OPEN ACCESS GUIDE TO AUDIOLOGY AND HEARING AIDS FOR OTOLARYNGOLOGISTS

TELEHEALTH FOR AUDIOLOGICAL MANAGEMENT

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For well over 150 years the medical profession has taken advantage of advances in technology to improve the way they care for patients. The telegraph, radio, telephone, internet and smartphone provided new opportunities to deliver services, often to people in rural and remote areas [1]. The use of these telecommunication and information technologies in medicine is called ***telemedicine*** or ***telehealth***; in the field of ear and hearing health the terms ***tele-otology*** and ***tele-audiology*** are also used.

With the high and increasing prevalence of hearing loss - one of the most common global disabilities - there is a great need for changes in the way that audiological services are delivered. This is especially important in developing countries, where life-expectancy is increasing but where there are critical shortages of trained ear- and hearing-care clinicians [2, 3].

There is a growing number of tools for the screening [4-7] and diagnosis of hearing loss (Brennan-Jones et al. in *Open Access Guide to Audiology* – Telehealth for diagnosis of hearing loss; and ear disease [8, 9] that can be used to enhance existing services.

This chapter focuses on the management of those with hearing impairment, and how tele-audiological tools and approaches may assist to improve service delivery.

Audiological management of hearing loss

The key aspects of audiological management of hearing loss are:

a) Tools to assess needs of the person with hearing loss
b) Counselling
c) Provision and fitting of devices, including follow up of fittings, and
d) Tools to assess the outcomes

A number literature reviews have shown that there is little evidence to show that tele-audiology for the management of hearing loss provides outcomes that are equivalent to traditional means of management, i.e. face-to-face [10,11]. Despite the shortage of evidence, a number of programmes have been established, indicating that there is a degree of confidence in using technology to deliver such services. For example, hearing aids services are delivered to veterans by the US Veterans Affairs [12] and to communities in New Zealand [13]; and cochlear implants can be programmed over the internet for people in remote clinics [14].

In light of the shortage of evidence, the following should be taken as general advice only.

Procedures and equipment

Tele-audiology services are usually ‘live’, using a video-conference (VC) system that allows the parties to hear and see each other. The following describes the matters that need to be considered to manage a person with a hearing impairment.

The key consideration is that management of a hearing impairment is for the most part the rehabilitation of communication, and that there must be an effective communication channel between the clinician and the person with a hearing impairment, as well as with significant-others (family members, close friends and carers). There are technical and human aspects to consider. Technical aspects are to make sure that the equipment functions with high fidelity (both audio and video), that seating is

optimal, and the acoustics at both sites. It is likely that there are technical limitations which could have an impact on the communication between the clinician and patient. It is important that these limitations are recognised, and that the clinician ensures that optimal communication can still take place. This may include repeating spoken information, speaking clearly and slowly, asking for confirmation of instructtions, and making use of a facilitator.

In this light the following must be considered:

Site: Tele-audiology services can be provided to unlimited types of remote sites. This can include rural and remote clinics or hospitals, facilities co-located with other health services or professionals, nursing homes, and even people's homes. The primary requirements are a fast and reliable internet connection, equipment (as detailed below) and a relatively quiet space where external sounds and ambient noise are minimised.

Facilitator: In a face-to-face consultation, the clinician can physically examine the patient, and also physically handle and manipulate a hearing aid or cochlear implant and equipment. In many cases the patient is unable to perform these tasks. However, it can be done by a facilitator. For some tasks a family member or friend may be able to fill this role. For example, when the hearing aid needs to be checked and taken off the ear (and the patient cannot hear anything), the clinician can instruct the family member. However, a health worker or nurse can easily be trained to take on many other tasks, including otoscopy and connection of equipment [15].

Tools to assess needs and outcomes: There are currently no tools specially designed to be used for tele-audiology. However, the audiologist has an array of tools to assess the needs of the patient and to measure outcomes post-fitting that can be adapted to be used for tele-audiology. Surveys such as the *International Outcome Inventory for Hearing Aids (IOI-HA)* [16] and *Client Oriented Scale of Improvement (COSI)* [17] can be administered live via a video-conference facility and/or with the assistance of the facilitator, or perhaps be incorporated into clinical notes as part of the practice routine. Additional tools that can be considered are the *Hearing Aids Skills and Knowledge Inventory (HASKI)* [18] which is designed to measure hearing aid handling skills, and the *Cochlear Implant Management Skills (CIMS)* [19] for hearing implant handling skills. Discussion and counselling can also take place in a video-conference. However, this may be challenging for someone with a hearing impairment, especially when audio and/or video quality is less than excellent, e.g. due to delays, poor synchronisation or image breakup.

Otoscopy: The ear canal and eardrum may have to be examined by a facilitator using an otoscope for obstructions in the ear canal e.g. wax, foreign bodies, ear discharge (see chapter on otoscopy) [20]. A standard otoscope will require the facilitator to describe what they see. A video-otoscope will enable images to be captured and sent to the audiologist for interpretation. Streaming a live view from the video-otoscope to the audiologist would be useful, but in many cases limitations in bandwidth will prevent this. In addition, funding for video-otoscopes is not always available.

Hardware and software for programming hearing aids and hearing implants: All devices that allow a computer to communicate with a hearing aid (e.g. NOAHlink - see the chapter on Hearing Aid Fitting) or hearing implant will normally be at the site with the patient. The computer at the site of the patient can be a desktop computer,

laptop or a tablet computer. The software will have three main functions:

a) For communication by video-conferencing e.g. Zoom, Skype, Facetime, Adobe Connect, WebEX, Google Hangouts, TeamViewer
b) Remote control of the computer at the site of the patient e.g. TeamViewer, and
c) Hearing programming software from the manufacturer of the hearing aid or implant.

The facilitator must be familiar with using these applications. Furthermore, screen size should be large enough to cater for any visual impairment of the patient. The effectiveness or usability of this technology may be affected by the quality of the internet connection.

Making hearing aid moulds, handling devices and trouble-shooting: A facility for making hearing aid custom earpieces (or moulds) may be required if the service is to include hearing aid fitting. This will have to be performed by the facilitator and will require training. An important aspect of this is a good understanding of the anatomy of the ear and ear canal, and ability and skills in inspecting the ear canal. The facilitator will also need to be very familiar with all aspects of handling hearing aids and different implant processors. This will include inspection of the appropriateness of the fitting to the ear and ear canal (mould / dome / slim tube / receiver wire / device), cleaning, changing batteries, changing programmes, and connecting the device to the fitting hardware. For more information, see the chapter on Hearing Aid Fitting.

Verification by Real Ear Measurements (REMS): Verification of hearing aid fitting is an important step to ensure that the hearing aid is delivering the right amount of sound at the eardrum. The facilitator will have to assist with this (to place the probe in the ear), and training will be necessary. This is one aspect that has been studied, but the evidence that facilitators can do this task properly is still weak [21].

Speech tests: Speech perception tests, in particular tests conducted in noise, are useful for assessing how well a hearing aid or implant works in real world outside of a controlled environment of a clinic. However, outside of a clinic it is difficult to control the environmental or ambient sounds. Testing has to take place in a 'free-field' with and without the hearing aid(s) fitted and thus, headphones cannot be used. Also it would be required to calibrate the sound source, i.e. loudspeakers. A potential alternative is the Digits-in-Noise test [22,23], which is an adaptive technique that provides a signal-to-noise ratio as a measure of hearing impairment and can be used in quiet office environments. This test can, for hearing aid assessments, be delivered via a computer or smartphone binaurally via one or two loudspeakers.

Follow up after fitting: Some time must be spent with the patient in the weeks following hearing aid fitting. This will include further counselling on expectations, adjustments of the hearing aids, and further training on managing and handling the hearing aids. Follow-up is also required over the patient's lifetime (at least once a year) to ensure optimisation of the hearing as acclimatisation will happen and hearing deterioration may progress.

Other matters

It is important, as it is for all clinical activities, that good records are kept and maintained. Furthermore, to be mindful of local regulations on licensure; in some jurisdictions, a clinician may not be allowed to manage patients in another province, state or country. Furthermore, in some cases there will be public health regulations and

policies to follow, and reimbursement policies to be aware of.

Typical applications

The following two case studies illustrate how tele-audiology may be used to provide a rehabilitation service.

Example 1: Mary, a 70-year retiree lives 250 km from the nearest audiology clinic. Mary does not drive and with no public transport, she relies on others to attend appointments. Coming to a hearing aid fitting appointment is feasible but attending two or more follow-up appointments is a problem. She does not have a good internet connection at home and is not a smartphone user. However, there is good internet connectivity at her local health clinic and Simon, the clinic nurse, has offered to help Mary with her hearing rehabilitation. At her face-to-face appointment with Chris, her audiologist, they discuss the situation with Simon via a phone call. They decide on the following solution. A set of hearing aids will be selected that can be remotely controlled by an audiologist by a smartphone. Simon will install the hearing aid 'app' on the clinic's phone, and Chris will train Simon, over the phone, how to use it. This includes making the connection between the hearing aids and the smart phone. Mary returns home with her hearing aids. After a couple of weeks, she arranges to meet Simon for a remote consultation with Chris. Some sounds are uncomfortable for her, which they discuss on the phone. After connecting the hearing aids to the phone, Chris can make some adjustments. They also spend some time speaking on the phone discussing some of the controls of the hearing aid. After a month, Mary returns to her local clinic complaining the right hearing aid does not appear to be working well. Together with Simon they check the batteries, but nothing they do seems to fix it. They decide to call Chris, and after some questioning it appears that the tube has become blocked with wax. Rather than explain further on the phone, Chris directs them to a YouTube video that shows how the tube can be cleaned or changed. This proves to provide the answers, and the hearing aid works as required. The team of Chris and Simon has worked well together to provide rehabilitation for Mary that suits her circumstances.

Example 2: Abby is a general practice nurse in a nursing home in a town with no audiologist. He notices that a number of the residents have hearing aids that they do not use. Mobility is an issue for most residents, making travel to a city difficult. Abby has a meeting with James, a city-based audiologist, who offers to provide him with training on the essentials of hearing aid maintenance. This proves to be very useful for getting more of the residents to wear their hearing aids. However, over time James notices that a wide variety of problems arise that he can't solve. Abby and James decide to use a comprehensive survey, a checklist, that asks about all the things that are may needed to be known to use a hearing aid. Abby will use this for all new residents, and also opportunistically for existing residents. Every month, James will connect with a group of residents via video-conferences to take them through all existing problems. James also makes herself available for one-on-one VC sessions with residents to discuss their particular problems. This partnership proves to be an effective solution to provide hearing aid services for a nursing home.

Concluding remarks

Providing hearing rehabilitation services remotely is an emerging field in audiology. Manufacturers are constantly providing new options, especially as they endeavour to reach segments of the market that have to date been poor adopters. Recent advances

include smartphone apps to make self-adjustments, and more reliable wireless connections between hearing and other devices. It will be important to carefully assess each of these to ensure that they provide high quality services to those with hearing impairment.

References

1. Eikelboom RH, Swanepoel DW. Teleaudiology. In: Eren G, Webster JG, editors. Telemedicine and Electronic Medicine. *The e-Medicine, e-Health, m-Health, Telemedicine and Telehealth Handbook*. 1. Boca Raton, FL: CRC Press; 2016. p. 539-60
2. Goulios H, Patuzzi RB. Audiology education and practice from an international perspective. *Int J Audiol*. 2008;47(10):647-64
3. Fagan JJ, Jacobs M. Survey of ENT services in Africa: need for a comprehensive intervention. *Glob Health Action*. 2009;2
4. Swanepoel DW, Myburgh HC, Howe DM, Mahomed F, Eikelboom RH. Smartphone hearing screening with integrated quality control and data management. *Int J Audiol*. 2014:1-9
5. Elliott G, Smith AC, Bensink ME, Brown C, Stewart C, Perry C, et al. The feasibility of a community-based mobile telehealth screening service for Aboriginal and Torres Strait Islander children in Australia. *Telemed J E Health*. 2010;16(9):950-6
6. Folmer RL, Vachhani J, McMillan GP, Watson C, Kidd GR, Feeney MP. Validation of a Computer-Administered Version of the Digits-in-Noise Test for Hearing Screening in the United States. *J Am Acad Audiol*. 2017;28(2):161-9
7. Smits C, Merkus P, Houtgast T. How we do it: The Dutch functional hearing-screening tests by telephone and internet. *Clin Otolaryngol*. 2006;31(5): 436-40
8. Eikelboom RH, Mbao MN, Coates HL, Atlas MD, Gallop MA. Validation of tele-otology to diagnose ear disease in children. *Int J Pediatr Otorhinolaryngol*. 2005;69(6):739-44
9. Mbao MN, Eikelboom RH, Atlas MD, Gallop MA. Evaluation of video-otoscopes suitable for tele-otology. *Telemed J E Health*. 2003;9(4):325-30
10. Swanepoel D, Hall JW, 3rd. A systematic review of telehealth applications in audiology. *Telemed J E Health*. 2010;16(2):181-200
11. Tao KFM, Brennan-Jones CG, Capobianco-Fava DM, Jayakody DMP, Friedland PL, Swanepoel DW, et al. Teleaudiology Services for Rehabilitation With Hearing Aids in Adults: A Systematic Review. *J Speech Lang Hear Res*. 2018;61(7):1831-49
12. Pross SE, Bourne AL, Cheung SW. TeleAudiology in the Veterans Health Administration. *Otol Neurotol*. 2016; 37(7):847-50
13. Cooling G. Is Remote Fitting of Hearing Aids The Future? 2017 [Available from: https://www.hearingaidknow.com/is-remote-hearing-care-the-future
14. Kuzovkov V, Yanov Y, Levin S, Bovo R, Rosignoli M, Eskilsson G, et al. Remote programming of MED-EL cochlear implants: users' and professionals' evaluation of the remote programming experience. *Acta Otolaryngol*. 2014;134(7):709-16
15. Biagio L, Swanepoel DW, Adeyemo A, Hall JW, 3rd, Vinck BM. Asynchronous video-otoscopy by a telehealth facilitator. *Telemedicine and e-Health. Telemedicine and e-Health.* 2013; In press
16. Cox RM, Alexander GC. The International Outcome Inventory for Hearing Aids (IOI-HA): psychometric properties of the English version. *Int J Audiol*. 2002;41(1):30-5
17. Dillon H, James A, Ginis J. Client Oriented Scale of Improvement (COSI) and its relationship to several other

measures of benefit and satisfaction provided by hearing aids. *J Am Acad Audiol*. 1997;8(1):27-43
18. Bennett RJ, Meyer C, Eikelboom RH, Atlas MD. Evaluating hearing aid management: Development of the Hearing Aid Skills and Knowledge Inventory (HASKI). *American Journal of Audiology*. 2018; In press
19. Bennett RJ, Jayakody DMP, Eikelboom RH, Taljaard DS, Atlas MD. A prospective study evaluating cochlear implant management skills: development and validation of the Cochlear Implant Management Skills survey. *Clin Otolaryngol*. 2016;41(1):51-8
20. Biagio L, Swanepoel DW, Adeyemo A, Hall JW, 3rd, Vinck B. Asynchronous video-otoscopy with a telehealth facilitator. *Telemed J E Health*. 2013; 19(4):252-8
21. Ferrari DV, Bernardez-Braga GR. Remote probe microphone measurement to verify hearing aid performance. *J Telemed Telecare*. 2009;15(3):122-4
22. Smits C, Watson CS, Kidd GR, Moore DR, Goverts ST. A comparison between the Dutch and American-English digits-in-noise (DIN) tests in normal-hearing listeners. *Int J Audiol*. 2016;55(6):358-65
23. Potgieter JM, Swanepoel DW, Myburgh HC, Smits C. The South African English Smartphone Digits-in-Noise Hearing Test: Effect of Age, Hearing Loss, and Speaking Competence. *Ear Hear*. 2017

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