EMERGING APPLICATIONS IN TELEAUDIOLOGY

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Telehealth, or telemedicine, is the provision of healthcare services using a telecommunications medium. Specifically, telehealth indicates that practitioner services are provided to patients using an electronic medium such as a computer network, the telephone, satellite or two-way radio. Telehealth services are used to serve people living in rural or inner city communities who often experience limited healthcare access. However, home healthcare via telehealth services are gaining popularity as individuals with health disorders are frequently confined to their residence due to blindness, physical ailments or the lack of transportation.

Although telehealth is a common term, similar terms are often used today. These terms include telemedicine, e-care, e-health, telepractice, and telecare. In audiology, teleaudiology is gaining popularity. Telehealth as a term is more broadly defined to include those services provided by allied healthcare professionals and by physicians alike. Because of the continued need to provide care to individuals in underserved areas, telehealth services are now commonly used in many professions, including cardiology, radiography, otology, pediatrics, pharmacology, psychology, psychiatry, and speech-language pathology.

Telehealth Models

Telehealth services can be delivered by synchronous (real time) or asynchronous (store and forward) methods. Synchronous data communication is typically conducted via interactive video. In contrast, asynchronous services require that data has been recorded first at the patient site and then, after some period of time, sent electronically to the clinician for interpretation. A hybrid system is a highly flexible model which utilizes both synchronous and asynchronous technology to achieve desired healthcare services.

Asynchronous Telehealth Technology

Asynchronous procedures are commonly employed when there is inadequate bandwidth for synchronous procedures. In addition, asynchronous applications may be utilized when time is less of a concern regarding the diagnosis or for those occasions when the clinician is unavailable to conduct services. Finally, analog equipment which cannot be used for remote computing purposes can be gainfully configured for asynchronous applications. For example, an older immittance system, which provides data only by thermal printer, can still be used for asynchronous applications. This is accomplished by scanning patient immittance results into a computer and sending the data (via email attachment) to an audiologist for interpretation. Of course, many audiometric systems now are incorporating Bluetooth technology or traditional computerized methods for storing or transmitting patient data.

Asynchronous data transfer is used by audiologists today and may in fact be a common practice. Specifically, teleaudiology is utilized when information such as tympanograms, audiograms, auditory brainstem response recordings, or video-otoscopy images are transmitted via email or by fax. Asynchronous studies have been published evaluating the efficacy of telehealth with tympanometry, video-nystagmography (VNG), and video-otoscopy (Birkmire-Peters et al, 1999). In addition, E-mail communication was used to deliver cognitive-behavioral therapy for tinnitus treatment (Kaldo-Sandström et al, 2004) and for counseling new hearing aid users (Laplante-Lévesque et al, 2006).

One appealing asynchronous application is self-assessment of hearing sensitivity. Presently, self-assessment procedures involving hearing testing online appear to suffer from questionable calibration, poor validation, and the lack of control over environmental noise levels. Automated screening and diagnostic systems are being developed by equipment manufacturers which have addressed many of the pitfalls found with common Internet tests and other services. Indeed, automated systems may be quite common in the future and buoyed by telehealth technology.

Synchronous Services

Synchronous services are characterized by the clinician delivering services to clients in real time or "live." Such services may include the use of online chat, the telephone, interactive video, or remote computing technology. Interactive video is typically utilized with synchronous services to observe client responses to stimuli and to assure clinicians that audiometric equipment (transducer, probes, and electrodes) are properly placed. Interactive video may be provided by a laptop webcam or by a dedicated camera system that is interfaced directly to the computer network. While interactive video can require substantial bandwidth, the benefits are obvious, as the clinician and patient with services that are essentially provided "face-to-face." High costs have limited routine use of interactive video in the past. However, interactive video is increasingly available and affordable (even in isolated communities) due to less costly consumer level interactive video technology.

Audiologists may use two synchronous telehealth models. The first model is the traditional model used in other professions. This model requires the extensive use of high-quality interactive video in which the clinician supervises testing by a technician at the patient site. Once the technician obtains patient data, the clinician will typically provide a diagnosis and recommend management. For this model to be effective, the technician must be able to administer, but not necessarily interpret, audiology test results.

Another form of synchronous audiology services incorporates remote-computing software or web-based solutions permitting clinicians to test patients at distant sites. The idea behind this strategy is to provide quality services by an audiologist in real time and essentially under normal clinical conditions. This is a reasonable telehealth strategy to consider as many audiology systems are computerized utilizing a Microsoft Windows platform and therefore can be incorporated for remote computing applications. Consequently, a clinician at one site can control computerized audiology equipment at a distant patient site using remote computing software over a network, modem or the Internet. An advantage to this method is that a technician is not required to do testing at the patient site. However, a technician is still required to do tasks such as patient basic instructions, transducer placement, otoscopy, and have some skills in running the computer at the patient site. Investigators have employed synchronous protocols to administer a variety of common hearing tests to subjects including pure tone, speech, otoacoustic emissions and the auditory brainstem evoked response (Givens & Elangovan, 2003; Krumm, 2007). In addition, synchronous technology has been utilized to program cochlear implants (Ramos et al, 2008), program and verify hearing aids functioning (Ferrari & Bernardez-Braga, 2009, Wesendahl, 2003), and to provide neural response/telemetry assessment (Shapiro, Huang, Shaw, Roland & Lalwani, 2008). Remote computing in teleaudiology requires further validation but has been used successfully to administer hearing tests over considerable distances and is a promising technology.

Remote Computing Software Options

Remote computing software is abundant and is often bundled with video conferencing software available from most any of the video-conferencing manufacturers. However, web-based conferencing software may be faster and just as cost effective as PC based video-conferencing software. Programs such as "Skype," "Teamviewer" and "DimDim" may be used to provide low cost means to remote computing services. These programs are often more compatible with firewalls and often provide necessary data encryption or virtual private networking capabilities which are essential for maintaining patient confidentiality.

The Hybrid Model. While the sole use of asynchronous or synchronous technology appears to be reasonable in some circumstances, audiologists should consider the most efficient system to deliver telehealth services. In many cases, a hybrid model will yield the best solution for hearing healthcare services. The Hybrid Model offers both synchronous and asynchronous tests which can be used effectively in a telehealth program to provide typical audiology services over the continuum from screening to onsite (or face-to-face) services.

Most of the efforts in teleaudiology involve synchronous methods. While this is a logical area to study, hybrid systems will most likely be the model adopted. A hybrid model worth consideration is one in which synchronous services are used primarily for diagnostic services (or training purposes) while asynchronous services are employed for screening purposes.

FUTURE TRENDS IN TELEAUDIOLOGY

Automated Audiology Services

While the thought of having computers or phone systems to conduct automated hearing services may be on the fringe of good sense, automated systems may have a place for consumers. Already, many audiologists have adopted the use of automation in amplification. Specifically, automated hearing aid gain algorithms are commonly employed in which the hearing aid becomes gradually louder over time when first fit on a patient. This process is practical as many practitioners have found their patients frequently want softer (and undesirable) gain with new hearing aids. Hearing aids also have automated noise reduction, feedback reduction, program selection and data logging. Arguably while valuable, these features are automated and audiologists presume they will work as advertised. Many clinicians counsel their patients to purchase aids with automated features and patients are willing to pay the additional costs to have these features.

A different level of hearing aid automation might incorporate a personal computer (or broadband cell phone) and a web-based system. A web-based system could analyze the functioning of the hearing aid via a custom interface plug, Bluetooth connection or telecoil. Such a design might be desirable to help consumers deal with issues including occlusion, gain at specific frequencies (to increase intelligibility), speech in noise issues, decrease peak output, or to troubleshoot a dysfunctional hearing aid. Such a system could then direct the consumer to return to their hearing healthcare provider. In addition, the clinician serving this consumer can have the records of online adjustments sent to their office for immediate review and follow-up for continuity of care.

Early Hearing Detection and Intervention (EHDI) Program

Recently, state EHDI programs received funding promoting the use of teleaudiology EHDI services. Consequently, EHDI services will represent a substantial role in teleaudiology in each state.

The use of telehealth for EHDI can result in greater professional expertise for diagnostics, amplification, habilitation, continuity of services and up-to-date documentation of infant progress to providers and parents.

Conclusion

While telehealth technology seems reasonable to use for self screening, automated hearing services and diagnostics, the author recommends cautious validation and program review for the audiology practitioner interested in starting remote clinical services. Questionnaires should be provided to consumers who are served through telehealth technology to evaluate the effectiveness and efficiency of the service provided. Also, committees consisting of consumers, administrators, clinicians and license board liaisons should be formed to assure that proper procedures are developed for community teleaudiology services. Following the establishment of these mechanisms, audiologists should be capable of delivering robust teleaudiology services to consumers living in underserved or distant locales.

References

Birkmire-Peters, D.P., Peters, L.J. & Whitaker, L.A. (1999). A usability evaluation for telemedicine medical equipment: a case study. *Telemed J*, 5(2):209–212.

Ferrari, D.V. & Bernardez-Braga, G.R. 2009. Remote probe microphone measurement to verify hearing aid performance. *J Telemed Telecare*, 15, 122-124.

Givens, G. & Elangovan, S. (2003). Internet application to tele-audiology-"nothin' but net." *Am J Audiol*, 12:50–65.

Kaldo-Sandström,V., Larsen, H.C. & Andersson, G. (2004). Internet-based cognitive-behavioral self-help treatment of tinnitus: clinical effectiveness and predictors of outcome. *Am J Audiol*, 13(2):185–192.

Krumm, M. (2007). Audiology telemedicine. *J Telemed Telecare*, 13: 224–229.

References

Laplante-Lévesque, A., Pichora-Fuller, M.K. & Gagné, J.P. (2003). Providing an internet-based audiological counselling programme to new hearing aid users: a qualitative study. *Int J Audiol*, 45:697–706.

Ramos, A., Rodriguez, C., Martinez-Beneyto, P., Perez, D., Gault, A., Falcon, J.C. & Boyle, P. (2009). Use of telemedicine in the remote programming of cochlear implants. *Acta Otolaryngol*, 129, 533-540.

Shapiro, W., Huang,T., Shaw, T., Roland, J. & Lalwani, A. (2008). Remote intraoperative monitoring during cochlear implant surgery is feasible and efficient. *Otology & Neurotology*, 29:495-498.

Wesendahl, T. (2003). Hearing aid fitting: application of telemedicine in audiology. *International Tinnitus Journal*, 9(1), 56-8.

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