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## Meeting Abstracts

### Presentations - Thursday, July 27

Theme: Barriers & Facilitators

#### 08:45 Keynote

**Presenter:** Elizabeth Krupinski

**Affiliation:** Emory University

**Title:** Making Telehealth Mainstream: Challenges & Winning Strategies

**Abstract:** Telehealth is changing the healthcare environment and patient care. It is continually evolving as technology and opinions change, but still faces challenges.

**Summary:** Telehealth is changing the healthcare environment and patient care. It is continually evolving as technology and opinions change, but still faces challenges. Appreciating the evidence for the effectiveness and efficiency of telehealth provides the foundation for expansion and new delivery models by educating those who formulate policy and practice guidelines.

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#### 09:45 Podium Session

**Presenter:** Helen Cullington

**Affiliation:** University of Southampton, United Kingdom

**Title:** Cochlear implant care: putting clients in charge

**Abstract:** Sixty adults using cochlear implants participated in a RCT. One group used tools to care for their implant at home; a control group followed the usual care pathway. The remote care group were more empowered and had better hearing after the trial. Feedback was positive, especially for home hearing testing.

**Summary:** Background: Around 1,400 people receive a cochlear implant in the United Kingdom each year. People using cochlear implants require lifetime follow-up in order for their implant to be checked and adjusted, and for rehabilitation. Care is provided at one of 19 specialist tertiary centres in the UK, which may be several hours away from the client's home, necessitating travelling expense, time off work and family disruption. The median round trip journey to our centre is 148 kilometres, with an estimated travel cost of \$52. We propose only seeing people with implants when they need to be seen, avoiding clinic-led regular appointment schedules. This involves providing tools to support the ability and confidence of clients to know when an appointment may be needed. At the University of Southampton Auditory

Implant Service, we completed an innovative project to make the care pathway person-centred and provide a more efficient service to allow for more timely identification of issues.

**Aim:** To design, implement and evaluate a person-centred long-term follow-up pathway for adults with cochlear implants offering:

- home hearing test on iPad or computer (Digit Triplet Test)
- online support tool for troubleshooting, rehab, info etc.
- upgraded processor sent to home instead of clinic visit
- self-mapping for some people

**Method:** This was a two-arm feasibility Randomised Controlled Trial involving 60 adults using cochlear implants with at least 6 months device experience in a 6 month clinical trial of remote care. The control group followed their usual care pathway. The remote care group were given tools to care for their implant and hearing at home. The main outcome evaluated was empowerment; this has been shown to be strongly linked to better outcomes in people with long-term conditions. Secondary outcomes were hearing, quality of life, and subjective feedback from clients and clinicians.

**Results:** The 36 female and 24 male participants were aged from 20 to 83 years, with an average of 63 years in the control group and 64 years in the remote care group. They lived between 8 and 251 kilometres from their cochlear implant centre, with an average of 68 km. The remote care group had a significant increase in their cochlear implant empowerment after using the remote care tools. Quality of life remained unchanged in the two groups. The hearing test result had improved in the remote care group, although they had not noticed a change. The control group, however, felt their hearing had become slightly worse. Subjective feedback was positive with most clients finding the home hearing test the most valuable tool.

**Conclusion and plans for spread:** Offering remote follow-up may result in more empowered people with cochlear implants; more stable hearing; reduced client travel expense, time and disruption; greater equality in service delivery and more freedom to optimise the allocation of clinic resources. At this centre, some aspects of remote care are now offered to adults as part of personalised stratified care, with a full roll out planned by the end of 2017.

**Presenter:** Lisette van Leeuwen

**Affiliation:** VUmc, the Netherlands

**Title:** Barriers and enablers to the implementation of an ICF-based e-intake tool in clinical Audio-Otology practice.

**Co- Authors:** M Pronk PhD, P Merkus PhD, ST Goverts PhD, Prof. SE Kramer PhD

**Abstract:** To identify patients' and clinicians' perceived barriers and enablers to the implementation of an ICF-based e-intake tool in clinical Audio-Otology practice, interviews were held. Patients were mostly positive about the tool, while clinicians reported some important barriers. The identified barriers and enablers will be incorporated in the implementation strategy.

**Summary:** The Brief International Classification of Functioning Disability and Health Core Set for Hearing Loss was developed to serve as a minimum standard for the reporting of the functioning and health of patients with hearing loss<sup>1</sup>. Based on this Core Set we aim to develop and implement an e-intake tool (a Patient Reported Outcome Measure (PROM)) for patients with ear/hearing problems who visit an ENT-doctor or an Audiology Clinic for the first time. Its purpose is to identify the patient's functioning profile given his/her health condition and facilitate discussion between the clinician and the patient so that they can jointly determine the patient's needs and appropriate treatment steps. Implementation of such tools is known to be highly challenging. Before implementation into clinical practice, the acceptance by its potential users should be taken into account. Two key recommendations in this regard are (1) to use change management principles to help PROM implementation into clinical practice; and (2) to take into account the enablers and barriers in preparing, implementing, and evaluating PROM measurement<sup>2</sup>.

Interviews and focus groups were organized with patients and clinicians (i.e., audiologists and ENT-doctors). Interview questions reflected the COM-B framework which includes three behavior change constructs: capability, opportunity and motivation<sup>3</sup>. Transcripts of the interviews were analyzed thematically based on the COM-B elements to identify possible barriers and enablers as well as possible (design) features that should be incorporated in the e-intake tool.

Patients were generally positive and willing to use the e-intake tool. Capability-enablers included providing information on the purpose and relevance of the e-intake tool. In addition, patients indicated their preference for a digital

questionnaire to be filled out at home. The main motivation to complete the tool was the possibility of facilitating a more directed intake process and subsequent efficient care provision. Clinicians raised important concerns towards the use of the tool in their routine practice. An important opportunity-barrier was limited time and high turnover practice, especially in the ENT department. Regarding motivational-barriers, both ENT-doctors and audiologists expressed concerns about the responsibility they felt about having to address functioning topics that may not directly relate to the patient's ear/hearing problem and they felt were no part of their expertise (e.g., depression). They also questioned whether the tool would be relevant for all patient groups. For instance, they did not perceive any added value of the tool in patients with well-marked ear/hearing problems (e.g., ear infection, presbycusis) for whom the treatment options are evident (e.g., medication, hearing aids). Enablers to clinicians use were the motivation to pursue a complete picture of the patient and the perceived added value of the preparation by the patient. Important opportunity-enablers included that patients can submit their information prior to the consultation and that the resultant functioning profile is integrated in the electronic patient record system.

The enablers and barriers identified in this study inform the designers on which behavioral change techniques, intervention functions, and policy categories might be used to maximize acceptability and ease of implementation by both patients and hearing health clinicians.

1. Danermark, B., Granberg, S., Kramer, S. E., et al. (2013). The creation of a comprehensive and a brief core set for hearing loss using the international classification of functioning, disability and health. *Am J Audiol*, 22, 323-328
2. International Society for Quality of Life Research (prepared by Aaronson N, Elliot T, Greenhalgh J, Halyard M, Hess R, Miller D, Reeve B, Santana M, Snyder C). *User's Guide to Implementing Patient-Reported Outcomes Assessment in Clinical Practice*, Version: January 2015.
3. Michie S, van Stralen MM, West R (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implement Sci*; 6: 42.

**Presenter:** Filiep Vanpoucke

**Affiliation:** Cochlear Technology Centre, Mechelen, Belgium

**Title:** Empowering Senior Cochlear Implant Users in their Home Environment

**Co- Authors:** Birgit Philips (Cochlear), Feike de Graaff (VUmc, Netherlands), Cas Smits (VUmc), Inge Doorn (OPCI, Netherlands), Paul Govaerts (Otoconsult, Belgium)

**Abstract:** After cochlear implantation (CI) the typical after care path is quite intense, consisting of multiple visits to the clinic for device fitting, counseling, and hearing habilitation. We created an application offering information on living with an implant, hearing tests and device diagnostics. We will show preliminary results from user evaluations.

**Summary:** The period before and after cochlear implantation is a time full of uncertainty. Clinicians are typically fairly conservative in their counseling on expected hearing outcomes. Several weeks pass by before the implant is switched on and user have to retrain their brain because of the different nature of the sound. The user needs to travel frequently to his CI care center, quite often a university or expert clinic at considerable distance requiring significant travel. If they are still professionally active, they need to take time off. Or at an elder age, their general health state may make travel difficult. Our consortium received a grant (AAL-2013-6-065) from the European Union in the context of the Ambient Assisted Living programme to develop a self-support application for new senior cochlear implant users. The members were companies (Cochlear and Otoconsult), a clinic (VUmc Amsterdam) and a society of cochlear implant users (OPCI). We organized user groups to identify the most pressing needs of senior CI users in the initial period. They identified a need for more and reliable information about the use of the device; access to device diagnostics, hearing performance assessment; hearing exercises and device use information.

During the course of the project, a self-management app (My Hearing App) was developed with modules covering each of the above functionalities. E.g. a speech audiometry module was developed for speech in noise (digit triplets) and speech in quiet (CVC lists) testing. A lot of care was devoted to the sound calibration in order to achieve similar results as in the clinic sound booth setting. Another module allows to visualize device usage patterns. The data from the app is stored in a secure server in the cloud and can be accessed remotely by the clinician.

The design philosophy was rooted in self-determination theory. The app should result in more autonomy, i.e. CI listeners are less dependent on their professional care givers, a higher competence in terms of knowledge about their device and skill level to handle their device, and a more intense relationship with their caregivers.

Two main evaluations are performed with the integrated app. The first evaluation targeted newly implanted users. The medical centre of the University of Amsterdam is offering this app as an add-on to their CI care as usual. The project ends with a second evaluation with experienced users also trialing the application. We will present the preliminary results of these evaluations both from the clinic's perspective as from the user's perspective.

## 11:00 Demonstration Session

**Presenter:** Wendy Steuerwald

**Affiliation:** Cincinnati Children's Hospital Medical Center

**Title:** Cincinnati Children's Hospital Medical Center Teleaudiology Challenges and Resolutions

**Co- Authors:** Thomas Evans, Michael Scott

**Abstract:** CCHMC Teleaudiology is focused on using technology as a method to improve patient access and care. We are offering some services and answering questions, with a focus on hearing device troubleshooting at the patient's home and school and international cochlear implant mapping.

**Summary:** Parents of pediatric audiology patients often urgently need to connect with their child's audiologist. Parents often have questions about their child's hearing device or need help troubleshooting, especially if they suspect the device is not functioning correctly. It is often challenging to obtain a prompt audiology appointment due to scheduling constraints, transportation issues, or a lack of audiology services close to the child. We are offering teleaudiology as a way for patients to connect to their audiologist for questions and some services, with a focus on hearing device troubleshooting, hearing aid and cochlear implant questions, and international cochlear implant mapping. We are also providing hearing aid and FM troubleshooting services to schools via teleaudiology as a timely way to help students with their hearing devices during the school day. Since insurance coverage is a barrier, we chose to focus on the services that are typically not charged to insurance.

Cincinnati Children's Hospital Medical Center (CCHMC) division of audiology started our teleaudiology program in 2015. Our first step was to survey parents of patients to determine if they had the technology that could be used for teleaudiology. Survey results showed that 98% had the technology necessary to receive services via teleaudiology. The next step was audiology staff training. Staff were trained by the CCHMC Teleaudiology Team by practicing with each other, by simulated patient encounters, and then with actual patients. Computers in private offices were selected in each location for teleaudiology use. Cisco Jabber software was installed on each computer. Jabber is the platform that CCHMC teleaudiology uses to connect with patients. Audiology staff were instructed on what to do if there were connection issues, such as the parent could not connect, the parent could see us, and the picture was pixelated. Audiology staff kept a log of all the connection problems that occurred and how they were resolved. The log was shared with all teleaudiology providers. Some providers did not want to participate in teleaudiology due to fears of not being able to connect with patients, or fears of patients being upset by connection difficulties. We are working with staff to alleviate these fears by sharing success stories and continued education. Not all challenges were able to be resolved. Decreased bandwidth is often an issue in some areas. CCHMC is fortunate to have a Telehealth Center that is open 7 days a week to help patients and staff with telehealth issues.

**Presenter:** Georgina Blasco

**Affiliation:** Walter Reed NMMC, Bethesda MD, USA

**Title:** Department of Defense TeleAudiology

**Co- Authors:** Jylkka, Margaret; Ramos, Leilani; Zion, Danielle; Brungart, Douglas

**Abstract:** Teleaudiology proof-of-concept services have proven to be of substantial benefit within the Department of Defense (DoD). Logistical feasibility and technological considerations for providing remote audiology services in the DoD have been evaluated with the goal to expand services across DoD Contiguous United States (CONUS) and Outside the

Contiguous United States (OCONUS).

**Summary:** Hearing loss and tinnitus are the most prevalent permanent injuries in the military attributed to hazardous noise exposure in active duty service members who, despite efforts from hearing conservation programs, continue to experience hearing-related issues warranting referral for audiological services. The increasing numbers of patients reporting such injuries are experiencing difficulties accessing audiology services within the Military Health System (MHS) due to its lack of specialty services in remote areas. As a result, patients needing audiology specialty care have experienced one of the following: declined care, been referred out of the TRICARE network, endure long commutes to nearest MTF, delayed care, increased time off from work if commuting to MTF, missed appointments, exacerbated traumatic conditions with the stress of long waiting periods, increased travel times and/or being in over stimulating/busy environments of MTFs (for patients with TBI and/or PTSD). Teleaudiology has the potential to expand the accessibility of audiology specialty services to patients in remote areas and substantially decrease the above listed experiences. In addition, telehealth has ample potential to decrease expenses related to travel, lost duty time, and potentially eliminating purchased care cost.

In order to evaluate the feasibility of providing TeleAudiology services within the DoD, we partnered the Walter Reed National Military Medical Center Audiology and Hearing Conservation Clinics with the DiLorenzo TRICAREHealth Clinic at the Pentagon to execute a proof-of-concept study for remote provision of hearing healthcare services. Selection of an adequate remote site is crucial for the success of a telehealth initiative with the greatest challenges falling within the umbrella of Information Technologies (IT).

Teleaudiology services proved to provide state-of-the-art diagnostic evaluations, rehabilitative (hearing aid), and hearing conservation readiness audiology services. During this initiative, patients received quicker access to specialty services, decreased time away from work, minimized need to postpone appointment, and decrease stress of commuting. These specialty services can also be provided to Service member's families and retirees and will ultimately further improve the overall patient-centered quality of care.

Upon expansion of these services across DoD, we are anticipating an overall improvement in patient experience, quality of care and decrease in out of network purchased care cost. Near future expansion within this WRNMMC and DTHC initiative include WRNMMC's speech-language-pathology (SLP) and Otolaryngology specialty telehealth services. Otolaryngology and SLP will be evaluating the feasibility and quality of care via Tele-SLP and TeleOtolaryngology health services within the DoD, as well as patient and provider satisfaction.

**Presenter:** Alessia Paglialonga

**Affiliation:** CNR, National Research Council, Italy

**Title:** Characterization of Features of Mobile Apps by Automated Extraction of Information from the Web

**Abstract:** In the perspective to offer tools to assist patients and hearing healthcare professionals in informed adoption of apps for improved service delivery, our research develops methods to characterize apps and to identify their features. In this study, we developed an automated method to extract apps' features directly from the Web.

**Summary:** Internet-based tools and, in particular, mobile health (m-Health) technology are driving a paradigm shift in service delivery in hearing healthcare (HHC). Wide adoption of smartphones in the general population and proliferation of health-related apps open novel opportunities for improved patient outcomes, promotion of preventive behaviors, remote service delivery, and patient-centered care. However, among the >165,000 health apps available on the app stores, only a limited number have been tested for reliability and efficacy. In spite of a rapid development in HHC, systematic methods to assess apps are lacking.

The aim of our research is to develop methods to assist HHC professionals in informed, aware selection and adoption of apps for themselves as well as for patients and their families. Recently, we have developed a descriptive model to characterize apps for HHC, the ALFA4Hearing model (At-a-glance Labeling for Features of Apps for Hearing Healthcare), which includes 29 features grouped into five main components: Promoters, Services, Implementation, Users, and Descriptive information. Currently, we are developing automated methods, based on text analytics, to extract information about apps' features directly from the Web.

As a first step, in this study we implemented a custom software to: (i) browse the webpages of all the apps in the Medical (M) and Health & Fitness (H&F) categories on the US iTunes app store; (ii) extract apps' information from the

apps webpages' HTML source code; and (ii) analyse information by using text analytics tools (MetaMap by the National Library of Medicine and Alchemy API, by IBM) to identify the apps' medical specialties and characterize their features. Specifically, to assess the viability of the method, here we focused on features in the Promoters component.

Our software browsed 33858 M and 51994 H&F apps' webpages. After removing duplicates and non English apps, we obtained a local database of 66185 unique apps (as of Dec 20, 2016). Automated identification of the medical specialties resulted in 1.9% of apps for HHC (1257 out of 66185). Interestingly, this percentage is similar to the ones of Cardiology (2.1%), Gynecology & Obstetrics (2.1%), and Orthopedics (2.0%), i.e. medical specialties that make extensive use of apps. The analysis of promoters showed that Manufacturers and Independent Developers promoted 99% of apps combined, whereas promoters from the healthcare and science areas (e.g., Government Services, Healthcare Providers, or Scientific and Educational Organizations) are still playing a minor role. This suggests that there might be ample room for a greater involvement of these stakeholders into the process of developing and promoting mobile apps for HHC.

This preliminary study showed promising results and suggested the viability of an automated approach for extracting information about the apps' features from the iTunes app store. Further research would be important to develop more powerful and robust tools for automated extraction of all the features in the ALFA4Hearing model, also assessing additional sources of information on the Web. Automated methods for app characterization could represent promising tools to help hearing professionals in identifying apps and could contribute to increase accessibility and usability of apps for HHC.

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## Theme: Ethics

### 13:45 Keynote

**Author:** Elizabeth Buchanan

**Affiliation:** University of Wisconsin – Stout

**Title:** Ethical issues Related to Internet-based Research and Service Delivery

**Abstract:** The internet, both as a media and local of research, has afforded myriad disciplines with unique research opportunities, while pushing boundaries on standard methodologies and ethical norms. This presentation will provide an overview of current Internet research practices in general with a focus on the unique ethical issues in audiological Internet-based research.

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### 14:45 Podium Session

**Presenter:** Derek Hoare

**Affiliation:** University of Nottingham (UK)

**Title:** Ethical considerations in a qualitative analysis of threads in online support groups for tinnitus

**Co- Authors:** Eve Ainscough, Sandra Smith (NIHR Nottingham Biomedical Research Centre, University of Nottingham), Kate Greenwell (University of Southampton)

**Abstract:** Online support group are a popular coping strategy for those living with tinnitus. To study the potential benefits or harm of participation we examined posts in four online groups in the public domain. To do this without informed consent several ethical issues related to study design and reporting were considered.

**Summary: Background:** Tinnitus is the perception of noise without an external sound source. Current management typically aims to moderate associated reactions and allow patients to retain an adequate quality of life. With the

increasing recognition of the internet as a repository for health advice, information and support, the online support group has become a popular coping strategy for those living with chronic conditions like tinnitus. Patients find that communicating with each other in a forum to provide encouragement and share information, in the absence of physical and temporal boundaries, can be valuable. However, the potential positive and negative aspects of participation in these forums for people with tinnitus have yet to be studied. The sole context under which this is ethically viable, without the explicit need for informed consent, is if the data is taken from what can be considered a public domain. Some authors have argued that there is indeed an indistinct definition of what is 'public' in an online environment. By one set of criteria forums posts might be considered public if they (1) are taken from a forum where registration or subscription is not required to secure access, (2) the forum has an abundant number of members, and (3) the individual and social norms of the group suggest it is a public domain. Anonymity is another important ethical consideration. There has been frequent debate concerning use of direct quotes from online participants, with recommendations of caution in doing so. The main issue here stems from the potential traceability of lengthy verbatim quotes in search engines.

**Method:** In this study 641 messages posted between February and April 2016 were randomly selected from across four public online support groups with embedded discussion forums. Messages were coded by three separate analysts using an inductive approach to thematic analysis. To avoid traceability of the quotes used in this study none are reported verbatim. In adhering to the strictest ethical standards distinguishable personal and clinical information has equally been removed including the names of the online support group, the forum members' actual names, and any pseudo-names used.

**Results:** Analysis found nine independent themes pertaining to aspects of participation in an online support group for tinnitus. We found that using forums allowed users to exchange knowledge and experiences, express complex emotions, profit from a network of support and engage in every-day conversation away from the burden of their tinnitus. However, their experience appeared to be compromised by negative messages, limited communication at times, and informational issues such as conflicting advice or information overload.

**Conclusions:** This study represents the first research into tinnitus and online support groups. A non-intrusive (passive) analysis method was used, whereby messages comprising the data set were retrieved without direct interaction with the discussion forum. Subjects as individuals and the community as a whole are deemed to be at low risk from potential harm in this study.

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## Presentations - Friday, July 28

### Theme: Big Data

#### 08:30 Keynote

**Presenter:** Harvey Dillon

**Affiliation:** National Acoustics Laboratories, Australia

**Title:** Potential of Large Scale Data in Hearing Rehabilitation

**Abstract:** This talk will show some relationships between information that can readily be collected from adult clients at the time of their hearing assessment, characteristics of the devices they are fitted with, characteristics of the clinicians providing their rehabilitation, and outcomes reported three months after hearing aid fitting.

## 09:30 Podium Session

**Presenter:** Ariane Laplante-Lévesque

**Affiliation:** Eriksholm Research Centre (Denmark) and Linköping University (Sweden)

**Title:** Evotion: A European research project generating big data evidence and decision support for public health hearing policies

**Co- Authors:** Lukas H B Tietz, Niels Henrik Pontoppidan (Eriksholm Research Centre, Oticon A/S)

**Abstract:** This project develops a platform that enables: 1) the collection of heterogeneous data related to hearing loss and 2) the performance of big data analytics. This will generate evidence and decision support for holistic public health policies regarding hearing loss prevention and treatment in adults in Europe and beyond.

**Summary:** According to the World Health Organization, hearing loss is the fifth cause of years lived with disability. Hearing loss is associated with social isolation, unemployment and early retirement, mental illness, and cognitive decline. This is why hearing loss is defined as a public health problem. Holistic management of hearing loss calls for public health policies that target hearing loss prevention, protection from noise, early diagnosis, long-term treatment and rehabilitation, detection and prevention of cognitive decline, and socio-economic inclusion of people with hearing loss.

This project, which spans 2016-2019 and includes 13 partner organizations, creates a platform that enables data to inform public policy making regarding hearing loss prevention and management. This evidence base is built through collection of: 1) existing large datasets from five of its partner organizations (retrospective data) and 2) real-time data from hearing aids and sensors worn by people with hearing loss from four of its partner organizations (prospective data). The collected data include: physiologic, cognitive, pharmacologic, occupational, behavioral, environmental, and open web data as well as audiologic data such as noise exposure, temporary threshold shifts, and hearing aid usage. Beyond helping people at risk of or with hearing loss, and informing clinical practices, the platform will help health policy makers to identify, simulate, select, and monitor the effectiveness of current and new hearing loss interventions. This presentation focuses on the hearing aids and sensors used for the data collection, the types of data to be collected, as well as how the decision making support arising from the project will lead to evidence-based public health policy formulation.

**Presenter:** Moumita Choudhury

**Affiliation:** New Mexico State University, Las Cruces, NM

**Title:** Social Media and Hearing Aids

**Abstract:** In the United States, 61% adults access the Internet for health and medical information. The Internet can be used to improve patient education, patient care, and professional networking. This study investigates the utilization pattern of social media hearing aid (HA) user communities. Specifically, the meso-level social processes of HA communities in social media websites were studied.

**Summary:** Background: The Internet has become a widely accepted alternative social environment in the past decade. The social media offers highly interactive platforms through which individuals and communities share, discuss and modify user-generated content. Recently, social media tools are becoming increasingly popular in gaining healthcare information. There are many social media websites available on the World Wide Web (www) that provides supportive communities to patients and their families where they receive comfort, insight and potential leads to new treatments. The Pew Internet and the American Life Project reported that in the United States, 61% adults access the Internet for health and medical information (Fox & Jones, 2009). The same research also reported that 49% have accessed a website that provides information about a specific medical condition. Patients and their families are increasingly relying on social media to receive healthcare information and share personal experiences and opinions on health concerns. The vast amount of health information available in the Internet for consumer health education may have the potential for improving individual health (Eng et al, 1998; Robinson et al, 1998).

Hearing loss is the third most prevalent chronic condition in older adults (Collins, 1997). In the United States, 48.1 million



people report some degree of hearing loss (Lin, Niparko & Ferucci, 2011) and 30.5% of people with hearing loss use hearing aids (The National Health Interview Survey, 2012). In recent years, a few studies reported the online activities by the hearing impaired, deaf and hard-of-hearing communities (Barak & Sadovsky, 2008; & Blom et al, 2014). However, the usage of Internet or social media websites by hearing aid user communities has not been investigated. This knowledge may prove to be a powerful tool to understand the unmet needs of hearing aid user communities, provide focused education and help all stakeholder—clinicians, researchers and manufacturers—connect to patients and families in a better way.

The purpose of the present research was to analyze the participation of the hearing aid user communities in social media websites. Specifically, the meso-level social processes of hearing aid user communities in social media websites were studied.

**Methods:** We conducted a systematic survey of online hearing aid and hearing aid user related social media sources. Using standard search engines, the search term hearing aid(s), hearing aid users, forum and blog identified five social media platforms and Websites, such as, Facebook, Twitter, Youtube, blogs and online forums. The items were manually scraped from the social media websites, collated and analyzed using simple thematic analysis. The activity on Social Media platforms and websites were quantified by indices of membership and posts. All the sources identified were assigned to functional categories, such as, personal stories, general information about hearing aids, hearing aid care, support, etc.

**Results:** Nearly 600 social media sources were identified, including 24 Facebook groups, 107 Facebook pages, 191 Twitter accounts, 174 Youtube videos, 69 blogs and 34 forums. The pattern of utilization of each social media platforms by hearing aid users and their families or caregivers will be presented.

**Conclusion:** This is one of the first studies that investigated the utilization of social media by hearing aid user communities. The results suggest that hearing aid users leave their digital footprint in a wide variety of social media sources. Online social media platforms provide a new vista to discuss treatments, share information, promote new products and provide support.

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## Theme: Methodology

### 11:10 Keynote

**Presenter:** De Wet Swanepoel

**Affiliation:** University of Pretoria

**Title:** mHealth in hearing care: research evidence and priorities

**Abstract:** Hearing loss is a pervasive chronic disability affecting a billion people annually. Novel solutions, capitalizing on advances in technology and connectivity, demonstrate promise for increasing access, improving quality and reducing costs of care. Evidence on implementation of eHealth initiatives will prioritise future hearing care research.

**Summary:** Hearing loss is a pervasive chronic disability that affects more than a billion people annually. Unsurprisingly, it is a leading contributor to the global burden of disease. Early access to hearing care is critical for optimal outcomes, but for most of those affected it remains out of reach. Novel solutions, capitalizing on advances in technology and connectivity, demonstrate promise for increasing access and quality of care whilst reducing costs. The penetration and ubiquity of mobile phones, even in developing countries, make mHealth a powerful potential tool for widespread impact. This presentation will review research evidence on the implementation and evaluation of initiatives in eHealth and mHealth hearing care to prioritise future requirements. Apart from mHealth research proving equivalence to standard services, future work should evaluate its potential to create new models of hearing health access and care.

## 13:10 Podium Session

**Presenter:** Elisabet Thorén

**Affiliation:** Eriksholm Research Centre, Denmark

**Title:** Outcome of feasibility study of Eriksholm Guide to Better Hearing

**Co- Authors:** David Maidment, Melanie Ferguson (NIHR Nottingham Biomedical Research Centre, UK)

**Summary:** Recent studies show that online audiological rehabilitation programmes have the potential to reduce self-reported residual hearing problems in experienced hearing aid users. When using online tools and internet-supported rehabilitation in a cost-effective way, more people can access comprehensive rehabilitation programmes that go well beyond the basic fitting of hearing aids.

The literature shows a number of advantages to using audiological concepts with digital applications in different phases of the patient journey. For example, studies have used online tools to keep in contact with first time users of hearing aids between physical meetings in the clinic (1,2). Other studies have evaluated home-delivered education programs for hearing-aid users and their significant others, with positive results (3,4).

Studies indicate that the internet can be used to deliver education and rehabilitation to experienced hearing aid users who report residual hearing problems (5,6). Based on previous experiences with internet interventions and online audiological rehabilitation, a self-management program has been developed further, where participants are guided through a program structured around learning modules containing different topics and associated interactive tasks (7). The program is branded the 'Eriksholm Guide to Better Hearing', where focus has been on the delivery of content that it is accessible for a broad target group, and possible to implement in a clinical setting.

The participants in earlier studies were self-recruited hearing-aid users, with self-reported hearing problems. In the future, it should be possible, in a cost-effective way, to use online tools and internet-supported rehabilitation in a clinical setting. This could enable more people to access comprehensive rehabilitation programmes (8). An important next step is to evaluate whether the content and format of online audiological rehabilitation programmes are suitable in a clinical setting.

We aim to evaluate the effectiveness of the Eriksholm Guide to Better Hearing in the UK publicly-funded National Health Service (NHS) with a clinical sample of adult hearing aid users, using a randomised controlled trial (RCT) design. The RCT will evaluate the effectiveness of the online rehabilitation programme. We are currently completing a feasibility study, which is a precursor of the RCT. This study will estimate a number of parameters necessary for the design of a RCT. This systematic approach of completing a feasibility study prior to a full-scale evaluation is strongly advocated by the Medical Research Council (MRC) Guidelines for developing and evaluating complex interventions (9), ensuring that any uncertainties are addressed and that the intervention operates as intended.

To this end, the feasibility study takes a mixed-methods approach and focuses on collecting input on the following; 1. The recruitment process, 2. Feasibility/acceptability of approach and 3. Users' perspective/opinions of the intervention. In terms of recruitment, we will assess both clinicians' willingness to recruit participants and participants' willingness to consent, thereby indicating the number of eligible patients. We will evaluate feasibility of approach by collecting quantitative outcomes to determine the characteristics of the potential outcome measures. The users' perspective/opinions regarding delivery of the program through different devices will be collected via focus groups, which will inform how the program is used and how often (i.e. usability). In addition, we will gather participants' views concerning what they like and dislike about the program (i.e. acceptability) and how much of the program that is completed (adherence).

To address these objectives, hearing aid users will try out the online program away from the laboratory at home. After finishing the online program, all participants who completed both baseline and follow-up sessions will be invited to attend a focus group. Preliminary findings from the study will be presented.

**Presenter:** Michelle Hughes

**Affiliation:** Boys Town National Research Hospital

**Title:** Remote Programming for Pediatric Cochlear Implant Recipients

**Co- Authors:** Joshua Sevier AuD, Sangsook Choi PhD

**Abstract:** This study examined the feasibility of remotely programming cochlear-implant (CI) sound processors for pediatric recipients using conditioned play audiometry and visual reinforcement audiometry. Results show that both test methods yield behavioral thresholds that are similar to those obtained in the traditional in-person condition.

**Summary:** Cochlear-implant (CI) programming requires numerous visits to the CI center within the first year, with annual or semi-annual visits thereafter. The number of required visits tends to be higher for young children, who typically provide limited and sometimes unreliable behavioral feedback necessary for accurate CI programming. This, coupled with the fact that CI centers are not geographically widespread, can create burdens for families to attend all of the appointments needed for proper follow-up. Delivery of CI services via telepractice offers a potential avenue to ease these burdens. The purpose of this study was to examine the feasibility of remotely programming CI sound processors for very young children, who require specialized testing techniques compared to those used with adults. Two studies were conducted. In the first study, 19 children aged 5 – 7 years were tested using conditioned play audiometry (CPA), which involves conditioning the child to listen for a sound and then to respond to the stimulus within the framework of a play task (e.g., drop a ball in a bucket when the sound is heard). In the second study, a group of younger children aged 1 – 3 years (N=16 participants to date) was tested using visual reinforcement audiometry (VRA), which involves reinforcing a child's looking behavior toward a lighted or animated toy when a sound is heard. For both studies, behavioral thresholds were obtained for three electrodes spaced across the array (basal, middle, and apical) using an AB-BA design (A, in person; B, remote) over two study visits. Results for the CPA group showed no statistically significant difference in thresholds between remote and in-person conditions. The average test time was not significantly different between conditions. Last, the hit rate (ratio of responses obtained versus attempted) was also not significantly different between test conditions. Data collection for the VRA group is nearly complete (goal is 20 participants), and preliminary results are similar to those for the CPA group. Results from these studies suggest that telepractice is a feasible option for improving access to CI programming services for very young children.

**Presenter:** Eldré Beukes

**Affiliation:** Anglia Ruskin University

**Title:** Audiology-guided Internet-based cognitive behavioural therapy for adults with tinnitus in the UK

**Co- Authors:** Prof Gerhard Andersson (Linköping University, Linköping, Sweden)

**Abstract:** Audiology-guided Internet-based Cognitive Behavioural Therapy for a UK population has been designed and evaluated in a three-phase clinical trial. Feasibility and efficacy were established for both tinnitus and the associated comorbidities. Results include longer-term outcomes, outcome predictors and comparison of this intervention to that of standard face to face care.

**Summary:** Aim: Variation in access to evidence-based tinnitus care exists in the UK, resulting in some with troublesome tinnitus, left without guidance on managing the devastating effects tinnitus may have. Additional cost and clinically effective tinnitus management routes are imperative to increase access to tinnitus care. An innovative way to improve access is providing Cognitive Behavioural Therapy via the Internet (iCBT), using a model applied in Sweden and Germany. As iCBT is not available in the United Kingdom (UK), the purpose of this research was to develop and evaluate such an intervention to determine the intervention effects on tinnitus and associated comorbidities. A further aim was to determine whether this intervention could be guided by an Audiologist, as in the past it has been delivered by Clinical Psychologists.

**Material and Methods:** The Internet intervention used in Sweden was redesigned and adapted for a UK population and tested by both tinnitus professionals (n=5) and tinnitus users (n=29). This intervention was then evaluated in a three phase clinical trial. The first phase investigated feasibility (n=37). Phase two was an efficacy study, utilising a randomised, delayed treatment effectiveness trial, with a two-month and one year follow-up (n=146). Phase three was



an inferiority trial comparing iCBT to standard clinical care which is individual face-to-face tinnitus therapy (n=80). Standardised self-reported outcome measures for tinnitus distress, hearing disability, insomnia, anxiety, depression, hyperacusis, cognitive failures and satisfaction with life were used to assess outcome.

Results: The intervention was highly rated by both professionals and tinnitus users. Feasibility was established in terms of recruitment potential and suitable attrition and compliance rates. Undertaking iCBT led to significant reduction in tinnitus distress and many of the problems associated with tinnitus. These results remained stable post-treatment.

Overall, participants reported positive experiences using the intervention.

Conclusions: Guided iCBT for tinnitus using Audiological support in the UK has indicated efficacy at reducing tinnitus distress and associated symptoms. Further work should be directed to exploring moderators and mediators of outcome, comparing result when guided by an Audiology or Psychologist, and which specific aspects of iCBT result in positive outcomes, in view of dissemination of this intervention for those with tinnitus in the UK.

**Presenter:** Annette Cleveland Nielsen

**Affiliation:** Eriksholm Research Centre, Denmark

**Title:** User Designed and Innovated eHealth Solutions for Service Delivery to Elderly Persons with Hearing Impairment

**Co- Authors:** Sergi Rotger-Griful (Eriksholm Research Centre, Oticon A/S), Anne Marie Kanstrup (Aalborg University, Denmark), Ariane Laplante-Lévesque (Eriksholm Research Centre, Linköping University, Sweden)

**Abstract:** We involve elderly persons with hearing impairment, their significant others, and audiologists in innovating and designing eHealth solutions for service delivery of hearing rehabilitation. Our participatory User Innovation Management method reveals insights on the complex interplay related to eHealth assisted hearing rehabilitation within an eHealth ecosystem and specifies user requirements.

**Summary:** Hearing impairment (HI) is the fifth most common chronic disease in the world, its prevalence is increasing with an ageing population and there is a shortage of hearing care professionals: eHealth could be a solution to the problem of exploding demand for hearing care [1]. However, most eHealth solutions are not implemented past research projects, as they are developed due to technological opportunities rather than to fulfill the needs and expectations of their target users. Moreover, there are concerns that the elderly population will have difficulties using eHealth solutions: not being tech-savvy or suffer from other chronic diseases influencing eHealth abilities. Research has identified an abundance of hearing apps to support care, but their adoption is low [1]. Elderly people have shown capabilities in inventing through new technologies, but this have not been investigated in elderly persons with HI. Therefore, we investigate the key actors' needs, expectations and visions within future hearing rehabilitation service delivery in order to develop solutions that will fulfill the real needs of the users. We involve participants through a human-centred design for interactive systems [2] and the User Innovation Management method [3], where participants are partners in the design and innovation process through activities and use of visual tangible artefacts that support their innovation potential.

Through 3 rounds of focus group meetings, we involve 36 elderly persons with HI (PHIs), 10 significant others (SOs) and 8 audiologists (AUDs) in creating user designed and innovated eHealth solutions for service delivery to elderly PHIs within an eHealth ecosystem. The eHealth ecosystem enables information, learning, and communication flow between hearing aids (HAs), users, mobile phones, a cloud service provider, and AUDs. Through online questionnaires, we select the participants for their interest in innovation within hearing rehabilitation and screen them for eHealth literacy, mobile device proficiency, and satisfaction with hearing aids (IOI-HA for PHIs).

Finding from our focus groups presents 1) insights on the complex interplay related to eHealth assisted hearing rehabilitation, 2) specification of user requirements for eHealth assisted hearing rehabilitation, and 3) an integrated design of a mobile eHealth application with the functionality and interaction defined in cooperation with the key actors. The complex interplay relates for instance to PHIs requirements for personalised information delivery with the right timing, timely on-demand communication, and ongoing learning about hearing, HAs, new available technology and self-management. The participating SOs express requirements for access to the same information as PHIs and involvement in the hearing rehabilitation process. The AUDs have requirements for efficient communication with PHIs and empowered PHIs taking responsibility for their rehabilitation, as those PHIs presumably will enable more efficient client journeys. The key actors' visions for eHealth assisted hearing rehabilitation calls for connecting service delivery having both digital

and physical services as well as self-service and self-monitoring. In the last focus group rounds in April, we will transform the visions into eHealth solutions in cooperation with the PHIs meeting their needs and expectations for future hearing rehabilitation.

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2. European Committee for Standardization. (2010). *Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems (ISO 9241-210:2010)*
3. Kanstrup, A. M. & Bertelsen, P. (2011). *User Innovation Management: a handbook*. Aalborg Universitetsforlag

**Presenter:** Jingjing Xu

**Affiliation:** Starkey Hearing Technologies, Eden Prairie, MN

**Title:** Assessing auditory ecology of younger normal-hearing listeners and older hearing aid wearers using a smartphone/hearing aid-based ecological momentary assessment system

**Co- Authors:** Yu-Hsiang Wu, Elizabeth Stangl (University of Iowa); Shareka Pentony; Octav Chipara, Syed Shabih Hasan (University of Iowa); Jason Galster

**Abstract:** The purpose of this presentation is to demonstrate a smartphone/hearing aid-based ecological momentary assessment system for examining a listener's auditory ecology. For both younger normal-hearing listeners and older hearing aid wearers, data collected for characterizing different listening environments from subjective and objective measures will be presented and discussed.

**Summary:** Auditory ecology often refers to the range, type, and importance of the listening environments in which listeners are asked to function. Understanding and accounting for factors that are related to a listener's auditory ecology can potentially improve the technical and personal aspects of individualized hearing aid provision. Specifically, research has shown that the effect of hearing aid technologies is a function of auditory ecology. Therefore, knowledge of a listener's auditory ecology and the interaction between auditory ecology, hearing aid technologies, and the listener's perception could be used to achieve individualized hearing aid optimization.

Our long-term goal is to develop methods for optimizing the performance of hearing aids to better meet the real-world and individualized listening demands of the user. To achieve this goal, we will utilize (1) hearing aids that can wirelessly stream real-time data regarding their configurations and the estimated environment characteristics to the Internet via smartphones, (2) Ecological Momentary Assessment (EMA) techniques that collect in-situ hearing aid and listener's perception data, (3) smartphone algorithms/apps that can extract audio features to characterize the environment, and (4) cloud computing. In this on-going pilot study, we are taking the first step to test a new smartphone/hearing aid based EMA system to verify the environment data provided by hearing aids and to explore the relationship between environmental characteristics and the listener's perception. Specifically, we ask the following two questions: How well do the subjective reported auditory environments correlate to the objective measurements by the smartphone and the hearing aids? Are these correlations different for younger normal-hearing listeners and older hearing aid users?

A total of ten younger normal-hearing listeners (<40 years) and ten older hearing aid users will participate in the study. All participants will be bilaterally fitted with Starkey Halo2 hearing aids running research firmware. Devices for normal-hearing listeners will be programmed to be acoustically transparent (0 dB insertion gain). All participants will wear hearing aids and go about their daily activities for one week. During the trial, EMA surveys will be delivered approximately every 1.5 hours via an android phone. The collected data in each EMA measure include (1) overall sound level, environmental classification, and estimated signal-to-noise ratio (SNR) from the hearing aids; (2) a subjective survey regarding the environment and listening experience via an EMA app; and (3) an audio recording of the environment from the smartphone. All the data will be stored in the smartphone during the trial.

For each age group, overall sound level, environmental classification, estimated SNR will be compared to the corresponding self-reported data from the survey. In addition, the recorded audio clip for each EMA will also be used to estimate SNR, which will be compared to the SNR estimated by the hearing aids for the same environment. The factors that relate to auditory ecology for the two groups of listeners will be outlined. Strengths and weaknesses of this new assessment approach, as well as the feasibility of real-world, individualized hearing aid optimization will be discussed.

## 15:05 Demonstration Session

**Presenter:** K. Todd Houston

**Affiliation:** The University of Akron (Akron, Ohio)

**Title:** Telepractice: Using Distance Technology to Connect, Communicate, & Enhance Language Learning in Children with Hearing Loss

**Abstract:** Today, an array of distance technology is available to assist early interventionists, speech-language pathologists, and audiologists to enhance communication

**Summary:** Hearing loss in children has been described as the most common health condition in newborns, affecting 1-3 per 1000 births. Because of newborn hearing screening, early diagnosis and fitting of hearing technology, and enrollment in intervention, many children with hearing loss are achieving language outcomes that rival their hearing peers by the time they reach kindergarten or first grade. That is, these outcomes are possible if parents have access to services that are timely, consistent, and are provided by well-trained practitioners who are knowledgeable about childhood hearing loss and communication development.

Unfortunately, many parents and caregivers who have young children with hearing loss may not have access to highly qualified speech-language pathologists who can provide appropriate services. Fortunately, telepractice models are now being used throughout the United States and around the world to provide parents with access to much needed services that are not available in their local communities.

At The University of Akron, a model of telepractice has been developed to provide family-centered early intervention services to children with hearing loss and their parents/caregivers. This presentation will focus on how this model was developed, the clinical protocols that are used, and the communication outcomes of the patients who have been served.

**Presenter:** Marc Shapiro

**Affiliation:** Creare, Hanover, NH

**Title:** Open Source Mobile Software for Distributed Studies of Hearing

**Abstract:** We present an open source mobile application (“Open TabSINT”) that enables researchers to administer customized hearing tests and questionnaires across multiple sites. The system is designed to provide researchers flexibility in deploying human research protocols while minimizing the effort required in administering the study.

**Summary:** In collaboration with the Hearing Center of Excellence and the Walter Reed National Military Medical Center (WRNMMC), we have developed an open source mobile application and software framework (“Open TabSINT”) that enables researchers to administer customized hearing tests and questionnaires on mobile devices located across multiple sites. The system is designed to provide researchers flexibility in deploying human research study protocols while minimizing the effort required in administering the study.

Researchers create and modify protocols by editing a text-based (JSON) template. The application includes templates for multiple speech-in-noise tests and over 25 questionnaire types such as multiple choice, button grids, Lickert scales, image maps, videos, etc. Once developed, the protocol is uploaded to a cloud-based webserver, remote git repository, or the local SD card of a device. The application is configured at runtime to process the protocol and media files and upload completed test results. The webserver includes a SQL database to store protocols and results which can then be queried remotely; it can also be extended to provide extra services, including soundcard-specific calibration of media files and automated post-processing of results. The git repository option allows for the deployment of the app to multiple, possibly remote, users without need for a dedicated server with database functionality. In this instance, the sound files, if any, must be pre-calibrated for the specific end-user configuration. The SD card option provides a simple way to use TabSINT when few mobile devices are needed, and remote data access isn’t required or desired.

Open TabSINT includes an application programming interface for “plugins”, allowing external contributors to build hardware and software that can interface directly with TabSINT, leveraging the existing user interface and data management framework. This feature has allowed us to pair TabSINT with a Bluetooth audiometric headset with noise

attenuation, as well as a Bluetooth Otoacoustic Emissions Probe. This feature has greatly expanded the use of TabSINT for research studies. Now housed on GitHub, this software is available to researchers across the world to use and adapt to their specific needs. Researchers with engineering resources can also contribute to the repository to further improve the features and robustness of this software.

Currently, Open TabSINT is in use by multiple researchers across the world including: the Walter Reed National Military Medical Center; National University of Singapore; The University of Northern Colorado; The University of Maryland; Dartmouth School of Medicine; The University of Connecticut; The House Clinic; The Department of Defense Hearing Center of Excellence; as well as some private sector firms. To date, this system has collected over 9000 individual results across more than 70 study sites.

**Presenter:** David Stockdale

**Affiliation:** British Tinnitus Association

**Title:** Take On Tinnitus - What we learned

**Co- Author:** Dave Carr

**Abstract:** The British Tinnitus Association started examining and assessing how to produce an interactive 'e-learning' programme on tinnitus in 2014 (attending the first Internet Audiology conference was an important feasibility step!) launching Take on Tinnitus in September 2016. The process the BTA went through offers some learning and insight for others considering a similar pathway.

**Summary:** The aim of the Take on Tinnitus project is to design and deliver online concise accurate information to people who were new to tinnitus in a timely and reassuring manner.

**Material and methods:** From conversations with people with tinnitus on the British Tinnitus Association's (BTA) helpline and through the network of support groups, we identified that not everything on the internet is useful, accurate, or beneficial to people with tinnitus as quality and veracity is variable. Time can be wasted or anxiety increased by accessing online resources that make unsubstantiated claims. After an initial scoping exercise an e-learning programme was developed based on training provided to BTA helpline volunteers, underpinned by BTA information resources. A specialist e-learning company worked alongside BTA staff to develop a series of modules each focusing on a common area of tinnitus. For each module a storyboard and script was produced. By working with the BTA Professional Advisers' Committee, trustees, hearing professionals and people with tinnitus we were able to identify areas of need, test prototypes and check for bugs.

Take on Tinnitus can be used on mobile phones, tablets or computers. After an initial taster unit, there are seven learning modules covering fundamentals of tinnitus, hearing and tinnitus, benefits of using sound, tinnitus and relaxation, sleep and tinnitus, benefits of talking about it and living your life with tinnitus. Each module takes 10-15 minutes to complete. Each includes interactive exercises, video clips and self-tests to keep users engaged. A key aspect to the Take on Tinnitus site was using video. Three video subjects were selected: A BTA volunteer, case study member and a support group organiser. The subjects were chosen in part to bring a diverse feel to the video clips, but also because they all had very personal stories of how they live with tinnitus. A bespoke Learning Management System (LMS) was developed to register users on to the site. This was to ensure the registration process was as user-friendly as possible and would allow for automatic follow up monitoring of users using quality of life questions based on the Tinnitus Functional Index (TFI).

**Results:** To date the Take on Tinnitus site has received over 1700 registrations from people with tinnitus and quantitative feedback from GPs, hearing therapists and audiologists has been extremely positive.

**Conclusions:** E-learning has become an important part of the support provided to tinnitus patients. An e-learning site such as Take on Tinnitus can provide immediate reassurance to someone experiencing tinnitus for the first time, give basic information on the condition prior to visiting a GP and provide a useful support if waiting for a referral on from the GP to other NHS services.

# Posters

- 1 Authors:** Paula Maria Pereira Paiva, Bruno Pentead, Marina Morettin Zupelari, Natália Barreto Frederigue Lopes, Orozimbo Alves Costa, Seiji Isotani, Deborah Viviane

**Affiliation:** University of São Paulo, School of Dentistry at Bauru

**Title:** Educational data mining for understanding students' behavior in a virtual learning environments: a case study

**Topic Area:** Big data

**Abstract:** This case study presents the potential of educational data mining (EDM) techniques to understand students' behavior in virtual learning environments. EDM enabled the recognition of interaction patterns among students, tutor and professors. The results suggest that EDM can help course managers make timely and effective decisions during pedagogical practice.

**Summary:** Introduction: Distance learning can increase opportunities for continuing professional education. In addition, the Virtual Learning Environments used for hosting the courseware accumulate a great deal of information which is very valuable for analyzing students' behavior. Educational Data Mining (EDM) is a branch of learning science, concerned with exploring and studying these large datasets. By using various data mining methods, one can identify unique patterns which may help study, predict and improve a student's academic performance.

Objective: To present the potential of EDM techniques to better understand students' behavior in virtual learning environments.

Methods: Case study. The "Auditory Rehabilitation in Children - ARC" course, developed by the University of São Paulo and Samaritano Association with the support of the Ministry of Health, had the goal of training 99 hearing healthcare professionals who worked in 68 public hearing clinics. The ARC ran for 18 months and comprised of 27 modules covering topics from hearing loss identification to intervention. This learner-centered course used active and problem-solving methodologies that enable reflections on clinical practice challenges, while encouraging the achievement of the skills needed to transform them.

Two collaborative activities carried out in one of the course's modules were analyzed. For the discussion forum, social network analysis was employed to model interactions among individuals as well as patterns emerging from them. This analysis also provides insights concerning the structural characteristics of the network. Data from the wiki were analyzed in terms of the process for the document's construction, with the aim of identifying strategies for collaborative writing adopted by each group of students.

Results: The use of EDM allowed the visual identification of groups' characteristics. From the generated social network, it was possible to distinguish the strong influence of tutors and teachers in the forum activities, acting as hubs among the course participants, facilitating, mediating and motivating discussions. Also, it showed strong links between certain students, who exchanged large numbers of comments among them. On the other hand, a few students did not interact directly with their peers at any time, answering only the main question posted by the tutor. When inspecting the wiki activity, one can see how different groups adopted diverse strategies, both in time taken and content written. Some groups adopted a more cooperative approach, with every individual contributing with a small part, in a more structured manner, and others, a more collaborative, in which all participants were responsible for changes and a lot of modifications occurred.

Conclusion: EDM enables the recognition of patterns of interaction and collaboration among students, tutor and professors and their work strategy. By recording interaction data from both students and instructors, it is possible to monitor the learning process, as it occurs in the learning environment, not just through summative assessments in the end of a module. Although preliminary, the results suggest that the use of such methods, along with the situational knowledge of teachers and tutors, can help course managers make more timely and effective decisions during pedagogical practice.
- 2 Authors:** Fabiana Souza Pinto-Azenha; Esteban A. Lopez (School of Engineering, USP); Deborah V. Ferrari

**Affiliation:** University of Sao Paulo - Bauru School of Dentistry

**Title:** MoBALS - a smartphone based remote microphone for people with mild hearing losses: preliminary results

**Topic Area:** Barriers and facilitators to the implementation of telepractice

**Abstract:** A smartphone based remote microphone (MoBALS) was compared to hearing aids and a traditional FM

system in 20 individuals with mild sensorineural hearing losses. S/N ratios (HINT) for unaided and aided conditions were significant lower than those for MoBALS and FM. Other MoBALS' benefits will be discussed.

**Summary:** Adults and the elderly with mild hearing losses may experience difficulties for speech understanding, especially in acoustically adverse situations - e.g. presence of noise, reverberation or distance between talkers. The use of remote microphone technologies, as the FM system, among others, can minimize the detrimental impact of such conditions. Such systems are used alone or in conjunction with hearing aids (HA) or cochlear implants (CI). In Brazil, hearing aids and other devices are provided, free of charge, via the Unified Health System. Still, in case of adults and the elderly, the system favors those with disabling hearing impairments. The Mobile Based Assistive Listening System (MoBALS) is a smartphone-based remote microphone application available for Android platform. This application emulates the functionality of a Frequency Modulated (FM) system, using at least two smartphones connect to the same Wi-Fi router - one for transmission and other for reception. This study evaluated the MoBALS' efficacy in comparison to hearing aids and a traditional FM system. Twenty individuals (16 males and 04 females, age varying from 53 to 85 yrs old) with sensorineural mild hearing loss (threshold average in the frequencies of 0.5, 1, 2 and 4 kHz, in the better ear, between 26 and 40 dB HL) participated in this study. All participants were fitted with bilateral hearing aids (different brands and styles) for a minimum period of six months. The hearing in noise test (HINT-Brazil) was carried out with speech and noise presented at 0 and 180 azimuth, respectively, in the following conditions: unaided, hearing aid only, MoBALS only and FM only. For MoBALS and FM conditions the remote microphone was placed 15 cm distant from the front speaker. Participants also answered the International Outcome Inventory for Hearing Aids (IOI-HA) concerning their experience with hearing aids. The average S/N ratios obtained with HINT was 1.8 (unaided); 1.4 (aided), -4.8 (MoBALS) and -5.3 dB (FM). Statistical significant differences ( $p < 0,005$ ) were found between the unaided and aided conditions, when compared to MoBALS and FM conditions. There was no statistical difference between unaided and aided conditions as well as between MoBALS and FM conditions. Mean IOI scores were 30.6 (range 25-34) indicating participants experienced benefits with hearing aids in real world - however, there is a risk for gratitude bias. Participants also provided positive comments for MoBALS, in terms of its affordability and convenience. Other benefits provided by MoBALS' features will be discussed.

**3 Authors:** Bruno Elias Penteadó, Paula Maria Pereira Paiva, Marina Morettin-Zupelari, Natália Barreto Frederigue Lopes, Deborah Viviane Ferrari, Seiji Isotani

**Affiliation:** University of São Paulo

**Title:** Educational data mining methods: opportunities for teaching and learning in Audiology

**Topic Area:** Big data

**Abstract:** Educational data mining combines different methods to help understand how people learn and to create tools to support the learning process. This work presents an overview of EDM methods and their potential application for teaching and learning in Audiology. A taxonomy is presented with five basic categories and corresponding examples

**Summary:** Educational data mining (EDM) combines methods from different disciplines for understanding how people learn and for aiding the creation of tools that support this learning process. Its uniqueness stems from characteristics of data coming from educational contexts (e.g. multilevel hierarchies, non-independence in data, etc). Widespread technologies and methods like MOOCs, collaborative tools, intelligent tutoring systems, among other instructional tools, provide an increasing source of data, with large and longitudinal aspects. EDM allows extracting useful information beyond the statistical reports generated by learning management systems. Learning Analytics (LA) is a similar research field, complementary in the objective of understanding how the learning process works. Regarding EDM studies' goals, popular topics are clustered in four major categories: cognition, learning and performance assessment; learning transfer and the discovery of cognitive models; affective states, motivation and metacognition; and language and discourse analysis. To achieve these goals, methods borrowed from other disciplines as well as its own methods, specially using machine learning techniques, are used to describe, model and predict constructs and behaviors in and after learning sessions. The aim of this work is to present an overview of EDM and LA methods and their potential application for teaching and learning in Audiology. A taxonomy is presented evolving from five basic categories. For any of them, a set of independent variables is collected, usually from the learning system adopted and using the breadcrumbs left by the user interaction or the course content:

- Prediction methods: used to predict categorical or numerical variables - e.g. to predict if a student presents a high



likelihood to drop out a course (based on his interaction with students and tutors in the course and performance in learning activities) to inform the tutors beforehand to act upon it;

-Structure discovery: used to discover structures not known a priori, seeking to find out structures or clusters that emerge naturally from the data - e.g. grouping students according to their behavior or performance to facilitate intervention by the tutors;

-Relationship mining: used to find significant relations among variables, as in correlations, sequential patterns mining and association rules. For instance, learning trajectories can be used to understand what sort of temporal behavior are more likely to show a better learning performance or common misconceptions;

-Distillation of data for human judgement: visualization of complex data to assist decision making or understand phenomena in the course; the learning curves are an example, which represents how fast a user is learning a specific topic and may be used to shorten a topic, since the students have learning right from the beginning and avoid overpractice;

-Discovery with models: constructs are learned and modeled from data and used as input to other methods; e.g. metacognition or affective states may be predicted from the user actions and, in turn, be used to predict learning behaviors in the course platform, enabling the tutors to understand which variables influence more in student performance.

The potential use of such methods for analyzing patient education strategies/system will also be discussed.

- 4** **Authors:** Gabriella Tognola, Alessia Paglialonga, Alessandra Murri, Francesco Pinciroli, Domenico Cuda  
**Affiliation:** IEIIT CNR - Institute of Electronics, Computer and Telecommunication Engineering of the Italian National Research Council (Piazza L. Vinci 32, 20133 Milan, Italy)  
**Title:** An application towards text analytics and cognitive computing for clinical big-data in aged people with hearing disabilities  
**Topic Area:** Big data  
**Abstract:** This contribution presents the first attempt in the hearing healthcare, to design and develop an easy-to-use pre-prototype clinical system for extracting, collating and analyzing audiological big-data from the diversified audiological free-text notes of the patient record. We will illustrate the results obtained from the evaluation phase of such a pre-prototype in the clinical management of aged people with hearing disabilities.
- 5** **Authors:** Dennis Barbour, Roman Garnett, Xinyu Song  
**Affiliation:** Washington University  
**Title:** Online Machine Learning Audiometry  
**Topic Area:** Big data  
**Abstract:** The limiting factor in traditional audiometry is the stipulation for a human-centric methodology. By replacing human inference at intermediate steps with advanced machine learning, tremendously more useful diagnostic information becomes available for clinicians to evaluate patient health.  
**Summary:** Traditional audiometric tests are designed strictly for human inference. Even automated audiometry concatenates human-friendly steps and returns the same diagnostic information as traditional methods. Over the past decade, however, the combination of powerful computing platforms, advanced algorithms and large datasets have enabled tremendous breakthroughs in other applications. For example, it is now commonplace to speak into a cell phone, upload that recording to a remote server, convert the recording to a text transcript, perform a natural language search or other action on the text, and then send the result back to the phone. This entire sequence occurs automatically within seconds without any user input other than speaking (i.e., inputting the raw data). We have developed that same kind of platform for medical inference. In the case of the pure-tone audiogram, patient responses are acted upon in real-time by a remote server, which estimates the best audiogram with the data collected up to that point. The algorithms used are advanced enough to return, for the first time, the complete high-resolution audiogram in less time than is required to estimate a crude octave-resolution threshold audiogram using traditional methods. Special applications for our online machine learning audiometry include evaluating patients for whom data collection is challenging and/or limiting, such as young children, and inferring function that requires extremely large amounts of data using traditional methods, such as audiogram fine structure.

- 6 Author:** Jesse Norris, Deanna Meinke (University of Northern Colorado), Odile Clavier  
**Affiliation:** Creare, Hanover, New Hampshire  
**Title:** Mobile technology for booth-less audiometry  
**Topic Area:** Barriers and facilitators to the implementation of telepractice  
**Abstract:** Conducting audiometry using internet technologies is difficult because of the need for a controlled noise environment, as well as automated test paradigms. We present the results of two human studies conducted with a prototype noise attenuating, wireless audiometric headset that pairs with a mobile device to administer automated audiograms.  
**Summary:** Worldwide, increasing access to hearing health care will require enabling currently available commodities (Internet, smartphones) to conduct surveillance of hearing loss, and high-quality automated audiometry to be used beyond traditional clinical environments. One major problem with conducting audiometry using internet technologies is the need for a controlled noise environment, as well as automated test paradigms that enable individuals with limited training to proctor rather than administer a hearing test. We present the results of two human studies conducted with a prototype for a noise attenuating, mobile, and wireless audiometric headset. Real Ear Attenuation at Threshold (REAT) testing with the headset has shown an attenuation Noise Reduction Statistic (NRSA) of 34. As a point of comparison, this level of attenuation is on-par with a single-walled sound booth.  
In the first study, we used a controlled noise environment to determine the maximum overall noise level that would yield threshold changes within normal test-retest reliability but would not lead to a significant threshold shift during repeated testing. Automated audiometric thresholds were measured in 21 normal hearing subjects in quiet and in background brown shaped noise up to 65 dBA. Thresholds were measured between 250 Hz and 8000 Hz. Across all frequencies, most subjects begin to show significantly elevated thresholds caused by the presence of ambient noise above 55 dBA. In a second study, we evaluated the test-retest reliability of automated thresholds measured with the headset in typical environments where such tests might be conducted outside of a sound booth: at a physician's office, in a school, and in a health clinic. Tests were administered by untrained individuals such as nurses and volunteers. Forty one children (aged 6 to 15) were tested with the noise attenuating headset along with a tablet application that controlled the test and registered the user responses. Thresholds were measured at frequencies between 250 Hz and 8000 Hz following the modified Hughson-Westlake method. The median test-retest repeatability was 0 dB across all subjects and sites, with 25th and 75th percentiles within +/-5 dB. It was found that children under the age of 9 may require additional adaptation of the user interface to improve the use of the system, but most children reacted very positively to the technology.
- 7 Authors:** Derek Hoare, Kate Greenwell, Magdalena Sereda; Neil Coulson; Adam Geraghty; Debbie Featherstone (Clitheroe Therapies Clinic, UK)  
**Affiliation:** NIHR Nottingham Biomedical Research Centre; University of Southampton, Southampton, UK  
**Title:** Identifying the factors that influenced the implementation of an internet-based intervention for tinnitus self-management  
**Topic Area:** Barriers and facilitators to the implementation of telepractice  
**Abstract:** This presentation will describe how the person-based approach to intervention development was used to evaluate and optimise an internet-based intervention for tinnitus self-management. Specifically, this approach allowed us to understand and accommodate users' perspectives into intervention development, and identify potential implementation and contextual factors that may influence its delivery.  
**Summary: Background:** Tinnitus is a common symptom that can affect an individual's emotional and functional quality of life. Internet-based interventions have the potential to reduce the disparity in access to psychological support that people with tinnitus currently experience. One example is the Tinnitus E-Programme 1.0, which was developed in the UK to support self-management in people with tinnitus. Although freely available online, there was little understanding of how the intervention is used, its active ingredients, how it works, the circumstances in which it works best, and whom it works best for.  
**Aim:** This research aimed to address these issues by evaluating and optimising the Tinnitus E-Programme 1.0. Specifically, this presentation will focus on how this research explored users' perspectives of the intervention to identify any implementation and contextual (e.g. pre-existing conditions or user beliefs) factors that may strengthen or impede its delivery.

**Methods:** First, a process evaluation of the Tinnitus E-Programme 1.0 utilised mixed methods with two different study populations. In Study 1, 27 current and past users of the intervention completed an internet survey. Study 2 carried out semi-structured interviews with 13 people with tinnitus who completed the intervention for the first time. This group also completed a relaxation log to assess adherence to relaxation goals over a 4-week period. Second, using a person-based approach to intervention development (Yardley et al., 2015), key barriers and facilitators to engagement with the intervention were identified and used to inform the development of a new version of the intervention (Tinnitus E-Programme 2.0). Finally, qualitative think aloud interviews were carried out with 19 people with tinnitus to evaluate this new intervention.

**Results:** The process evaluation of the Tinnitus E-Programme 1.0 revealed that the intervention was acceptable to its target users. Users identified several benefits they experienced from using the intervention, but its implementation was limited by instances of poor usability, user engagement, and adherence to behavioural goals. These issues were addressed in the development of the Tinnitus E-Programme 2.0 and users of this new intervention viewed the intervention's content and design features positively. Users particularly valued education about tinnitus and its management and related to the educational content and advice. However, reactions to the relaxation therapy and cognitive therapy were mixed. Users' pre-existing beliefs regarding tinnitus and self-management, their perceptions of relevance, and the nature of tinnitus influenced users' engagement with the intervention.

**Conclusion:** The person-based approach enabled us to identify several implementation and contextual issues that influenced the delivery of the Tinnitus E-Programme 1.0 and 2.0. It also allowed key barriers and facilitators to be identified and addressed to maximise user engagement and adherence to the intervention. Further development work is needed to the Tinnitus E-Programme 2.0 that introduces and evaluates additional intervention content and design features.

**8 Authors:** Katjia Lund, Flemming Wang Jensen

**Affiliation:** CBG Job & Development Centre

**Title:** Change based learning in educational hearing loss rehabilitation

**Topic Area:** Barriers and facilitators to the implementation of telepractice

**Abstract:** This study evaluates a method to promote quality and efficiency in educational rehabilitation among employees with hearing loss. The method induces structure and opportunities for interdisciplinarity. Participant data provides information on how to prioritize the resources and paves the way for the development of a digital version of the method.

**Summary:** Background and target group: Employees with hearing disabilities are more vulnerable to experiencing cognitive and physical challenges than their normal hearing colleagues. Based on a three-year study on hearing loss, stress and work new methods for qualifying educational rehabilitation of employees with hearing loss have in this study been developed and put into use.

**Objectives of the study:** The aim of the study was to test a progression tool using CBL (change based learning) as a method to promote quality and efficiency in the educational hearing rehabilitation among employees with hearing loss. An objective was also to evaluate the digital potential of the progression tool to further decrease the usage of both human and financial resources in the field.

**Study design:** In the period from September 2015 to May 2016 a group of 9 participants attended a job retention course at CBG Job and Development Centre. The course was organized based on the CBL method and. A new tool to ensure educational rehabilitation progress among the participants, the Roadmap for Change (ROC), was introduced at the beginning of the course and tested throughout the course. The ROC includes participant data as well as 19 primary objectives for change (POCs) and a varying number of intermediate objectives for change (IOCs), which were related to the POCs and defined in a co-created interaction between professionals and participants.

**Analysis:** The educational rehabilitation progression was measured using the ROC. The IOCs were measured to evaluate the level of detail needed to gain sufficient insight in the situation, to encourage progress among the participants and to promote quality and efficiency in the rehabilitation process. To support the statistics the hearing therapist organizing the course was asked to evaluate the use of the ROC. Her reflections are included in the final evaluation of the tool. To evaluate the digital potential of the ROC we have taken the results from a study on hearing loss, stress and work, where the method was to self-monitor here-and-now experiences, into consideration.

Results: The progression tool serves as a type of self-monitoring method and has qualified the BDA course by creating more structure, better overview, opportunities for interdisciplinarity and a more structured pattern for action in matters that need urgent attention. The number of IOCs related to each POC tell us in which areas the participants prioritize action and make progress during the course. This information enhances the ability to prioritize the educational approach, as well as actions and interventions when organizing future BDA courses. The results indicate, that the ROC can be reduced to 6 POCs thus paving the way for developing a digital platform where co-creation and motivation in the educational rehabilitation process of employees with hearing loss are key elements. On this basis, a prototype of a digital platform is in the progress of being developed. We expect to present it at the 2nd international meeting on Internet and Audiology in Louisville, July 2017.

**9 Authors:** Harvey Abrams, Luodi Yu (University of Minnesota); Aparna Rao (Arizona State University); Yang Zhang, Philip C. Burton (University of Minnesota); Dania Rishiq (University of South Alabama)

**Affiliation:** Starkey Hearing Technologies

**Title:** Changes in Cortical Functional Connectivity for Audiovisual Speech Perception Associated with Hearing Aid Use with or without Auditory Training

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** In this pilot experiment, we tested whether and how hearing aid use and the use of a commercially available auditory training program, ReadMyQuips (RMQ), changed cortical functional connectivity for audiovisual speech perception as measured by fMRI. The results showed initial evidence of facilitation for audiovisual speech perception from hearing aid use with additional benefit from the RMQ training program.

**Summary:** Background: Perception of speech is multimodal. In speech-in-noise tasks, normal-hearing listeners' perceptual accuracy in the auditory-visual (AV) condition is consistently higher than in the auditory-only (AO) or visual-only (VO) conditions (Summerfield, 1979). When hearing loss is present, rehabilitation may involve speechreading designed to better utilize visual cues in challenging listening environment. "Read My Quips" (RMQ) is a computer-based program designed to improve speech understanding in the presence of background noise. The program uses both auditory and visual cues of speech to improve recognition. RMQ training has been shown to improve hearing-aid users' speech-in-noise perception as well as confidence in auditory selective attention task (Rao et al. 2016). The aim of this follow-up fMRI study was to investigate the functional neuroanatomic mechanisms for RMQ-training-induced brain plasticity in hearing aid users. Our experimental protocol relied on the well-known McGurk effect of hearing /da/ from visual articulation of /ga/ dubbed with the /ba/ sound. Previous research on normal-hearing listeners has shown stronger connectivity between areas for multimodal integration (i.e., left superior temporal sulcus, STS) and unimodal regions in the McGurk perceivers than the non-perceivers (Nath & Beauchamp, 2012). In the current pilot experiment, we tested whether and how hearing aid use and auditory training change cortical functional connectivity for audiovisual speech perception.

**Methodology:** One male and one female volunteer with sensorineural hearing loss served as the control and experimental participants, C1 and C2 respectively, for this study. Both were part of a larger-scale behavioral study (Rishiq et al. 2016). The C1 received bilateral hearing aids only; C2 received bilateral hearing aids plus 4 weeks of auditory training with RMQ. fMRI data were collected at pretest, after 4 weeks of hearing aid use alone and again after an additional 4 weeks during which time C2 received RMQ training. /ba/and /ga/ stimuli were presented in the following conditions: AO; VO; congruent; McGurk incongruent; non-McGurk incongruent. fMRI data analysis was carried out using Analysis of FunctionalNeuroImages software (AFNI). FreeSurfer and Surface Mapping with AFNI were used to identify regions of interest (ROI) for each participant.

**Results:** For the incongruent conditions, C1 showed decreased activity within the visual ROI from pretest to posttest, whereas the C2 remained at the same level after hearing aid use and training. For the McGurk incongruent condition, C2 showed increased activity within the auditory ROI from pretest to posttest, whereas the C1 remained the same. Both participants showed the trend of increased STS activity from pretest to posttest. Furthermore, in the McGurk incongruent condition, the auditory-STS connectivity was strengthened to a greater extent in C2 compared to C1 from pretest to posttest.

**Conclusions:** Acclimatization to hearing aid use was observed in terms of brain plasticity: Both RMQ trained and untrained participants showed increased activity within ROIs for audiovisual speech perception. Enhanced connectivity between unimodal ROIs and the multimodal ROI was observed at posttest compared to pretest in both participants, with greater magnitude of change observed in the trained experimental participant. The increased

auditory response coupled with enhanced coordination with STS in the experimental participant may suggest improved reliability of auditory percept in multisensory listening situations. The results show initial evidence of facilitation for audiovisual speech perception from hearing aid use with additional benefit from the RMQ training program.

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**10 Authors:** David Moore, Oliver Zobay, Robert MacKinnon, Bill Whitmer, Michael Akeroyd (MRC Institute of Hearing Research, UK)

**Affiliation:** Cincinnati Children's Hospital

**Title:** Does leisure music listening cause hearing loss?

**Topic Area:** Big data

**Abstract:** An internet-based experiment asked 17–75 y.o. about music listening history and current hearing. Objective measure used high-frequency speech-in-noise. We found a very weak relation between speech intelligibility and music exposure. Personal music player listening did not reduce speech intelligibility. Self-reported difficulty and tinnitus showed a small increase with music exposure.

**Summary:** People love listening to music, but frequent reports in the media and elsewhere suggest that listening to music as a leisure activity can damage your hearing. There is no doubt that exposure to loud sounds, including music and other leisure activities (e.g. firearms, car racing), can produce hearing loss. Both orchestral and rock musicians and music students may acquire hearing loss, though their losses are often small when corrected for age. For more casual music listening there is little objective evidence. We report here a large (n = 4950), internet-based, public participation experiment that asked people from 17 – 75 years old about their lifetime history of listening to music and their current hearing abilities. Participants were mostly recruited through staff of the UK Medical Research Council and Cincinnati Children's Hospital. Music exposure was divided into pubs/clubs, concerts and personal music players. Hearing was measured objectively with a test of speech intelligibility in the presence of low-pass background noise, sensitizing the test to high frequency hearing loss (HF-SRT). We found clear, decreasing speech intelligibility with increasing age and occupational noise exposure, but only a very weak relationship (effect size,  $R^2 = 0.0025$ ) between speech intelligibility and lifetime exposure to music, controlling for age, occupational noise, recent exposure to loud noise or loud music (< 24 hours), and listening device. Personal music player listening did not significantly reduce speech intelligibility. Statistical modeling predicted that the increase of HF-SRT due to music exposure plateaued at 0.4 dB beyond the age of 45. By contrast, the age-related increase of HF-SRT between 45 – 75 years old was 5.4 dB. These results input to current concerns about a form of 'hidden hearing loss', synaptopathy in the ribbon synapse of the cochlea's inner hair cells resulting from noise exposure, but without an audiometric signature. Using a more ecologically valid test of hearing in humans, with increased sensitivity to the high frequency, low spontaneous activity auditory nerve fibers thought to be affected by HHL, we found little evidence for concern. Self-reported hearing difficulty and tinnitus each showed a small increase with music exposure. Overall, the results provide little objective evidence that leisure music exposure produces a functionally important hearing loss.

**11 Authors:** Charles S. Watson, Gary R. Kidd, James D. Miller

**Affiliation:** Communication Disorders Technology, Inc.

**Title:** The US National Hearing Test

**Topic Area:** Barriers and facilitators to the implementation of telepractice

**Abstract:** The US National Hearing Test is a digits-in-noise test that has been taken by 100,000+ callers, roughly 80% had estimated hearing loss (HFPTA) in excess of 25 dB in at least one ear. Numbers of callers who failed the test and sought professional help are consistent with other recent reports.

**Summary:** Telephone-administered screening tests have been taken by large numbers of persons with ARHL, both

in the US (Watson et al., 2015) and, earlier, in several other countries (Watson, et al., 2012). In May-June, 2014, the National Hearing Test (NHT), (Watson et al., 2012; Williams-Sanchez, et al., 2014) was offered free to anyone who called a number provided in several newspaper articles. Of the 40,000+ callers, 81% had scores above an estimated mean loss (HFPTA) of 25 dB in at least one ear. Health/science reporters had been encouraged to mention that the NHT was: (1) scientifically validated, (2) developed with NIH funding, (3) non-profit (no profit was permitted under grant support) and (4) that the results would be given to the test taker at the end of the call, and to no one else. Articles with that information appeared in three large-circulation newspapers, eleven smaller ones, and several blogs associated with newspapers. Probably less than 5-10% of the 37 million adults in the US who report a hearing problem read these articles. It is impossible to determine which of the publicized claims about the NHT test (1-4 above) were primarily responsible for this enthusiastic response. Focus groups led us to conclude that this response exceeds that made to free tests offered by for-profit organizations because of concerns about commercial motives and not feeling ready to confront someone trying to sell them a hearing aid. Those concerns may have been relieved by what they were told about the NHT. We have now reviewed test scores for nearly 100,000 callers. Those whose performance in one or both ears was below normal (estimated HFPTA>25 dB) were advised to consult an audiologist or a doctor specializing in hearing. Follow-up calls to about 5500 of those who failed the test, 2-6 months after the test, found that approximately 38 percent of those who completed the survey said that they either had sought professional help, or planned to do so (similar to Meyer et al., 2011). Yueh et al. (2010) found that about 10% of those who failed screening tests obtained hearing aids within one year. It might be concluded from these and other follow-up reports that the influence of hearing screening is too small to justify providing it, but that conclusion is premature. First, the decision to seek professional help for ARHL is not made, on the average, for 7-10 years after initial signs of loss (Kochkin, 2009; Medwetsky and Scherer, 2011). It is thus possible that the time required to decide to take action is reduced by the influence of failing a screening test, but only from 7-10 to perhaps 2-5 years. Recently there has been support for this prediction: "Eighteen months after failing a free online hearing screening, 61% of the participants who completed the follow-up reported having sought help" (Ingo et al., 2016). These findings suggest that better promotion of free and confidential telephone-based hearing screening would lead to a substantial increase in the number of people who seek professional help.

**12 Authors:** Melanie Ferguson; David Maidment; Helen Henshaw; Neil Coulson (University of Nottingham, UK), Heather Wharrad (University of Nottingham, UK)

**Affiliation:** NIHR Nottingham Biomedical Research Centre, UK

**Title:** Personalising hearing m-health information for the smartphone generation

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** Two studies are underway that aim to increase interactivity and personalisation of information for people with hearing loss and their communication partners. Combining the theoretically-driven COM-B model of health behaviour change and a real-time Think Aloud analysis, this research will develop and evaluate an 'on-the-go' mobile-enhanced health information programme.

**Summary:** Smartphones are ubiquitous. Mobile phone-access to the internet more than doubled between 2010 and 2014 (24% to 58%) in the typical first-time hearing aid user age group. Therefore, opportunities for using m-health technologies to deliver hearing healthcare, education, and increase access to hearing-related interventions, are increasing year-on-year. An RCT of C2Hear, a series of multimedia videos (or reusable learning objects, RLOs) for first-time hearing aid users (n=203) showed multiple benefits. These included greater knowledge of hearing aids and communication, better hearing aid handling skills, and higher hearing aid use in suboptimal users. In addition, the RLOs were rated as highly useful, increased patient's confidence to discuss hearing aids and communication, and were preferable to written information. C2Hear Online is now freely available via YouTube, and at the end of January has had nearly 25,000 views (53% UK; 30% North America). In order to futureproof the concept, further developments of C2Hear are underway that involve mobile technologies, which aim to (i) increase the user's interactivity with the programme, and (ii) personalise the programme by tailoring information to meet individuals' needs.

**Interactivity:** A mobile-enhanced RLO (m-RLO) for communication partners (CPs) in the form of a web-based app on Communication Tactics has been developed. Interactive elements include examples of hearing loss in noise and in quiet, setting communication goals, a drag and drop activity on how best to communicate, and a restaurant 'game' that lets users explore where best to sit to have a conversation in groups or in a couple.

A meta-synthesis of the qualitative literature on people with hearing loss and their CPs has shown that aligning coping strategies across couples helps to overcome barriers and difficulties that are posed by hearing loss. As such, this app is currently undergoing a synchronous, real-time Think Aloud evaluation to assess the usability of the app with a person with hearing loss and their CP to better understand what works in terms of the app's content, relevance, and joint-working. Participants will also assess the quality of the app using the Mobile Application Rating Scale. Usability results will be presented. Additional m-RLOs (understanding hearing loss, and the psychosocial aspects of hearing loss) are under development.

**Personalisation:** The development of the next stage, a personalised m-health programme, involves the identification of short 1-2 minute segments of C2Hear. This will be based on the theoretically driven health behaviour change model (COM-B), alongside an ecological approach that will use a Think Aloud analysis to 'data-tag' each mini m-RLO. A resulting self-evaluation questionnaire will then enable individualised tailoring of the information 'on-the-go' at a time that suits the user. Self-evaluation, and, at a later, date text-messaging, will also be incorporated to develop a self-management m-health programme.

Future research will extend this underpinning m-health programme to develop information for non-audiological healthcare practitioners and the general public. With the likely increase in 'over the counter' listening devices, personal sound amplification products and self-fitting hearing aids, the need for high-quality interactive and personalised information has never been greater.

**13 Authors:** David Maidment, Melanie Ferguson

**Affiliation:** NIHR Nottingham Biomedical Research Centre

**Title:** Alternative listening devices to transform hearing healthcare service delivery

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** While the most common clinical intervention for people with hearing loss is hearing aids, the majority of people who would benefit from using hearing aids do not take them up. Alternative listening devices to conventional hearing aids, such as those that can be linked to smartphones, may address this unmet need.

**Summary:** Hearing aids are currently the primary clinical management strategy for hearing loss. However, 2 out of 3 people that would benefit from using hearing aids do not take them up. The stigma associated with hearing loss and hearing aids might contribute to a delay or avoidance in seeking help [1]. People with hearing loss report that they are concerned or embarrassed that hearing aids will make them look old and that they will be treated differently by others. In addition, in the UK publicly funded National Health Service patients have limited choice in terms of what hearing devices are available for them to use to manage their hearing loss. There is, therefore, a need to assess alternative service delivery models, which can increase patient choice, accessibility and acceptability of hearing services for people with hearing loss that do not currently access or accept hearing aids.

Alternative listening devices to conventional hearing aids may, in part, address this unmet need because they have mass appeal and greater accessibility. Alternatives include hearing devices that can be linked to smartphones or tablet computers, as well as smartphone apps that allow the users mobile phone to act as a hearing aid when paired with wireless earphones. Novel to all of these devices is that they allow users to conveniently fit and adjust their hearing settings at a time that suits the user. As a result, they require limited or no input from an audiologist in terms of fitting and adjustment, which opens up the possibilities of new healthcare delivery models to reduce costs for audiology services, whilst maximizing patient choice, accessibility and acceptability.

In the first registered systematic review assessing the effectiveness of alternative listening devices to conventional hearing aids, we found that alternatives improved outcomes (e.g. speech intelligibility and quality of life) relative to hearing aids [2, 3]. However, the evidence was judged to be low in terms of quality and with a high risk of bias. As such, the magnitude of benefit provided by alternative listening devices remains uncertain. To begin to address this, we are currently assessing the perspectives of adults with mild-to-moderate hearing loss with regards to usability, delivery, accessibility, acceptability and adherence of alternative listening devices. This preliminary work lays the foundation of a feasibility study of alternative listening devices necessary to estimate important parameters prior to completing a full-scale evaluation.

We have also begun to consult audiologists to ascertain their opinions of alternative listening devices and their impact on audiological services. Clinicians have been generally positive, but are also mindful that devices need to be supplemented with additional high-quality information, rehabilitation and support. Indeed, it is becoming increasingly recognized that the delivery of audiological rehabilitation using the internet (e.g. C2Hear Online [4]),



can supplement device fitting in order to address accessibility barriers.

Thus, when coupled with the provision of online rehabilitation tools, alternative listening devices will likely transform hearing healthcare service delivery in the future.

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4. Ferguson, M.A., M. Brandreth, P. Leighton, W. Brassington, and H. Wharrad, A randomized controlled trial to evaluate the benefits of a multimedia educational programme for first-time hearing aid users. *Ear & Hearing*, 2016. 37(2): p. 123-136.

**14 Authors:** Kelly Watts, Rebecca Welles (NSMRL/Leidos); Pat Zurek (Sensimetrics Corporation)

**Affiliation:** HCE / NSMRL / zCore Business Solutions (Groton, CT)

**Title:** Warfighter's Hearing Health Instructional Primer (WHHIP): An app for military hearing conservation programs

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** The WHHIP is a free app-based reference source for US military hearing conservation programs. It is available in the Google Play Store for personal Android phones. The WHHIP can provide answers to why protecting hearing is important, why/what devices should be worn, and how to understand hearing test results.

**Summary:** The DoD Hearing Center of Excellence's (HCE's) Training Needs Assessment (2013) identified provision of educational and training material through an app as appropriate and worthwhile for inclusion in military hearing conservation programs. A review of the available apps for Android and Apple platforms was undertaken in late 2015 and again in 2016, which verified the lack of an app that could fulfill the gap identified. In 2016, the Office of Naval Research (ONR) Noise-Induced Hearing Loss (NIHL) Program funded the Naval Submarine Medical Research Laboratory (NSMRL) to create the Warfighter's Hearing Health Instructional Primer (WHHIP). The Sensimetrics Corporation developed the app and was responsible for its release to the Google Play Store on November 30, 2016. The WHHIP is an app-based introduction to the principles of hearing conservation. The materials cover the required elements of hearing conservation training and much more. The WHHIP is designed to provide the US service member with insight into why good hearing health is important and how good hearing health can be maintained. The WHHIP includes answers to common questions, such as "why is noise hazardous?" or "should my ears ring after firing a weapon?" The WHHIP is also designed to provide answers to questions that might result from audiological encounters, such as "what do the results of my hearing test mean?" However, the WHHIP should not be viewed as a primary training tool but rather as a supplementary one.

The WHHIP educational materials are primarily text-based and found in the "Learn" activity of the app. Videos and auditory examples can be found throughout "Learn." As a part of the transition plan for the Military Hearing Preservation (MHP) Training Kit, the WHHIP includes ideas and materials that were originally created for the MHP Training Kit. The "Demo" activity of the app is very similar to the "Sound Library" module of the MHP Training Kit. "Demo" provides an area for the user to explore various sound and speech examples that can be played through simulations of hearing loss and/or tinnitus. The "Demo" activity allows the user to experience the devastating effects of auditory injury without suffering the long-term consequences. A new feature developed specifically for the WHHIP is the "HPD Check" activity wherein the user can determine if his/her earplugs appear to be fit well. The images captured from the ear selfie can serve as a reminder for later fittings. Standard images of well-fit earplugs in service member's ears are also included in "HPD Check."

**15 Author:** Odile Clavier; Marc Shapiro; Kelly White, Veterans Administration; Lindsay Prusick, EarLens; David Eddins, University of South Florida; Harvey Abrams, Starkey

**Affiliation:** Creare LLC

**Title:** Mobile Application for Auditory Training and Tinnitus Management

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** In this poster, we present a mobile application for auditory training and tinnitus management. The app gives users the option to manage their tinnitus and perform hearing in noise training tasks which are designed as video games to encourage regular use and increase speech-in-noise recognition as well as verbal memory.

**Summary:** Communication in the presence of background sound is a major issue for employees in factories, and noisy venues, as well as military service members who potentially face challenging high-noise conditions. Many of these individuals are also potentially exposed to high noise and subsequently experience tinnitus. In this poster we present a mobile application (app) for auditory training and tinnitus management for individual users. This app gives users the option to navigate through several modules on their own, or to take a more guided approach based on answers to an initial assessment. The app includes two primary modules: one targets improved hearing in noise, and the other supports the user in managing tinnitus symptoms. Both modules contain educational materials related to hearing, hearing protection, listening strategies, and tinnitus in the form of multimedia presentations including interactive graphics, pictures, and videos. Tinnitus management is inspired by the Progressive Audiologic Tinnitus Management (PATM) program developed at the VA, and allows the user to generate personalized behavioral and cognitive interventions delivered through the app. Auditory training comes in the form of three engaging video games (in addition to educational materials) that maintain user interest over time and provide context for listening tasks. To encourage adherence, users get graphical feedback on usage. The poster will present the strategies used to leverage an existing clinical program such as the PATM and translate it into an app that is self-managed. It will also show how game mechanics can be leveraged to help users develop better listening strategies in background noise. Preliminary data on usability from a pilot study with several potential users will be presented.

**16 Authors:** David Stockdale, Magdalena Sereda, Kiri Newton, Sandra Smith

**Affiliation:** British Tinnitus Association, Sheffield, UK

**Title:** Mobile applications for management of tinnitus

**Summary:** Introduction: Sound therapy is a core component of many tinnitus management programmes. In recent years there has been a substantial increase in the use of mobile technology. This has provided an additional medium via which sound therapy can be delivered. Despite the increasing popularity of mobile applications (apps) in general it is unclear what proportion of people use apps for tinnitus management and which apps are the most popular. The purpose of this study was to identify apps that people use for tinnitus management, identify reasons for using and not using apps and evaluate their content and quality.

Methods: An online survey consisting of 33 questions gathered people's views about mobile apps used for tinnitus management, including reasons for use/non-use, factors important when choosing an app, which are the preferred apps, the perceived help for tinnitus and the positive/negative aspects of the apps. We have also looked at the content of those apps identified by people who completed the survey to identify the options and management techniques included in the apps. The Quality of the apps was assessed using the Mobile Application Rating Scale (MARS, Stoyanow et al., 2015).

Results: Of 643 people who responded to the survey, 25% used an app and 75% have never used an app to manage their tinnitus. The main reason for not using apps was lack of awareness (79%). Important factors when choosing an app were ease of use (87%), trustworthy source (44%), reviews (39%) and cost (39%). Responders identified 53 different apps, of which 13 were listed by at least two people. Content of the apps included: 1) various sound options; 2) relaxation/meditation; 3) information and advice; 4) psychological approaches. MARS quality scores varied between 1.6 and 4.2 (out of 5).

Discussion: There is a wide variety of apps that people use to manage their tinnitus. Some of those apps were developed specifically for tinnitus management while the majority were developed with other problems in mind (e.g. sleep difficulties, relaxation difficulties, stress). People who tried apps tended to find aspects that helped with their tinnitus or accompanying problems. However, lack of awareness was the main barrier to use of apps by people with tinnitus.

Conclusions: Further research should consider the place of apps in the tinnitus management (standalone self-management intervention vs part of the management by a hearing professional). As the content of the apps varies in respect to sound options, information and management strategies it seems that the choice of the best management app should be guided by individual patient needs and preferences, as well as quality of available apps.

**17 Authors:** Akilan Rajendran, Vidya Ramkumar, Roopa Nagarajan, Dhulase Subramaniyan B

**Affiliation:** Sri Ramachandra University, Chennai, Tamil Nadu, India

**Title:** Identification & management of middle ear disorders in community setting - A tele medicine approach

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** Middle ear disease (MED) are common among individuals with Cleft Lip and Palate in rural communities. Routine evaluations in hospital are unsuccessful due to travel distance and wage loss. Hence, CBR workers were trained with mobile phone based video otoscope using store and forward telemedicine. Images were stored and uploaded via internet. Audiologist at hospital reviewed and appropriate referrals were made to ENT physician. Among 324 ears, 93 - normal TM, 46 - dull TM, 92 - cerumen, 36 - MED and 57 - poor TM images. Thus, highlights the use of telemedicine enabled video-otoscope in community for identification of MED.

**Summary:** In our existing community based program for comprehensive management of individuals with Cleft Lip and Palate (CLP), middle ear (ME) disorders are suspected based on parent or patient's report of ear related symptoms. Routine evaluations in the hospital were unsuccessful as patients did not follow-up due to travel distance and wage loss. Further, it was not known if the patient's diagnosed with ME conditions recovered with medication. Therefore, a mobile phone based video otoscopy (ENTrerview) was introduced to evaluate ME status. Community based rehabilitation workers (CBRWs) were trained to triage patients from the community using store and forward telemedicine. Eight CBRWs from two districts of Tamil Nadu underwent a systematic training program in conducting otoscopy using ENTrerview device. Training program was adapted from the modules developed by Medtronics 'Shruti' program. CBRWs were trained and oriented briefly on anatomy and physiology of the ear, disorders of the ME and its etiology, using power point presentations, videos and ear models. Demonstration and hands on training was given regarding the operation of the ENTrerview device. Pre & post training evaluation was conducted for both knowledge and skill.

**18 Authors:** Saleth Monica, Vidya Ramkumar, Mark Krumm (Kent State University), Nitya Raman, Roopa Nagarajan, Lakshmi Venkatesh

**Affiliation:** Sri Ramachandra University, India

**Title:** School entry level tele-hearing screening in a town in South India

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** Tele-audiology has the potential to circumvent the scarcity of professionals and monetary resource allocation in developing countries. Feasibility of tele-hearing screening was assessed among 3 to 5 year old children in a school located in South India. Concurrence between in-person and telehealth conditions was obtained. Strengths and challenges were documented.

**Summary:** School screening is warranted in developing countries that do not have newborn hearing screening as schools provide access to a large number of young children from 3 years of age. Due to scarcity of technical manpower and equipment, hearing screening programs are not often conducted in developing countries. In these circumstances, telehealth services appear to be a reasonable solution. Consequently, this study assessed the feasibility of tele-hearing screening in a primary school. The screening procedures includes video-otoscopy, PTA and DPOAE. They were carried out using Firefly DE 500A digital video-otoscope and Neuro-Audio version 10. A total of thirty one children underwent testing twice, one in-person and other via tele method. In-person testing was performed by an audiologist at the school site whereas tele-method testing was performed by an audiologist at the hospital site along with the help of the facilitator. The hospital site audiologist was 400kms away from the school. Videoconferencing and remote computing were established using Team viewer 10, thereby the audiologist from the hospital site operated the audiometer and DPOAE system interfaced to the computer. All the screening procedures were performed using mobile hotspot or dongle device internet connection. Multiple internet options were used to insure reliable connectivity.

Videotoscopy was performed only in-person. The image was stored and forward via email to the audiologist at the hospital site for analysis. PTA and DPOAE were performed via both methods. On comparison, a concurrence of greater than 87% was achieved between in-person and tele-video-otoscopy, 80% was achieved between in-person and tele-PTA and 83% was achieved between in-person and tele-DPOAE. Further, in-person and tele-PTA and tele-DPOAE were compared with Bland-Altman plot which showed no significant difference between two methods, thereby indicating no systematic bias in the tele-method of testing. Hence school screening can be performed via tele-method with the help of a trained facilitator. However, availability of internet, internet speed, performance of facilitator are important factors that influence tele-screening experience.

Strengths and limitations were documented for further implementation of tele-audiological screening in such small towns. It is recommended that multiple internet options be used for sustained connectivity. The bandwidth above

100 kbps was found to be ideal for seamless testing along with good videoconferencing. Since ambient noise levels varied and needed constant monitoring, an audiometer with in-built noise monitoring may be considered. As an alternative, a basic noise monitoring app like “Sound Meter” may be used at school site for noise monitoring by the facilitator.

This study demonstrated that tele-hearing screening in schools is feasible and comparable to in-person screening even in smaller towns in India, where bandwidth limitations exists. However, a screening program can be validated only when the outcomes of screening is confirmed with diagnostic testing. In addition, owing to variation in ambient noise at schools, testing that measure relative SNR such as “Speech in noise test” rather than absolute measure (DPOAE) may be included.

**19 Authors:** Vidya Ramkumar, C.S. Vanaja, Dr. K. Selvakumar, Dr. James W. Hall, Roopa Nagarajan

**Affiliation:** Sri Ramachandra University, Chennai, India

**Title:** Validation of DPOAE screening conducted by Village Health Workers using diagnostic tele-Auditory Brainstem Response as gold standard

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** In a community based hearing screening program for infants and young children in rural South India, trained village health workers conducted two stage DPOAE screening, and the validity of VHWs screening was evaluated using real-time diagnostic tele-Auditory Brainstem Response carried out through satellite and broadband connectivity at the villages.

**Summary:** Background: In a community based hearing screening program for infants and young children in rural villages, trained village health workers conducted two stage DPOAE screening, and tele-Auditory Brainstem Response (ABR) recording was implemented for diagnostic confirmation of hearing loss.

**Aim:** To assess the validity of DPOAE screening conducted by VHW in a rural community, using diagnostic tele-ABR as gold standard.

**Method:** 119 infants and young children (0 to 5 years of age) were randomly selected from a sampling frame of 2880 infants and young children who had undergone DPOAE screening by six VHWs in a rural community. Real time tele-ABR was conducted using satellite connectivity or broadband internet hotspot at the village. An audiologist, at the tertiary care hospital conducted the test via remote control of audiological equipment in the rural site. ABR was recorded using click stimuli and standard stimulus and recording parameters recommended for infants and young children. Wave morphology, repeatability and peak latency, were used for ABR analysis. Presence of peak V up to 40dBnHL was considered normal for tele-audiological diagnostic testing, keeping in mind the higher ambient noise levels in the non-clinical environment.

**Results:** Out of the 119 infants and young children who had undergone tele-ABR, testing was complete in all respects in 197 ears and data of these ears were included in analysis. The sensitivity of DPOAE screening conducted by VHW was 0.75 (75%) with 95% CI as  $\pm 6.05$ , specificity was 0.915 (91%) with 95% CI as  $\pm 3.89$ . The negative predictive value was 0.988 (98.8%) with 95% CI as  $\pm 1.52$ . The positive predictive value was 0.272(27.2%) with 95% CI as  $\pm 6.21$ .

**Conclusion:** The validity of DPOAE screening conducted by trained VHW is acceptable. This study adds further to the body of literature that supports the increasing role of grass-root workers in the provision of community-based services (Olusanya et al., 2008).



**20 Author:** Neal Ruperto, Valeriy Shafiro, Mike Hefferly, Patricia McCarthy

**Affiliation:** Rush University Chicago, IL, USA

**Title:** Putting tele-audiology into practice: Audiologists' perspectives

**Topic Area:** Barriers and facilitators to the implementation of telepractice

**Abstract:** Audiologists' knowledge, perceptions and attitudes toward tele-audiology can influence its adoption for clinical use. This study uses semi-structured interviews of audiologists in a hospital audiology clinic. It identifies the aspects of tele-audiology that are perceived as most beneficial and problematic in their daily practice and determines strategies for their implementation.

**Summary:** Tele-audiology comes in many forms, but with the singular goal to utilize tele-communicative technology to administer hearing health care. Among its potential benefits are the reduced burden of time and transportation faced by patients and their care-takers, the facilitation of communication, and the increased access to information

and electronic resources related to hearing loss. This is especially beneficial to those in remote, rural populations. Tele-audiology is being used successfully in the VA system and through programs such as the Alaska Federal Health Care Network where a large infrastructure has been developed and maintained to extend services. The purpose of this study is to identify perceived benefits, associated barriers, and possible strategies for adopting tele-audiology into daily practice. These responses were attained from a representative group of audiologists employed at a large urban hospital clinic. Data were collected in the form of semi-structured interviews. Audiologists were asked to describe their length of employment, clinical duties, and patient populations served. In addition, they were asked to identify what they perceived to be the most useful aspects of tele-audiology and how these could be implemented. Interviews were recorded and then transcribed. Data were analyzed using a qualitative content analysis approach where key themes are identified and merged into broader categories. Preliminary results suggested that the audiologists interviewed for this study perceive that tele-audiology can be used effectively for basic counseling of patients and their communication partners, maintenance or basic troubleshooting of devices, and the use of electronic forms for intake and follow-up. Concerns included the possibility of compromised quality of care, limited patient access to the necessary technology across patient populations, lack of outcome measures, complications with privacy, hospital protocols, and financial reimbursement. These results provide initial guidance for addressing several specific barriers to implementation of tele-audiology in everyday clinical practice. They also lay a foundation for developing a general strategy for customizing methods of tele-audiology to the demands of a specific clinical setting.

**21 Author:** Valeriy Shafiro

**Affiliation:** Rush University Medical Center

**Title:** Development of an Internet auditory training program: Lessons from online education

**Topic Area:** Methodology of implementation of internet-based research and service delivery

**Abstract:** Internet-based auditory training programs (ATP) may provide a cost-effective and practical means to improve communication for patients with hearing loss. However, the development of effective ATPs involves multiple technical and logistical challenges. Many such challenges can be successfully addressed by adopting design principles and software tools developed in online education.

**Summary:** Internet-based auditory training programs (ATP) are gaining wider acceptance among audiologists and patients with hearing loss as a means of improving one's hearing and communication abilities. In addition to long reach and relatively low costs to participants, practical benefits include flexible timing and a greater degree of control over intervention delivery. However, studies on the effectiveness of Internet ATPs in adults with hearing impairments have produced mixed results, with only some reporting positive changes.

The lack of consistency in training outcomes across studies is not surprising, considering a variety of training methods, outcome measures, and patient populations investigated. Interactions among a diverse array of factors may have influenced previous results. Interventions that may be beneficial for some patients, may not necessarily lead to positive changes in others. To maximize training effectiveness and determine which kind of training would benefit a specific patient, a better understanding of the relationships between patient characteristics and intervention parameters is needed. However, there is limited research investigating ATPs.

The design and implementation of long-term Internet-based ATP studies is associated with multiple difficulties. In addition to prerequisite clinical and behavioral training knowledge, these include costs and expertise required to develop and maintain training software packages, which are user friendly and compatible with a broad range of personal computing devices, with fast delivery of auditory training materials. Unless ATP delivery is well executed, technical challenges will accumulate and patients, especially those with limited computer literacy, will be unwilling to continue. These factors substantially restrict research opportunities for developing rigorous training protocols to assess training related changes in randomized clinical trials (RCT). Very few published RCTs focused on Internet-based auditory training. The lack of detailed knowledge, in turn, prevents the development of effective research-based Internet training programs, while untested auditory training applications proliferate.

Online education may provide helpful guidance and stimulate further development of ATPs. Challenges similar to those presently encountered in the development of Internet ATPs have been addressed in online education during the last two decades. A large and continuously growing community of online learners and educators has produced a body of knowledge, including technical solutions that can be extended to the development of Internet ATPs. Specifically, many of the commonly used learning management systems and related software packages provide

options for incorporating sounds, images, video and interactive activities into a variety of learning tasks. Different types of feedback can be provided to maximize retention and maintain engagement. Furthermore, data management structures already exist that can be easily adapted to evaluating performance over time and performing initial statistical evaluations. The use of software tools and design principles from online education may circumvent a number of limiting factors discussed above, making large-scale auditory training studies easier to implement and more amenable to research and clinical needs. As a case study, this presentation will illustrate the application of an online educational package to the design of a RCT to evaluate the effectiveness of an auditory training program for cochlear implant patients.

[Support provided by the American Speech-Language-Hearing Foundation]

**22 Authors:** Tia McDonald (BTNRH, UAMS/UALR), Joshua Sevier AuD, Sangsook Choi PhD, Michelle Hughes PhD

**Affiliation:** Boys Town National Research Hospital Omaha, Nebraska

**Title:** Options for Remote Speech-Perception Testing with Adult Cochlear-Implant Recipients

**Topic Area:** Barriers and facilitators to the implementation of telepractice

**Abstract:** This study examined two options for testing speech perception with cochlear-implant recipients using distance technology. Option 1 involves remotely presenting speech stimuli via direct-connect to the sound processor. Option 2 involves free-field presentation through videoconferencing, and correcting scores based on performance-intensity functions for various reverberation and noise levels.

**Summary:** The use of telepractice to deliver clinical services to cochlear-implant (CI) recipients has gained momentum over the past decade. Research to date has primarily focused on evaluating the feasibility of remotely programming CI processors for adult recipients. However, speech-perception testing is also routinely performed at clinical programming visits to monitor progress and document outcomes with the CI. As a result, methods need to be developed and validated for testing speech perception during clinical visits that are conducted remotely. Speech-perception testing is traditionally performed in a sound-treated booth; however, it is possible that a sound booth might not be available in remote areas where CI services are delivered via telepractice. This presentation describes two studies underway in our laboratory that evaluate methods for speech-perception testing with CI recipients using distance technology.

In the first study, we are evaluating the feasibility of presenting speech stimuli via direct audio input (DAI) to the sound processor using a laptop computer controlled from a remote location. Because DAI bypasses the sound-processor microphone, thereby limiting the impact of background noise and reverberation, testing can be conducted in a typical room. For this study, participants are being tested in the traditional in-person, sound-booth condition and in the remote DAI condition using a split-half design. Scores for both conditions will be compared to determine if DAI can be used as a suitable alternative to sound-booth testing. Although the use of DAI for remote testing might prove to be feasible for some patients, challenges include the inability to assess the functioning of the processor microphone or to test in the bimodal (CI with hearing aid) or bilateral CI conditions.

In the second study, we are using DAI to present recorded speech material in a variety of conditions, including quiet, noise, and various degrees of reverberation. The goal will be to generate performance-intensity functions that could conceivably be used to correct for the background noise levels and reverberation characteristics of a given test environment. This method would require an initial measurement of the room acoustics at the remote test site, which would be used to determine which correction factor to apply. We plan to enroll 50 CI recipients for this study; data collection has just begun.



**23 Authors:** Husmita Ratanjee-Vanmali, De Wet Swanepoel

**Affiliation:** University of Pretoria

**Title:** Strengthening the role of the audiologist in the digital age: Initial study findings regarding people seeking hearing healthcare online – who are they?

**Topic Area:** Methodology of internet-based research and service delivery

**Abstract:** This research project will evaluate whether eHealth can reduce time, cost and improve access to hearing care for adult patients. The main aim is to determine how eHealth could improve audiology treatment and hearing aid outcomes by strengthening the role of the audiologist in the digital age. A secondary aim is to establish and influence evidence-based practice guidelines for hearing healthcare professionals willing to provide eHealth



services. Initial study findings will be presented in terms of demographic information, number of visits on the web page, number of participants in research study, number of participants who completed the online DINT (passed and failed), and number of participants who contacted the audiologist for discussion of DINT results before a diagnostic evaluation was confirmed.

**Summary:** This PhD project is entitled “Strengthening the role of the audiologist in the digital age”. The first study of the project describes the population seeking hearing health care online.

The study aims to describe the characteristics of adults ( $\geq 18$  years) searching for hearing health care online, according to the number in a sample population, demographic information (age, gender, etc.), hearing screening – triple digit in noise test (DINT) results, readiness to seek help and three most important situations where hearing difficulty is experienced.

This study will be conducted in the city of Durban, South Africa beginning in May 2017 with the aim of describing the characteristics of people looking for hearing health care online. Results will be reported based on the number of people, once failing the DINT will schedule an online consultation to discuss their DINT results, and then book a face-to-face appointment for a diagnostic evaluation to move forward in their hearing health care journey. These initial findings will determine which sections of the general population are actively using online methods to seek hearing health care information as well as the readiness to seek help immediately after failing an online hearing screening test.

Research suggest that PC and internet delivery of hearing screening, information and intervention is feasible for adults with hearing loss (Henshaw, Clark, Kang & Ferguson, 2012). The increase of mobile penetration globally holds promise that more individuals will have access to the internet which may increase one’s accessibility to services. Today, more people have access to a mobile device than to electricity and water in Sub-Saharan Africa (GSMA, 2015). In South Africa, audiology services are currently offered in both the private and public health sectors with an uneven distribution of professionals in urbanized settings.

This research project will offer services through a non-profit eHealth hearing clinic which is currently being established in Durban, South Africa. The proposed model is a combination of synchronous and asynchronous modes of online and face-to-face communication along the entire patient journey. On failing the online DINT, communication with the patient will be conducted through audio and video calls to discuss the results and assess the patient’s readiness to commit to a full diagnostic evaluation. The diagnostic audiological evaluation will be conducted by the audiologist in the patient’s home or workplace (face-to-face). The patient will be counselled based on the outcome of the diagnostic tests. If hearing loss is present and within the inclusion criteria of the study, the patient will be offered a free trial of amplification. During the two-week trial period, the patient and audiologist will be in contact via online modes of communication to assess the success of the trial period, answer any questions and offer further counselling. A second home visit (face-to-face) will be conducted to evaluate the trial period and confirmation if the patient wishes to purchase hearing aids. The patient will have access to an online aural rehabilitation program during the entire study. Continued support offered by the audiologist to the patient will continue through this hybrid service model and documented over the three year period.

Hearing eHealth practices are yet to be explored across the entire pathway of care. There is limited research available within tele-audiology regarding; feasibility cost reduction and improvement of accessibility of services across the patient journey, hence a clear recommendation for clinical practice cannot be made. This, therefore, warrants the need for further investigation of eHealth within the audiology profession and its implications for clinical practice.

**24 Authors:** Laura Coco, Nicole Marrone

**Affiliation:** University of Arizona Tucson

**Title:** The rural health workforce shortage: What are high-priority areas for teleaudiology?

**Topic Area:** Need for teleaudiology

**Abstract:** The availability of audiologists impacts the access and quality of hearing health care. Here we present an analysis of the geographic distribution of audiologists relative to the population of older adults in Arizona. Results support developing teleaudiology services to enhance access to care for rural, underserved communities.

**Summary:** Due to an uneven geographic distribution of healthcare professionals, areas of the United States are underresourced. Access to specialty services, such as audiology, is especially limited in some rural areas, where



aging Americans disproportionately live (Comartie & Nelson, 2009). Teleaudiology offers a potential solution, bridging the geographic divide by connecting the individual with the professional via the Internet. This research aims to identify high-priority areas for teleaudiology services in Arizona.

A retrospective analysis of geographic variation in the audiology workforce was conducted using publicly available datasets and mapped to the population of older adults (>65 years) in Arizona. Population data was gathered from the U.S. Census and audiologist provider data was obtained from the American Medical Association Health Workforce Mapper, using data from the Centers for Medicare and Medicaid Services' National Plan and Provider Enumeration System. Detailed population information will be presented for Arizona counties, including population density per square mile for individuals over 65 years old, as well as the distribution of audiologist providers by county. Additional analyses will include the number of individuals who are dually eligible for the delivery of both Medicaid and Medicare services.

The results of the workforce analysis will be tabulated and used to estimate resource availability by county for audiologists. Results will include population-to-provider ratio, percent of population below 100% of the federal poverty line, and the number of adults over age 65 years, following the shortage designation criteria of the Health Resources and Services Administration for primary care and dental health. In future research, we will analyze detailed population health data, including hearing status information, to better characterize the population in need relative to the available providers.

It has been suggested that the number of practicing audiologists needs to at least double by 2030 to meet demand for services (Windmill & Freeman, 2013). Strategies such as teleaudiology are needed to increase the capacity of current practices and improve patient access. Identifying which geographic areas have potential need for audiologists could allow teleaudiology programs to target areas of greatest need. Results will also be relevant for healthcare policymakers about where audiologists are needed most, serving as an important initial step towards closing the gap in access to care.

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