and institutional guidelines
• Re-stocking supplies for future appointments
• Reporting any equipment problems to audiologist and biomedical engineering support
• Completing paperwork as required by audiologist and partner organization

The audiology assistant is a critical member of the team providing clinical services by tele-audiology. As the audiologist’s “hands” at the patient site, the audiology assistant must be appropriately trained and supervised to provide the patient- and family-centered care expected in healthcare organizations. The audiologist is ultimately responsible for ensuring that all services provided by tele-audiology are conducted with the same degree of quality and compassion as in face-to-face encounters, regardless of who “touches” the patient.
6. Licensure/Regulation

The practitioners of tele-audiology in the United States are required to hold state licensure in their profession. The composition of state licensure laws are widely varied yet all have the common practice of restricting patient treatment within their state borders unless their state licensure is held by the practitioner. The issue of licensure and crossing state borders has become one of significance in tele-audiology as it has become regarding other Telehealth disciplines.

Currently (2014) there are at least 17 states with some form of telepractice regulation or rules pertaining to the remote application of audiology. These state regulations vary in the design of telepractice from allowing tele-audiology as long as it conforms to the same level of service as the traditional model, to prohibiting any form of telepractice (Delaware). While the practitioner is focused on reaching all the consumers that can benefit from their services the licensure community is focused on consumer protection. Hence lie the differences of opinions as to which is the best model from which to apply tele-audiology to our potential patients and at the same time protect them from harmful practice.

The challenges in this are two fold;

1. To create a more common licensure view of the profession of audiology
   All too often professional associations and/or accrediting bodies are forming practice standards with little to no input from their peer professionals in the licensure community. Thus when standards are changed the licensure laws become further away from what the accrediting bodies and perhaps the profession wishes to exist.

2. To achieve a legal method of protecting the consumer across state lines
   This is no small task as the United States is organized on states’ rights to govern “with the police power to enforce consumer protection delegated to state licensure boards”. This concept makes it difficult if not inconvenient to cross state lines to prosecute a professional whom has harmed a consumer. Of importance to note in this area is the significant variation in levels of prosecution among states. Some states have their licensure Boards organized with little to no power to prosecute harmful practitioners whereas others carry legal powers as administrative law judges with their own legal resources. Several approaches have been proposed such as multi state compacts, limited licensure, expedited licensure to a federal licensure. All of these
approaches are worth examining but bring their own issues and concerns with regard to uniformity and the paramount concern of consumer protection while providing additional service delivery models and consequent greater access to care.

The area of licensure/regulation should remain a priority to the audiology community to better serve our patients.

7. Reimbursement
Reimbursement for Telepractice exists in forty-four states. According to the State Telehealth Laws and Medicaid Program document from the Center for Connected Health Policy these states only reimburse for live video procedures although 7 states reimburse partially for store and forward applications. There are a number of nuances in the reimbursement policies that contribute to preventing actual reimbursement for non-medical applications. Several states have made progress on this issue and have passed legislature that requires insurance companies to reimburse for Telepractice if the practitioner is performing the same procedure as the traditional model.

The federal program of Medicare has influence on private insurance companies as to reimbursement. The first Medicare policies on Telepractice only listed a few professions as providers. (physicians, social workers, nurses and psychologists) The profession of audiology remains off this list at the current time. This negatively impacts our profession and is an area in which we would encourage AAA to take action. Private payers vary in their policies of telepractice reimbursement. However in recent years there have been 15 states with mandates to cover Telepractice procedures. These states are; California, Colorado, Georgia, Hawaii, Kentucky, Louisiana, Maine, Maryland, Michigan New Hampshire, Oklahoma, Oregon, Texas, Vermont and Virginia. Recently the states of Connecticut, Florida, Mississippi, New Mexico, South Carolina and Washington, and the District of Columbia have witnessed telehealth legislation regarding private payer bills.

Reimbursement policies for audiological services remain incomplete. It is only with more common implementation of the new, existing and developing technology that more blanket policies toward tele-audiology will take place.
Conclusions

The area of tele-audiology is certainly within the infancy stage of development and shows both great promise and remaining challenges (Givens et al. 2013). What is certain however is that this field will continue to develop and encompass more audiological services into the future. It is of the utmost importance that the AAA has a keen focus on this area as developing technology and patient need/demand will drive this area to a more common practice within our profession.

References

American Academy of Audiology (AAA) resolution on telehealth (2008).


