

**14<sup>th</sup> Congress  
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of Audiology Societies,  
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Lisbon, Portugal**

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## WORKSHOPS

## W01

**EFAS WG SHS School Age Hearing Screening**

**Speakers:** J. Wouters (Belgium), Lea Zupan, Jan de Laat, W. Dreschler (The Netherlands), S. Denys (Belgium)

## W02

**EFAS WG Auditory Processing Disorders**

**Speaker:** V. Iliadou (Greece)

**Summary:** The APD Gold standard for diagnosis will be presented based on an evidence based approach. Details on test battery development and use as well as sensitivity and specificity will be discussed. Hearing is more than we are currently testing. Tests for assessing auditory processing are speech in noise/babble perception, dichotic listening, temporal resolution, temporal processing, frequency discrimination, otoacoustic emissions, suppression of otoacoustic emissions and electrophysiology. An exaggerated debate on APD diagnosis is based on poor research that dismisses the current Clinical Expertise on the disorder and focuses on either suspected APD or listening difficulties without actually evaluating auditory processing.

## W03

**EFAS WG EDU Audiology Education**

**Speakers:** B. Kollmeier (Germany), J. Wouters (Belgium), T. Pitt-Byrne (Ireland), M. Pottek (Germany)

**Summary:** The Rauschholzhausen meeting about education in Audiology in Europe attempted to define first requirements for a European standard in university programs and professional training for the “General Audiologist” and the “Audiological Specialist”. This session will review the developments since then and the current state of training in technical, medical and pedagogical Audiology across Europe. Even though a common, widely accepted standard is still lacking, a number of successful training programs have shaped the field since 1999. While medical and educational audiology are highly dependent on the organization within the respective medical and school system in each European country, technical audiology – largely driven by international developments in hearing devices – is less bound to national peculiarities. This opens the chance for the exchange of students and course contents (e.g. by E-learning modules) across Europe. As an outlook, the German Cluster of Excellence Hearing4All develops a course system in its Joint Research Academy that might be used as a kind of reference program for graduate university education in the future.

## W05

**Tinnitus: why is it important to have standardization?**

**Speakers:** D. Hoare (UK), H. Haider

**Multidisciplinary European Guideline For Tinnitus**

Tinnitus involves the percept of a sound or sounds in the ear or head without an external source. Most individuals experiencing tinnitus have a neutral reaction to the percept. However, for some it becomes a problem. Bothering (distressing) tinnitus might be better described as a negative emotional and auditory experience, associated with, or described in terms of actual or potential physical or psychological harm.

Subjective tinnitus is a highly complex condition with a multifactorial origin, and therefore heterogeneous patient-profiles. In most people tinnitus is not traceable to medical causes. In most cases there is no available curative treatment.

Standard treatment, assessment, and referral-trajectories are poorly defined, not well established, and often insufficient. The lack of standard guidelines likely leads to untreated, under-, as well as over-treated patients. There is therefore a need for a European harmonized guideline for the assessment and treatment of tinnitus.

Through development and implementation of this guideline we anticipate that assessment and treatment of tinnitus will be significantly more effective, leading to reduced suffering and frustration for patients, their families, and clinicians alike.

**Evidence for biological markers in tinnitus: A systematic review**

**Introduction:** Biological markers are an emerging field in the area of Otology. Once identified, they may provide a means of determining the time-course or most effective treatment for an individual with tinnitus, presbycusis or any other otologic disease or impairment. Potential tinnitus biomarkers include mutations in mitochondrial DNA, chromosomal mutations, proteins, hormones, immunoglobulin, cytokine, interleukin, vitamins.

**Purpose:** To evaluate what biological factors are predictive of subjective tinnitus and tinnitus severity. The protocol is registered at PROSPERO: CRD42017070998.

**Methods:** We conducted a systematic search employing CINAHL, PsychINFO, EMBASE, ASSIA, PubMed, Web of Science, Science Direct, and EBSCO Host, using the search terms: tinnitus\* AND gene\* OR protein OR hormone OR immunoglobulin OR enzyme OR cytokine OR interleukin OR lipid OR vitamin OR marker. The initial search was complemented by scanning reference lists from relevant systematic reviews and the included primary studies;

citation searching of the included primary studies using Web of Science; and hand searching the last six months of key otology journals.

**Inclusion criteria:** Human subjects with subjective tinnitus. Searches were limited to articles in the English language, published in peer reviewed journals.

**Exclusion criteria:** Animal studies, objective tinnitus, Ménière's disease, Otosclerosis, Chronic otitis media, history of oncology and chemotherapy, ototoxic drugs intake, autoimmune diseases, neurodegenerative or demyelinating disease.

## W06

### EUSCREEN: Hearing screening for children in Europe

**Speakers:** I. Uhlén (Sweden), A.R. MacKey (Sweden), A. Goedegebure (The Netherlands), A.M.L. Bussé (The Netherlands)

Hearing screening of children in perspective of health economy and general health screening offered by governments. Availability of diagnostics and intervention. Status of screening programmes across European countries based on an extensive questionnaire and contacts with country representatives. Target conditions of screening and diagnostics.

## KEYNOTE LECTURES AND STRUCTURED SESSIONS

### KEYNOTE 1

#### Circadian regulation of the auditory system: New insights and therapeutic implications

**Speaker:** B. Canlon (Sweden)

It is well-established that nearly all physiological responses are under circadian regulation, such as the sleep and wake cycle, feeding behavior, metabolism, cognition, immune responses, blood pressure, urine production, detoxification and hormone release. It has recently been shown that even the cochlea possesses a robust self-sustained clock with ample expression of core circadian genes and proteins in both experimental animals and humans. Circadian mechanisms alter cochlear sensitivity to noise at different times of the day, with noise exposure during the active phase (night) causing permanent hearing loss, in contrast to animals fully recovering from the same noise exposure during the inactive phase (daytime). Moreover, we revealed that circadian vulnerability to auditory insults is not restricted to noise, but it also applies to cisplatin ototoxicity. These findings can also be extended to pharmacological treatment of hearing disorders. Data will be shown suggesting that time-dependent treatment strategies (chronopharmacology) can be highly successful for hearing disorders. Interestingly, dexamethasone treatment is only effective in preventing noise-induced hearing loss at specific times of the day. Treatment with dexamethasone in mice at day (corresponding in humans at night time) is effective against noise trauma while night treatment is not effective. We are now proposing that circadian aspects should be taken into consideration in order to improve the design and outcome of pharmacological interventions for treating hearing disorders. Finally, circadian biology needs to be implemented to the auditory system for clinical and experimental studies, since time-dependent rhythms appear to control important physiological responses in the cochlea.

### KEYNOTE 2

#### The importance of bilateral and spatial hearing in development evidence from children with bilateral and asymmetric hearing loss

**Speaker:** K.Gordon (Canada)

We study consequences of asymmetric hearing in children with bilateral profound deafness who used a unilateral cochlear implant before bilateral implantation and children who had access to acoustic hearing in one ear with or without a hearing aid before receiving a cochlear implant in the opposite ear (bimodal). Subgroups of such children show impaired learning and memory which has consequences for academic achievement. Our aim is to improve these key aspects in development by providing access to sound in both ears. Electrophysiological and behavioral measures post-implantation reveal benefits of bilateral implant/bimodal device which are reduced with delays to bilateral hearing; auditory cortices maintain an aural preference for the first hearing ear and asymmetries in speech detection and perception are persistent. We thus recommend that access to sound in both ears be provided to children as early as possible in development. Continuing work focuses on remaining challenges in integration of input from each ear which is needed to establish spatial hearing and reduce listening effort in children who have hearing loss.

### KEYNOTE 3

#### Assessing all five vestibular organs: clinical applications in adult and pediatric (CI) population

**Speaker:** A.J. Beynon (The Netherlands)

Conventional electronystagmography can be performed in CI candidates with the purpose to preoperatively choose the optimal ear. Taking into account the recent increase of very young and very old CI recipients, it is important

to know which preop variables could predict postop vestibular degradation in both patient groups.

This lecture will focus on vestibular assessment based on > 800 CI subjects. We have obtained vestibular data at different frequency ranges covering low-frequency caloric irrigational tests, rotary chair tests, video head impulse tests (vHIT) of all semicircular canals, i.e. including vertical LARP and RALP movements up to relatively high frequency sensitivity cervical- and ocular vestibular evoked myogenic (VEMP) testing.

Besides addressing possible pre- versus postop vestibular changes, all pros and cons of the different clinical tests and their interpretation with respect to cochlear implantation are elucidated.

#### KEYNOTE 4

### Hearing loss: demographics, indicators, and relevance – a review of progress and shortcomings in hearing assessment

**Speaker: I. Holube (Germany)**

Hearing loss is a major health challenge in the aging societies. In the case of Germany, prevalence of hearing impairment in adults is about 16% currently and further increasing. Results for other European countries are similar. This number refers to the WHO classification based on pure-tone thresholds that is appropriate for describing audibility deficits, but insufficient when it comes down to addressing identified hearing impairment in rehabilitation today. The audiological community went methodically far beyond pure-tone audiometry, triggered by in-disciplinary as well as interdisciplinary research, general technical advances, and economic prosperity. Hearing loss is no longer considered only an individual bad fate, but recognized as a social issue to be tackled on micro and macro level. Progress in rehabilitation is cumulative in nature. Approaches are added to modernize and to refine the inventory of methods, not claiming to replace it. Speech recognition tests complement assessment strategies that focus on audibility. However, speech tests in the lab cannot perfectly reflect and predict disability perception in the real life. Hence, on the one hand, new lab methods like listening effort emerged. On the other hand, questionnaires are administered to capture the patients' point of view and to be independent from experimental setups, procedures, and tasks in lab testing that are hardly witnessed in everyday situations. A fresh attempt to overcome the constraints of conventional questionnaires is a method called ecological momentary assessment (EMA). EMA allows for highly individual momentary data collection in everyday life and might substantially contribute to bring the real world into the lab. This presentation reviews the diversity of methods in hearing assessment, their strengths and shortcomings, and their possible future prospects.

#### Structured Session 01

### Educational audiology

**Chairs: M. Cravo (Portugal), A. Astolfi (Italy)**

**Speakers: K. Persson Waye (Sweden), K. Loh (Germany), N. Prodi (Italy), V. Lyberg Åhlander (Sweden), F. di Berardino (Italy), P. Bottalico (USA), B. Kollmeier (Germany)**

The preschool sound environment - effects on children's hearing and behaviour - Evaluation of an experiment on intentional switching of auditory selective attention for children -

Using the matrix sentence test in real classrooms with 11 to 14 years old students

Effects of voice quality and babble-noise on listening effort and well-being in primary

Italian speech audiometry in children: what's new and old - Effect of dysphonic voices on speech intelligibility in a college classroom - Predicting combined effect of reverberation and noise on binaural speech recognition in real classroom acoustics

#### Structured Session 02

### Hearing instruments or cochlear implants? Audiological indication criteria

**Chairs: J. Kiessling (Germany), N. Dillier (Switzerland)**

**Speakers: D. Vickers (UK), A. Snik (The Netherlands), P. H. Skarzynski (Poland), A. Lorens, H. Skarzynski (Poland), W. Nogueira (Germany), T. Gajecki, V. Hohmann, G. Grimm, A. Büchner (Hannover/Oldenburg, Germany)**

Defining the limits for audiometry and speech perception for adult cochlear implant indications

Bilateral acquired severe sensorineural hearing loss - what is the best amplification option?

Indications for CI in adults with different types of hearing loss – application of the Partial Deafness Treatment classification - Evaluation of bilateral and bimodal implantation in realistic sound environments and its consequences for indication criteria

**Structured Session 03****The smartphone revolution in audiology**

Chairs: T. Pitt -Byrne (Ireland),  
De Wet Swanepoel (South Africa)

Speakers: T. Pitt -Byrne (Ireland), S. Denys  
(Belgium), C.Thodi (Cyprus), B.Timmer  
(Australia), De Wet Swanepoel (South Africa)

The mobile revolution has seen smartphones and connectivity become ubiquitous personal tools that are changing the face of every industry, including health care. Hearing health care is no exception with smartphone and tablet technologies increasingly employed across the continuum of care in audiology. This session will cover a range of audiological applications for smartphones and tablets, including screening, diagnostics and interventions.

**Structured Session 04****APD: diagnostics and auditory training**

Chairs: J.H. Martins (Portugal), D. Bamiou (UK)

Speakers: V. Iliadou (Greece), N. Angenstein  
(Germany), H. Grech (Malta), D. Bamiou (UK),  
H. Thai Van

APD diagnostic criteria - the European approach - Considering linguistic factors when assessing for APD - Imaging studies of relevance to APD - Evidence based management for APD - APD definitions and controversies

**Structured Session 05****Recruiting the other ear in SSD and bimodal fitting**

Chairs: J. Wouters (Belgium), M. Manrique (Spain)

Speakers: S. Arndt (Germany), M. Manrique  
(Spain), M. Polonenko (Canada),  
A. van Wieringen (Belgium), M. Marx (France)

Influence of single-sided deafness on the auditory capacity of the better-hearing ear - Critical period in single sided deafness. Effectiveness of a cochlear implant for children with single sided deafness - Toddlers with congenital single sided deafness and a cochlear implant - Evaluation of binaural integration in cochlear implanted SSD subjects using PET scan.

**Structured Session 06****Improved prediction of speech intelligibility with hearing devices**

Chairs: B. Kollmeier (Germany), M. Boboschka  
(Russia)

Speakers: B. Kollmeier (Germany), W. Dreschler  
(The Netherlands), E. Zhilinskaya (Russia),  
M.R. Schädler (Germany), E. Lopez-Poveda  
(Spain), A. Büchner (Germany)

Why and how to predict aided patient performance? - Clinical Prediction of hearing device performance with the individual auditory profile). Precision Audiology with modern speech intelligibility tests - diagnostics and hearing aid prescription & benefit assessment - Precise Prediction of Hearing Aid benefit with FADE - one model for many applications - Non-audibility and non-acoustical factors affecting speech intelligibility. How to predict the success of a Cochlear implantation with clinical measurements and theoretical models

**Structured Session 07****Acoustically and electrically evoked potentials: from the electrocochleography to the response of auditory cortex**

Chairs: G. Tavartkiladze (Russia)

Speakers: N. t Dillier (Switzerland), A. Beynon  
(The Netherlands), G. Tavartkiladze (Russia),  
V. Bakhshinyan (Russia)

The use of electrically evoked potentials for improved cochlear implant coding strategies. Intra-operative CM recordings during cochlear implant insertions. Electrically evoked potentials in cochlear implant users: from periphery to auditory cortex. Innovative rehabilitation approaches in CI patients based on neural response telemetry.

## FREE PAPER SESSIONS

## Free Papers 01 -

## Bone conduction hearing devices

ID: 03790

**Speech understanding and sound localization with the adhesively attached Adhear bone conduction hearing system****Martin Kompis<sup>1</sup>, Tom Gawliczek<sup>2</sup>, Marco Caversaccio<sup>1,2</sup>, Wilhelm Wimmer<sup>2</sup>**<sup>1</sup> Department of ENT, Head and Neck Surgery, Inselspital, University of Bern, Switzerland<sup>2</sup> Hearing Research Laboratory, ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland**Keywords:** Bone conduction, Adhear, conductive hearing loss**Background:** Recently, the Adhear device (Medel, Inc.), an adhesively attached bone conduction system, was introduced. We compared its performance with Baha 5 bone conduction devices (Cochlear Inc) on softbands in subjects with normal inner ears.**Materials and Methods:** Audiological tests were performed with 15 normal hearing subjects.

Their ears were occluded using a new occlusion method and simulating a bilateral conductive hearing loss of 49 dB, when averaged over the frequency range of 500 to 4000 Hz and over all subjects. Sound field thresholds, speech reception thresholds in quiet and in noise, and sound localization were measured in unaided conditions and with both devices used unilaterally and bilaterally.

**Results:** All tests showed significantly better results the aided conditions than in the unaided condition. Sound field thresholds improved by 24.6 dB ( $p < .001$ ), speech reception thresholds in quiet by 20 dB ( $p < .001$ ) and in noise by 4 dB ( $p < .001$ ). Sound localization and speech understanding in noise was improved significantly (by +3.6 to 3.8 dB and by +34°), when the bone conduction devices were used bilaterally. The small differences between the Adhear and Baha on a softband were not statistically significant in any of the tests.**Conclusions:** Both devices, the Adhear and the Baha, showed significant improvements in speech understanding in quiet and in noise in subjects with normal inner ears. There was no significant difference between in any of the measurements. The bilateral use of either device improved speech understanding in noise and sound localization.

ID: 03791

**Speech understanding and hearing and with the non-implantable wearing option Baha SoundArc****Martin Kompis<sup>1</sup>, Tom Gawliczek<sup>2</sup>, Marco Caversaccio<sup>1,2</sup>, Wilhelm Wimmer<sup>2</sup>**<sup>1</sup> Department of ENT, Head and Neck Surgery, Inselspital, University of Bern, Switzerland<sup>2</sup> Hearing Research Laboratory, ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland**Keywords:** Bone conduction, SoundArc, conductive hearing loss.**Background:** Sound processors for bone anchored hearing systems can be mounted either on implants or they can be used without implantation, e.g. on a softband. A new non-invasive wearing device, the Baha SoundArc (Cochlear Inc.) has become available recently. We compared its performance to the softband in subjects with normal inner ears.**Materials and Methods:** Fifteen normal hearing subjects participated in this study. Their ears were occluded to simulate a bilateral conductive hearing loss of 49 dB, when averaged over all subjects in the frequency range 500 to 4000 Hz). The following tests were performed in unaided conditions and with unilateral and with bilateral Baha 5 devices: sound field thresholds, speech reception thresholds in quiet and in noise, and sound localization.**Results:** All results were significantly better in the aided than in the unaided conditions with either the Softband or the SoundArc. Sound field thresholds improved by 24 dB ( $p < .001$ ), speech reception thresholds in quiet by 20 dB ( $p < .001$ ) and in noise by 4 dB ( $p < .001$ ). Sound localization and speech understanding in noise was improved significantly (by +4 dB and by +28°), but only when the bone conduction devices were used bilaterally. None of the small differences between the Softband and the SoundArc was statistically significant in any of the test conditions.**Conclusions:** Sound processors mounted on both of the tested non-implantable wearing options bone conduction systems showed significant improvements in speech understanding. No significant difference between the two wearing options was found. Using two devices instead of just one improved speech understanding in noise and sound localization.**Conflicts of interest:** This study was supported by a research grant from Cochlear Inc.

ID: 03792

**Long term use of bone anchored hearing systems (BAHS) in single sided deafness**Martin Kompis<sup>1</sup>, Marco Caversaccio<sup>1,2</sup>, Wilhelm Wimmer<sup>2</sup><sup>1</sup> *Department of ENT, Head and Neck Surgery, Inselspital, University of Bern, Switzerland*<sup>2</sup> *Hearing Research Laboratory, ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland***Keywords:** Baha, bone conduction, CROS, BAHS, single sided deafness.**Background:** Some users with Bone Anchored Hearing Systems (BAHS) because of single sided deafness (SSD) eventually stop using their devices. The aim of this study was to investigate the probability, the average time delay and the reasons for to abandon the use.**Materials and methods:** Retrospective chart review of all 33 German speaking adults with SSD who had been implanted with a BAHS at our center and of whom the implant status and use of the BAHS were known.**Results:** 2.6 to 12.3 years after BAHS implantation, 21 implantees (63.6%) were still using their device (average use 7.9 years). Seven (21.2%) had stopped using their BAHS because of insufficient subjective benefit, i.e. because of audiological reasons. The subjective assessment of the benefit of the BAHS differ significantly from the assessment of the users, especially for situations in noise. Five former users (15.2%) became non-users for reasons, which are unrelated to their hearing performance, namely recurrent infections, implant loss, difficulties with the handling, or aesthetic reasons. Using the Kaplan-Meier estimator, it was found that approximately 85% of the BAHS can be expected to be still in use 5 years after implantation.**Conclusions:** Bone Anchored Hearing Systems in single sided deafness are still used by a majority 5 years after implantation.**Conflict of Interest:** none to declare

ID: 03852

**Bone conduction hearing aids in children younger than 2 years- audiological assessment**Katarzyna Cywka<sup>1</sup>, Piotr Henryk Skarzynski<sup>1,2,3</sup><sup>1</sup> *World Hearing Center, Institute of Physiology and Pathology of Hearing, Warsaw/Kajetany, Poland*<sup>2</sup> *Institute of Sensory Organs, Warsaw/Kajetany, Poland*<sup>3</sup> *Heart Failure and Cardiac Rehabilitation Department of the Medical University of Warsaw, Poland***Aim of the study:** The aim of this study was assess the development of auditory system in children up to two years

old after usage of hearing aids and assess the effectiveness of auditory prosthesis used.

**Material and methods:** The research group consisted of 20 patients of the Institute of Physiology and Pathology of Hearing, children up to 2 years old which use bone conduction hearing aids. The control group included 20 children with the normal hearing. The development of children auditory after the use of hearing aids was assessed on the basis of the LittleEars questionnaire completed by parents and a re-examination of the behavioral observation audiometry about 6 months after the hearing aids was founded.**Results:** The results of audiometric tests by BOA method showed improvement auditory reactions. The analysis of the LittleEars questionnaire answers indicates progression in the hearing ability of children who use bone conduction hearing aids.**Conclusions:** The use of bone conduction hearing aids in children with hearing loss gives opportunity to properly develop hearing perception. This is the first step and only way to enable auditory stimulation in this group of patients. The use of questionnaires supports audiological assessment and allows the monitoring of hearing development. Currently the survey database for assessment is very limited, therefore the creation of tool adapted accordingly and intended for children younger than 2 years old is recommended.

ID: 03854

**Audiological benefits after Bonebridge implantation**Piotr Henryk Skarzynski<sup>1,2,3</sup>, Katarzyna Cywka<sup>1</sup>, Bartłomiej Krol<sup>1</sup>, Beata Dziendziel<sup>1</sup>, Henryk Skarzynski<sup>1</sup><sup>1</sup> *World Hearing Center, Institute of Physiology and Pathology of Hearing, Warsaw/Kajetany, Poland*<sup>2</sup> *Institute of Sensory Organs, Warsaw/Kajetany, Poland*<sup>3</sup> *Heart Failure and Cardiac Rehabilitation Department of the Medical University of Warsaw, Poland*

The Bonebridge is active bone conduction implant system dedicated for patients suffer from chronic otitis media or congenital malformations, resulting with conductive or the mixed hearing loss. Moreover, it can be used by the patients with the single-sided deafness. Bonebridge consist of sound processor and coil that generate vibrations to the bone, transmitted via screws to mastoid. The aim of the study was to evaluate the audiological results of patients after implantation Bonebridge system.

18 cases of the patients with the mixed and the conductive hearing loss were analysed. Bonebridge implantation surgery were performed in all cases in the World Hearing Centre, Warsaw. The prospective study were performed, audiological tests included: pure tone audiometry, sound filed audiometry, sound field speech audiometry and the ABHAB questionnaire.

Results obtained before and after implantation were compared. In all cases hearing thresholds were stable. The post-implantation audiological results present considerable benefits of using the Bonebridge system. Moreover, AHAB questionnaire results shows the increase in hearing ability, the speech recognition and the spatial hearing.

Summing up, Bonebridge implant system provides the substantial audiological benefits. Furthermore, this study confirms the effectiveness and the safety of the system, with good aesthetic effect, crucial for patients.

**ID: 03927**

### First experiences with the new ADHEAR bone conduction system in Serbia

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**Keywords:** hearing benefit, quality of life, conductive hearing loss

**Background:** ADHEAR is new, non-implantable hearing system which can be used in patients with conductive hearing loss, and single-sided deafness. The aim of this study was to evaluate the audiological benefit and improvement in quality of life in patients with conductive hearing loss wearing ADHEAR.

**Materials and methods:** During the 12 months period, all patients diagnosed with unilateral or bilateral conductive hearing loss in Audiologic Department of our Clinic were screened for potential enrollment in this study. Other inclusion criteria, except from hearing loss, were: subjects older than 18 years, ones who were capable of answering the questionnaires and willing to participate in all tests. Exclusion criteria were: mixed hearing loss (BC thresholds higher than 25 dB HL), patient intolerance or incapability of wearing the device, presence of retrocochlear or central auditory disorder or any other physical or psychological disorder that would interfere with the ability to perform tests. All patient underwent tonal behavioral audiometry, free field with wobble tones and speech audiometry unaided and aided, and also filled Speech, Spatial, and Qualities of Hearing Scale, Assessment of Quality of Life-6dimensions at first visit, and two weeks after.

**Results:** The ADHEAR hearing system lead to the improvement of aided pure tone thresholds (at 0,5, 1, 2, and 3 kHz), and in speech audiometry compared to unaided condition. Furthermore, all patients showed significant improvement in all 6 measured dimensions of their quality of life, after two weeks of wearing the device. The speech, spatial and hearing also showed substantial improvement, based on filled questionnaires.

**Conclusions:** The ADHEAR hearing system is valuable, safe and beneficial conductive hearing system and it can be used in patients with conductive hearing loss with different

etiologies. It is easy to wear due to it adhesive adapter, and more importantly, patients are spared of any surgery.

**Conflicts of interests:** Authors state that they do not have any conflict of interests to declare.

**ID: 04019**

### Baha attract system - long term postoperative outcome with modified surgical technique

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**Keywords:** BAHA Attract, modified surgery

**Background:** Transcutaneous BAHA Attract systems became more and more popular nowadays, used for multiple types of hearing loss both in paediatric and adult cases. Based on a preliminary morphometric study, a modified surgical technique and implant loading method was developed in our Clinic, which reduce surgical time and possible postoperative complications.

**Materials and methods:** In a preliminary study with MRA, Doppler ultrasound measurement and cadaver dissection (n=50 subjects), we have proved, that the prevalence of major arteries is low in the upper-posterior area, although large in proximity to the auricle region. Therefore, in our 93 BAHA Attract implantees, incision line was performed in the superior-posterior region of the temporal area. Implant loading was also modified to avoid bone surface drilling. Patients have been followed for 3 years postoperatively. A one-page questionnaire -focusing on the hearing performance/wearing/comfort- was filled in all case. Audiological outcome was tested and compared in the two Attract groups: in Group1 (n=11) implant loading was performed in the recommended way, in Group2 (n=10) the implant loading was modified i.e. submaximal loading (for 4 mm implant 3 mm deep implant bed) was performed and periosteum was preserved around the implant.

**Results:** In most of the cases, implantation performed under local anaesthesia, average surgical time was ~10 min. Sound processor loading could be performed at the 4th week, but necessary magnet strength was lower, compared to the literature. Pain and tissue numbness was negligible according to the result of the questionnaire. Skin irritation (n=4) was solved with less strong magnet. Severe skin complication was detected in only 1 of the total 93 cases. Long term follow-up showed no further complication. Postoperative audiometry showed significantly better results compared to preoperative tests in both implanted groups. There was no significant difference between the groups in pure tone audiometry results despite the modified loading.

**Conclusion:** Based on our studies, superior-posterior incision line preserves the neurovascular integrity of the implant area, contributes to less postoperative complication, and provides better wearing comfort/aesthetic outcome. With modified implant loading bone polishing is avoidable, and do not affect audiological outcome.

**Conflict of interest:** We have no conflict of interest to declare.

ID: 04058

### Intracochlear pressure measurements to study human bone conduction perception

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**Keywords:** bone conduction transmission, intracochlear pressure, bone conduction perception, objective measures

**Background:** Multiple studies have investigated the cochlear transmission of air conduction (AC) stimulation using intracochlear pressure (ICP) measurements, whereas there is still a lack of reference data on ICP measurements with BC stimulation. Furthermore, the relation between objective cochlear pressure and behavioral measures with bone BC stimulation remains unknown. The presented study aims to study this relation in more detail.

**Methods and materials:** A behavioral experiment on 10 normal hearing subjects was performed in order to find equal loudness perception between an AC -unilaterally presented via insert phones- and a BC stimulus, which was presented via a Baha® 5 Power actuator (Cochlear Ltd., Sydney, Australia) mounted on a Baha® Softband. The contralateral ear was masked in order to find the ear specific thresholds. The BC stimulus was presented at a fixed level (i.e., 40, 50 and 60 dB HL) at nine different frequencies (250–6000 Hz). The AC stimulus that was presented before the BC stimulus could be changed by the subjects. Both stimuli were alternately presented for one second with one second of silence in between. A custom made software was used. A test-retest study was performed to evaluate the test reproducibility. Mean balanced AC thresholds were calculated for all subjects and these thresholds were used in the fresh-frozen cadaver experiments (N = 4) to evaluate the related pressure in the cochlea with BC and AC stimulation. Furthermore, ICP measurements will be compared with standard velocity measurements to investigate the correlation with the behavioral loudness balancing experiments.

**Results:** Results of the behavioral experiments in normal hearing subjects revealed reproducible results in almost all subjects. Linear loudness function where found between 40, 50 and 60 dB HL. The cadaver experiments are

ongoing and will be performed in February, so preliminary results of this study will be discussed on the conference.

**Conclusion:** Comparing both behavioral and objective measurements will lead to more insight into the transmission at the level of the cochlear mechanics. It is hypothesized that similar pressures will be found in the cochlea with AC and BC stimulation, which is a good validation for the ICP measurements. As a result, ICP measurements could be used as preclinical tool to characterize different acoustic hearing implants and to predict the best outcome for patients.

ID: 04124

### Short-term and first long-term outcomes for children treated with the bone conduction hearing system ADHEAR

Katrin Neumann

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**Keywords:** conductive hearing loss, aural atresia, hearing aid, children, adhesive

**Background:** Bone conduction hearing devices as integrated in softbands (BCD-S) are frequently not well accepted by children with conductive hearing loss due to pressure on the head, sweating, or cosmetic stigma. The hearing system ADHEAR uses a new bone conduction concept with an audio processor connected to an adhesive adapter fixed behind the ear. This study evaluated the short- and long-term efficacy of the ADHEAR in children compared with conventional BCD-S.

**Material and Methods:** For 10 children with conductive hearing loss (age: 8 months to 9.7 years) the ADHEAR was compared with a BCD-S. Aided and unaided pure tone/behavioral observational audiometry and – if applicable – speech audiometry in quiet and noise were performed initially and after 8 weeks of ADHEAR use. The subjective hearing gain, usage of the ADHEAR, and patients' as well as parents' satisfaction were assessed by questionnaires. First long-term results and data of four additional children are available.

**Results:** The functional gain with the ADHEAR (t-test,  $p = .012$ ,  $n = 11$ ), averaged over 0.5, 1, 2, and 4 kHz, exceeded that one achieved with BCD-S (34.7 dB HL  $\pm$  14.1 SD vs. 27.7 dB HL  $\pm$  14.7 SD). Speech perception in quiet and noise improved in the aided situation similarly for both hearing devices. All parents except two evaluated the ADHEAR as useful for their child. After an average use of 13 months ( $n=4$ ) the functional gain with the ADHEAR remained stable or even improved, as did the adhesion time of the adhesive adapter and the wear acceptance. Eight weeks after first fitting six children used the ADHEAR permanently, one year later eight children and the additional 4 children.

**Conclusion:** Meanwhile, 11 of 13 children use the ADHEAR permanently, among them three with multiple disabilities. Initial problems regarding wear comfort, fixation of the adhesive, skin irritations, and feedback noise

have been largely overcome by technical and handling optimization. One child received an active middle ear implant and one continued in using a softband-integrated BCD. The ADHEAR system is a favorable technical solution for children with conductive hearing loss or chronic draining ears.

**Conflicts of interest:** Study devices were provided by MED-EL. The authors received grant and research support for projects performed with MED-EL travel and congress support for workshop and congress presentations.

## Free Papers 02 - Cochlear implants I

ID: 03785

### Experience with MRI scanning of hearing implant users

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Richard Zniva

MED-EL

**Key words:** Hearing Implant, MRI, Safety

**Background:** We know that 3 of 4 people will need an MRI in their lifetime and we know that MRI has an increased value in diagnostic medicine. This is also the case for hearing implant users. Audiologists need to consider MRI safety of a hearing implant when counselling candidates.

**Materials and Methods:** A data review about MRI scanning of patients with hearing implants is presented. Two studies will be described. The first is a review of MRIs within HEARING centres. This review covered the period 2013 to 2018. This asks about availability of information on MRI, how many users received an MRI, on what hearing implant, at what Tesla and where in the body. The second study shows outcomes in cochlear implant users who have had a magnet removed for their MRI.

**Results:** In the first study, 119 scans from 89 users were reported on. They covered a number of different cochlear implant housings, ABI and Vibrant devices. Most scans were for ABI users, who had the most scans per person, and most scans were in the head region. 1.5T was most used. There were no magnet dislocations or weakening when conducted under the Instructions for Use. Three cases of discomfort were reported on. In the second study, 10 magnets were removed and replaced without trouble. This study has been conducted since 2015. Average removal/replacement time was 31 minutes. No adverse events or difficulties were reported.

**Conclusion:** MRI scanning can be performed in a safe way when keeping to the safety guidelines for the implant. Recent innovations in hearing implant design enables safe MRI scanning at reduced effort for the radiologist and minimal discomfort for the user.

**Conflicts of interest:** All authors work for MED-EL.

ID: 03806

### The variability of fitting parameters across CI centers

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**Keywords** Cochlear implant – Parameters – Multicentric

**Background** There does not seem to have any consensus to achieve an optimal MAP. Indeed, the study by Vaerenberg and al. (2014) lists the different methods of programming in 47 centers offering cochlear implants around the world, highlights the great variability between the different places of programming. There is no “Good Clinical Practice” providing guidelines for CIs programming. The setting depends more on the center and the professionals than on the patient’s specific characteristics. Individuals with unsuitable programming have poor perceptual test results (Geers et al., 2004).

On this theoretical basis, our research questions are:

Which parameters are really changed by professionals?

What is the intra and inter center variability in the fittings?

**Material and methods** This multicentric longitudinal retrospective study investigate 4 centers (2 in Belgium and 2 in France), N=98. The parameters (strategy; number of electrodes T & C levels; T-SPL; C-SPL; maxima; rate; pulse width; loudness growth) are encoded at activation (T0), 3 months (T1), 6 months (T2), 1 year (T3), 2 years (T4) and 5 years (T5). To be included in this study, subjects must meet various inclusion criteria: Cochlear’s CI ; fitting in a center in Belgium or in France; adult (age> 18 years); a unilateral CI ; a post-lingual hearing loss and etiology of deafness: no meningitis. The fitting parameters fixed at T0 are compared to those used at the other studied times, using parametric or non-parametric tests.

**Results** Fixed effects (in ANOVA) time (T0 to T5), center and frequencies are significant for T levels and C levels. There is variation between centers. For the others specific fitting parameters, there are also significant variations between centers (p>0.05). The default value is changed differently in the centers.

**Conclusion** Currently, there is no a « clear policy » to fit CI. The fittings are « center’s dependent ». The default value of the parameters is sometimes changed but their adaptations remain limited. The auditory outcomes are not always evaluated.

ID: 03811

## Listening effort in daily life in adult patients with cochlear implant

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**Background,** Hearing impaired people often report stressful communication situations. Even patients with a cochlear implant (CI) suffer from a major listening effort especially in noisy situations. In order to be able to describe these in more detail, a survey of adult CI patients was conducted for the first time with a listening effort questionnaire (Schulte et al. 2015) This covers 17 different listening situations, which the patient has to categorize between “not exhausting” and “extremely stressful” and eight intermediate levels.

**Material and Method,** The prospective survey involved 72 patients with CI aged 18-85 years (mean 57 years) with different care. During regular follow-up appointments, speech understanding was measured using standard audiological testing techniques. The statistical evaluation was done descriptively in the corresponding care groups. The data were compared with information available from hearing aid users in the literature.

**Results,** Situations characterized by reverberation or a low signal-to-noise ratio are perceived as strenuous by patients with a cochlear implant. In comparison to user with hearing aid, CI-user describe the listening effort less in situations characterized by a signal-to-noise ratio. Likewise, they classify the listening effort in listening situations in quiet with lip readings less than hearing aid user.

**Conclusion,** The listening effort questionnaire can be used well in patients with a CI. It provides additional information about understanding speech in everyday situations, where patients can cope well and less well, and can provide additional information to customize the speech processor.

ID: 03818

## Middle ear infectious complications in cochlear implant patients – our experience

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**Keywords,** Cochlear implant, infectious complication, explantation

**Background:** In the last 70 years cochlear implantation has deeply changed the destiny of the deaf and hearing impaired. As high is the sky for the good working implant as deep is the sorrow for any threat of implant malfunction. What we fear the most is the necessity of explantation. Infections in the implanted ear are one of those threats. The literature state that explantation has to be done on average in 1.8% of inflammation cases.

**Material and methods:** We looked at the charts of 353 cochlear implant patients at the ENT Clinic University Medical Centre Ljubljana, Slovenia, Department of Audiology searching for middle ear complications on the implanted side.

**Results:** We found 58 episodes of acute and chronic (with and without cholesteatoma) middle ear inflammation and mastoiditis in 33 patients (4 adults and 29 children). 12 patients had more than one complication on CI side. The time from implantation to inflammation was in average 40 months (for acute otitis media 33.85 months, chronic inflammation without cholesteatoma 110 months, chronic inflammation with cholesteatoma 40.44 months and for mastoiditis 11.14 months). 36% (21) of patients had acute otitis media, 26% (15) acute mastoiditis, chronic otitis media without cholesteatoma was found in 17% (10) and in 20% (12) chronic otitis media with cholesteatoma. 86% of patients were hospitalized. 55% of patients were treated conservatively (with parenteral antibiotic), the others had myringotomy (2), incision and drainage of subperiosteal abscess (1), revision mastoidectomy (5), subtotal petrosectomy (1), tympanoplasty (6) done. In 0.5% (2) patients because of multiple unsuccessful tympanoplasties the explantation had to be performed. Both had received the new cochlear implant on the other side in the same act.

**Conclusion:** Regarding the data from the literature our results are highly comparable, regarding the explantations even better than reported.

**Conflicts of interest (if any):** We do not have any conflicts of interest

ID: 03834

## Comparison of bimodal benefit using DSL v5.0 and NAL-NL2 as hearing aid gain prescriptions

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**Keywords:** asymmetrical hearing loss, binaural summation, hearing aid prescription, DSL m[i/o]

**Background:** Among other factors, the bimodal benefit also depends on the hearing loss and the hearing aid gain settings contralateral to the cochlear implant. In earlier studies, the hearing loss in this side was mainly profound for the mid and high frequencies. For a reliable comparison of the resulting bimodal benefit of different hearing aid gain settings, a group of twenty bimodal subjects with only moderate to severe hearing loss contralateral to the cochlear implant (CI) was tested. The bimodal benefit was assessed using the hearing aid (HA) gain prescriptions DSL v5.0, NAL-NL2 and the recipients' own gain-setting as a reference for comparison.

**Material and Methods:** Speech recognition in quiet (Freiburg monosyllabics) and in noise (Göttingen sentence test) was tested in the bimodal, the HA alone and the CI alone condition. Each condition was tested for all

three gain settings. The bimodal benefit was determined for each gain setting as the difference score of the bimodal condition and the better ear. In addition, self-reported ratings of benefit were determined.

**Results:** Speech perception in quiet and in noise were both significantly higher with DSL v5.0 compared to NAL-NL2 and the own prescription. The bimodal benefit was also significantly higher for DSL v5.0 with a group median of 15 percentage points in quiet and in the noise.

**Conclusions:** The hearing aid gain prescriptions DSL v5.0 and NAL-NL2 are both suitable for the hearing aid fitting in bimodal users. Concerning subjects with moderate to severe hearing loss and given hearing aid experience contralateral to the implanted side, DSL v5.0 may provide improved speech perception and bimodal benefit.

**Conflicts of interest,** This study was supported, in part, by Cochlear Research and Development Ltd.

ID: 03862

### Long-term cognitive prognosis of profoundly deaf older adults after hearing rehabilitation using cochlear implant

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**Keywords:** hearing loss, elderly, cognitive decline, rehabilitation, speech perception

**Background:** Peripheral hearing loss is the main potentially modifiable risk of dementia in older adults. However, the impact of hearing rehabilitation on cognitive function remains unknown. The aim of the study was to analyze

long-term cognitive status and function following cochlear implantation in profoundly deaf patients (CI).

**Material and method:** This prospective observational longitudinal study included 70 adults aged 65 years and older qualifying as candidates for a CI in ten academic medical centers referent for CI. Cognitive tests were administered before CI, and at 1 and >5 years post-CI. Evaluation comprised six tests assessing attention, memory, orientation, executive function, mental flexibility, and fluency. Cognitive status was determined as normal, mild cognitive impairment (MCI) or as dementia. Speech perception in quiet and noise was assessed using disyllabic words and quality of life using the Nijmegen Cochlear Implant Questionnaire.

**Results:** The mean follow-up was 6.8 years [5.5-8.5]. Speech perception scores and quality of life remained stable between 1- and 7-years post-CI. Before CI, 31 patients (45%) had MCI; only 2 developed dementia during the follow-up, 61% remained stable and 32% returned to normal cognition. Among the 38 patients with normal cognition, none developed dementia during the follow-up although 32% developed MCI.

**Conclusion:** Among older adults with a profound hearing loss, MCI is highly prevalent. Nevertheless, we observed a low rate of progression to dementia, and cognitive function improved in some patients with MCI at baseline. These results highlight that CI should be strongly proposed for the management of profoundly deaf patients, even in case of MCI. Profoundly deaf patients may have a specific subtype of MCI with a possible positive impact of hearing rehabilitation on neurocognitive functioning.

**Conflict of interest:** no.

ID: 03864

### Pupillometry assessment of speech recognition and listening experience in adult cochlear implant patients

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**Keywords,** listening effort, pupillometry, pupil dilation, speech-in-noise

**Background,** Cochlear implant users often report experiencing important levels of listening effort in everyday listening situations, and are confronted with difficulties maintaining high intelligibility performance, even in low noise levels. Today, outcomes of cochlear implantation are mostly evaluated through psychophysical testing. For a given performance level however, different individuals might expend very different levels of cognitive engagement and effort. The aim of the present study was to investigate the pupillary response to word discrimination in cochlear implant patients.

**Materials and methods:** Data from ten adult cochlear implant patients were analysed. Pupillometric measures were combined to speech recognition scores in quiet and in noise at +10 dB signal-to-noise ratio. The main outcome measures of pupillometry were mean pupil dilation, maximal pupil dilation, dilation latency and mean dilation during return to baseline or relaxation time. Subjective hearing quality was evaluated by means of one self-reported fatigue questionnaire, and the Speech, Spatial and Qualities of Hearing scale (SSQ).

**Results,** Analyses show that the peak dilation amplitude (mean pupil dilation and maximal pupil dilation) were higher during the speech-in-noise test. Average peak dilation was measured at 0.24 +/- 0.12 mm in noise vs. 0.20 +/- 0.09 in quiet and maximal peak value was 0.31 +/- .12 in noise vs. 0.26 +/- .10 in quiet. No significant effect of the noise on pupil dilation peak latency was observed. Moreover, the pupil diameter remained larger after word presentation (relaxation time) for incorrectly repeated phonemes (0.22 +/- 0.11 mm) than for correctly repeated phonemes, without influence of the noise (0.15 +/- 0.10 mm,  $p < .05$ ). Concerning the questionnaires, the mean pupil dilation during the relaxation phase was significantly correlated with the spatial subscale score of the SSQ ( $p < .002$ ), and with the global score ( $p < .002$ ).

**Conclusions:** The analysis of pupillometric traces provided interesting information about the different processes engaged in this task. Pupillometric measures were indicative of listening difficulty, phoneme intelligibility, and correlated with general hearing experience. These preliminary results show that pupillometry constitutes a promising tool to improve objective quantification of cochlear implant performance in clinical settings.

**Conflict of interest:** M.H., T.D., and M.A. are employees of Oticon Medical. No other conflict of interest exists for this study.

ID: 03878

## Cochlear implant outcomes in children with congenital inner ear anomalies

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**Keywords:** Cochlear Implant, Inner Ear Anomaly, Audiometric Results

**Background:** Inner ear anomalies are a surgical challenge in cochlear implantation and auditory outcomes may vary due to the exact inner ear malformation, complete or partial insertion of the cochlear electrode array, differences in operation techniques, as well as other neural and cognitive impairments. The aim of this study was to assess the auditory long term outcomes for a large group of pediatric cochlear implant recipients with inner ear malformations. Auditory outcomes were assessed using a variety of measures, including speech perception outcomes, mode of communication, usage of the CI and speech perception tests both in quiet and in noise.

**Material and Methods:** Retrospective review of 126 pediatric cochlear implant cases from 2002 to 2017 with known congenital inner ear malformations (CIEM) determined on high-resolution computed tomography (HRCT). All implantations were performed by two surgeons and the auditory outcomes were measured between 3-7 years post implantation. Most children underwent speech perception tests of bi-syllabic stimuli as well of sentences in a sound attenuated room in quiet and noise (SNR +10dB). In addition, the IT-MAISE questionnaire was administered and the Category of Auditory Perception (CAP) determined. Details of CI usage, and educational setting of the child were also collected.

**Results:** The majority (90%) of patients with CIEM continue to consistently use their CI while 7% reported intermittent use and only one patient is a non-user. Most of the patients (73%, n=62) use oral language, while 18% (n=15) use a mix of oral and Israeli Sign Language and 9% (n=8) use sign language exclusively. Only 8% (n=2) attended schools for children with special needs. Auditory function, based on CAP scores revealed that over 60% are categorized at level 5 and over (out of 7 total levels). The auditory perception scores of the bi-syllabic words as well as sentences in Hebrew ranged between a mean of 77% to 86.5%, respectively. In SNR+10 the scores deteriorated to a mean of 56% for the bi-syllabic words and 80.9% for sentences. Performance scores are comparable to their peer's recipients of CI without CIEM.

**Conclusions:** Cochlear implantation can be successfully performed in children with inner ear malformations. Significant auditory benefits can be expected. The various types of inner ear malformations may have quite different prognoses for good auditory performance.

ID: 03928

### Pediatric cochlear implant recipients as adults: a survey

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**Keywords:** Cochlear implants, communication modality, educational outcomes, occupational outcomes

**Background:** This study sought to identify how pediatric cochlear implantation influences communication modality, education, and income over time. We expected that young adults who had received cochlear implants as children would 1) report wearing their devices all waking hours, 2) use spoken language, 3) attend post-secondary programs, and 4) study a wide array of academic areas.

**Materials and methods:** Fifty-six young adults with cochlear implants participated in a telephone survey developed and conducted by a pediatric cochlear implant team. The survey covered five topics: communication, education, vocation, socioeconomic status, and other. All of the participants had severe to profound bilateral sensorineural hearing loss and most had prelingual congenital hearing loss. They received a unilateral cochlear implant at an average age of 10.6 (SD=4.64) and participated in the survey at 21.52 (SD=2.29) years old, on average. Where applicable, results were compared to the general population of individuals in the same Canadian province of Ontario.

**Results:** Most of the participants reported using their cochlear implants all waking hours (49/56, 88%) and using listening and spoken language as their primary means of communication (42/56, 75%). They attended post-secondary programs at higher rates than the general population ( $\chi^2(1)=14.35$ ,  $p<.001$ ) and studied a wide range of academic topics. The sample was less likely to be employed than the general population ( $\chi^2(1)=21.87$ ,  $p<.001$ ) but those who were employed reported salaries similar to their peers in Ontario at the time.

**Conclusions:** Young adults who received cochlear implants as children often chose to continue wearing their device and used spoken language. They attended post-secondary programs and had earnings similar to their peers. Future studies should investigate post-cochlear implant outcomes beyond speech, language, and audition to evaluate the effects of cochlear implantation on the lives of those who use them.

**Conflicts of interest:** Dr. Cushing: Speaker's Bureau – Interacoustics, Royalties Plural Publishing Editor: Balance Disorders in the Pediatric Population, Dr. Cushing & Dr. Papsin: Speaker's Bureau: Cochlear Co., Patent Holder: Patents #: 7041-0: Systems and Methods for Balance Stabilization, Sponsored Research Agreement - Cochlear Americas. The remaining authors have nothing to declare.

### Free Papers 03 - Cochlear implants II

ID: 03929

### Applying the deconvolution method in Nucleus CIs to better characterize spread of excitation

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**Keywords:** Cochlear implant; eCAP; spread of excitation; deconvolution

**Background:** Spread-of-excitation (SOE) in cochlear implants can be estimated objectively by measuring electrically evoked compound action potentials (eCAPs) with forward masking. Biesheuvel et al. (2016, *Ear Hear*, 37, 572581) proposed that the amplitude of these eCAPs is the result of the convolution of the excitation pattern of the fixed probe with that of the roving masker. We report preliminary findings using the deconvolution technique developed by Biesheuvel et al. to analyze SOE data collected with Nucleus CI recipients to produce excitation density profiles (EDP).

**Material and methods:** Subjects were Nucleus CI recipients in which SOE patterns were acquired. Both masker and probe stimuli were presented at all odd-numbered electrode contacts. Probe and masker current levels (CL) were set at 225 CL units for all recordings. This produced an 11 by 11 matrix of N<sub>1</sub>P<sub>1</sub> eCAP amplitudes for analysis using the method described by Biesheuvel et al.

**Results:** Preliminary data with ten cases indicates that the deconvolution technique is applicable to Nucleus CIs. The EDPs were relatively heterogeneous across patients; most cases showed higher eCAP amplitudes with wider EDPs for more apical electrode contacts. Further, the EDPs from the pre-curved CI532 electrode arrays tend to be narrower than these from the CI422 devices. Verifying this effect in our data collected with Advanced Bionics implants showed comparable results; the EDPs from Mid-Scala electrode arrays are narrower than these from 1J arrays. More data will be presented at the time of the conference.

**Conclusions:** Preliminary results indicate that the deconvolution technique is practical and also applicable in Nucleus CIs. The technique opens the way to a better characterization of neural responses and the potential for improved diagnostics.

**Conflicts of interest:** Authors CJJ and HM are employed by Cochlear, manufacturer of Nucleus cochlear implants. MVSGG is a consultant for Cochlear. Authors JDB, JHMF, JJB and have no conflicts to disclose.

**ID: 03933**

## Cochlear microphonic changes during cochlear implantation are consistent with hair cell survival and electrode contact on the basilar membrane

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**Keywords,** Cochlear implants, electrocochleography, basilar membrane, hearing level, audiometry

**Background,** The cochlear microphonic (CM) is produced by hair cells, and its latency increases from the base to the apex of the cochlea due to the travelling wave. Here we describe the absence of these latency changes at cochlear locations with substantial hearing loss, consistent with the loss of outer hair cells, in both clinical and pre-clinical animal experiments. In addition, we show disordered progression of the travelling wave consistent with basilar membrane fixation by the electrode array in a subset of patients with drops in cochlear microphonic amplitude during implantation.

**Materials and methods,** Intra-operative electrocochleography was recorded from the apical electrode during implantation in 103 recipients of Cochlear’s slim-straight lateral wall electrode (CI522). Patients had audiometric thresholds of between 20- and 100-dB HL at 0.5-kHz. Acoustic responses were recorded using a 0.5-kHz stimulus tone presented with alternating polarity at 100- or 110-dB HL. The cochlear frequency place (CFP) was derived from CT imaging. Audiometric outcomes were collected pre-operatively and 3-months post-operatively. Cochlear microphonic latency was measured across 4 electrodes in groups of noise-trauma and control guinea pigs.

**Results,** During implantation, 59 patients showed a drop of cochlear microphonic amplitude with a loss of hearing. For electrodes at the 1-, 2-, and 4-kHz CFP, the latency shift between adjacent electrodes (when stimulated at the characteristic frequency) was negatively correlated with hearing loss. There was a significant, negative correlation between CM latency shift amplitude and HL for 1-, 2- and 4-kHz when tested on electrodes 22, 14 and 10 respectively (Pearson’s *r* values of -0.7, -0.8 and -0.8). CM latency shifts were largest on apical electrodes (mean of 0.3-ms on electrode 22) and gradually decreased in size on more basal electrodes (means of 0.15- and 0.05-ms on electrodes 14 and 10).

**Conclusions,** We argue that: (1) the changes in latency of the cochlear microphonic could have resulted from damping of the basilar membrane, caused by contact with the electrode array, (2) a shift in latency between adjacent electrodes, measured post-operatively, is a biomarker for local outer hair cell survival.

**ID: 03934**

## Results of intraoperative ECochG during the insertion of two types of electrode array: Slim Modiolar & Straight Electrode

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**Keywords,** Cochlear implants, electrocochleography, peri-modiolar

**Background,** Sudden drops in cochlear microphonic amplitude during cochlear implantation are associated with poor preservation of residual hearing in lateral wall arrays. However, to-date there has been little reporting of intra-operative changes during the insertion of peri-modiolar electrode arrays, such as Cochlear’s slim-modiolar CI532. Here we compare intra-operative electrocochleography in a large population of lateral wall CI522 recipients and CI532 recipients.

**Materials and methods,** Intra-operative electrocochleography was recorded from the apical electrode during implantation of 103 recipients of the lateral wall electrode (CI522) and 22 recipients of the peri-modiolar array (CI532). Patients had audiometric thresholds of between 20- and 115-dB HL at 0.5-kHz. During implantation, acoustic responses were recorded using a 0.5-kHz stimulus tone presented with alternating polarity at 100- or 110-dB HL. After insertion of the array, electrocochleography was recorded from every second electrode from the tip to the base of the array, using stimuli from 0.25- to 2-kHz and of 20- to 110-dB HL. Electrocochleography recordings were repeated 3-months after implantation. Audiometric outcomes were collected pre-operatively, then 3-months post-operatively.

**Results,** Detectable electrocochleographic responses were recorded in 83/103 CI522 recipients, compared with 17/22 CI532 recipients. 61/83 CI522 recipients showed a drop in cochlear microphonic amplitude after implantation, compared with 7/17 of the CI532 recipients. In both groups, most CM drops occurred during past 18-mm in the insertion (45% of the CI522 (15/34) and 60% (6/10) of the CI532 groups). In the CI532 group, drops in cochlear microphonic amplitude were found to occur during the insertion of the electrode sheath, as well as during advancement of the electrode array. In the CI532 drop group, post-operative residual hearing loss occurred primarily at high-frequencies.

**Conclusions,** Cochlear microphonic drops are detected during insertion of lateral wall and peri-modiolar arrays at similar rates, and at a similar point during the insertion. However, there are some differences in post-operative hearing loss that suggest different mechanisms. There is evidence of these drops occurring early during CI532 insertion, during the insertion of the sheath. Particular care must be taken during these recordings to ensure electrical connectivity early enough to detect these events.

**ID: 03935**

### Intra-op hearing preservation monitoring using electrocochleography

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**Keywords,** Cochlear implants, electrocochleography, residual hearing

**Background,** Intra-operative electrocochleography has recently shown promise as a tool for predicting hearing preservation during cochlear implantation. Sudden decreases in the cochlear microphonic, a potential derived from electrocochleography, during cochlear implantation are associated with poor preservation of residual hearing post-operatively. Here we correlate cochlear microphonic preservation with hearing preservation in a large population of patients receiving Cochlear's slim-straight lateral wall electrode array, and discuss important factors when considering who is eligible for monitoring of the cochlear microphonic, and how to identify sudden decreases associated with post-operative residual hearing loss.

**Materials and methods,** Intra-operative electrocochleography was recorded from the apical electrode during implantation in 103 recipients of Cochlear's slim-straight lateral wall electrode (CI522). Patients had audiometric thresholds of between 20- and 100-dB HL at 0.5-kHz. Acoustic responses were recorded using a 0.5-kHz stimulus tone presented with alternating polarity at 100- or 110-dB HL. Electrocochleography recordings were repeated 3- and 12-months after implantation. Audiometric outcomes were collected pre-operatively, then 3- and 12-months post-operatively.

**Results,** Sixty-one patients showed a drop in cochlear microphonic amplitude after implantation, with 22 patients showing no drop. Loss of residual hearing at 500-Hz was significantly greater in the drop group (median of 40-dB) than the no drop group (median of 12.5 dB). The microphonic was not detectable in 20 patients. A receiver-operator curve analysis suggests a cut-off for the drop condition of 60% reduction in microphonic amplitude. The presence of a detectable cochlear microphonic was significantly correlated with high-frequency audiometric thresholds, but not low-frequency thresholds.

**Conclusions,** Cochlear microphonic drops detected during implantation were significantly correlated with poorer preservation of residual hearing. Good high-frequency audiometric thresholds allowed an earlier detection of the cochlear microphonic to facilitate monitoring.

**ID: 03945**

### Noise reduction algorithm ForwardFocus – subjective feedback

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**Background:** The novel noise reduction algorithm ForwardFocus was assessed with cochlear implant (CI) recipients using the CP1000 sound processor. This algorithm is designed to reduce background noise from behind the listener using microphone directionality processing. ForwardFocus in the CP1000 offers in contrast to CP800 and CP900 additional possibilities of improving speech comprehension in noisy situations. The Background Noise Reduction (SNR-NR) in the CP900 is developed to reduce steady-state background noises irrespective of their direction. We investigated the subjective satisfaction of CI patients using different noise reduction algorithms on the basis of the Hearing Implant Sound Quality Index (HISQUI<sub>19</sub>) when upgrading from CP800 to newer speech processor versions.

**Material and Methods:** 20 adult CI patients were upgraded from CP800. They were equipped with CP1000 sound processor with standard SmartSound Options and the possibility to activate ForwardFocus, as well as with CP900 sound processor with SNR-NR. Patients received speech processors in randomized order. Programming was followed by a 2-3 weeks take-home phase. At each clinic visit the patients completed the HISQUI<sub>19</sub> for subjective rating of their perceived sound quality.

**Results:** In most cases the HISQUI score for the CP1000 sound processor shows slight improved hearing quality compared to CP900 or CP800 sound processor.

**Conclusion:** There was found significant improvement in speech perception using ForwardFocus. The HISQUI reflects these improvements, but in an indistinct way.

**Conflicts of interest:** Th. Hocke is employee of Cochlear. The other authors report no conflict of interest.

ID: 04008

## Impact of cochlear implantation on quality of life – longitudinal study

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**Keywords:** cochlear implant; quality of life; Nijmegen Cochlear Implant Questionnaire

**Background:** Evaluation of the effectiveness of cochlear implantation should include self-assessment instruments, such as quality of life questionnaires. The aim of this study was to monitor self-assessment of quality of life in individuals with post-lingual severe to profound sensorineural hearing loss who underwent cochlear implantation.

**Material and methods:** 11 participants with post-lingual severe to profound sensorineural hearing loss were evaluated on three moments: before cochlear implantation, one month and six months after cochlear implant activation. The instrument used was the *Nijmegen Cochlear Implantation Questionnaire*.

**Results:** Mean results on all of the six subdomains show great improvement, comparing the first and second moments, indicating a strong positive impact of cochlear implantation. The third moment shows mean results slightly higher than the second moment. 4 participants showed higher results in the second moment and a decrease in the third moment.

**Conclusion:** The results with the Nijmegen Cochlear Implantation Questionnaire on the three moments show a clear positive impact of cochlear implantation on quality of life. Implications for intervention will be discussed.

**Conflicts of interest:** The authors declare that there are no conflicts of interest.

ID: 04009

## Translation and cultural adaptation of the Nijmegen Cochlear Implant Questionnaire into European Portuguese

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**Keywords:** cochlear implant; quality of life; hearing impairment

**Background:** Quality of life is increasingly being viewed as important in the context of evaluating health results.

Using quality of life data allows complementing the assessment of the impact of a health condition or of a treatment. Regarding cochlear implantation, the *Nijmegen Cochlear Implant Questionnaire* is a widely used quality of life instrument. The aim of this study was the translation and cultural adaptation of that instrument.

**Material and methods:** Based on literature, the following steps for the translation and cultural adaptation of the instrument were established: (1) preparation, by obtaining authorization to use the instrument and inviting the team responsible for its development to be involved in the process; (2) translation, with the completion of two independent translations; (3) translation reconciliation, by creating a single version of the questionnaire, solving the discrepancies between translations; (4) back translation, with the completion of two independent translations of the version created in step 3; (5) back translation analysis and expert panel, by creating a single back-translated version, submitted to the evaluation of the team responsible for the development of the instrument, as well as the confrontation, performed by an expert panel, of all the translations, back translations, original version and feedback from the team responsible for the development of the instrument; (6) harmonization by the expert panel, with the development of the pre-final version; (7) test of the pre-final version, with a group of individuals representative of the target population; (8) review of the results of the pre-final version and finalization, by performing the necessary alterations; (9) final review; (10) final report.

**Results:** The steps established for the translation and cultural adaptation of the instrument were concluded. The title of the instrument in European Portuguese is “*Questionário sobre Implantação Coclear de Nijmegen*”.

**Conclusion:** The *Nijmegen Cochlear Implant Questionnaire* was translated and culturally adapted into European Portuguese. Validation of the instrument is being currently performed.

**Conflicts of interest:** The authors declare that there are no conflicts of interest.

ID: 04010

## The impact of cochlear implantation on third-party hearing loss-related quality of life – longitudinal study with spouses

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**Keywords:** Third-Party Disability Associated With Hearing Loss; Hearing Impairment; Significant Other

**Background:** Spouses of individuals with hearing loss experience third-party disability. The aim of this study was to monitor third-party hearing loss-related quality of life in spouses of individuals with post-lingual severe

to profound sensorineural hearing loss who underwent cochlear implantation.

**Material and methods:** 11 participants, spouses of individuals with post-lingual severe to profound sensorineural hearing loss, were evaluated on three moments: before cochlear implantation, one month and six months after cochlear implant activation. The instrument used was the *The Hearing Impairment Impact – Significant Other Profile*.

**Results:** Mean results show decrease in third-party disability associated with hearing loss that, on average, was moderate before cochlear implantation and was mild six months after cochlear implant activation.

**Conclusion:** Cochlear implantation has a positive impact on third-party hearing loss-related quality of life in spouses. Implications for intervention will be discussed.

**Conflicts of interest:** The authors declare that there are no conflicts of interest.

ID: 04011

### Translation and cultural adaptation of The Hearing Impairment Impact – Significant Other Profile into European Portuguese

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**Keywords:** Third Party Disability Associated With Hearing Loss; Hearing Impairment; Significant Other

**Background:** Spouses experience activity limitations and participation restrictions as a result of sharing their lives with an individual with hearing loss. *The Hearing Impairment Impact – Significant Other Profile* is an instrument that measures third-party hearing loss-related quality of life in spouses of people with hearing loss. The aim of this study was the translation and cultural adaptation of that instrument.

**Material and methods:** Based on literature, the following steps for the translation and cultural adaptation of the instrument were established: (1) preparation, by obtaining authorization to use the instrument and inviting the team responsible for its development to be involved in the process; (2) translation, with the completion of two independent translations; (3) translation reconciliation, by creating a single version of the questionnaire, solving the discrepancies between translations; (4) back translation, with the completion of two independent translations of the version created in step 3; (5) back translation analysis and expert panel, by creating a single back-translated version, submitted to the evaluation of the team responsible for the development of the instrument, as well as the confrontation, performed by an expert panel, of all the translations, back translations, original version and feedback from the team responsible for the development of the instrument;

(6) harmonization by the expert panel, with the development of the pre-final version; (7) test of the pre-final version, with a group of individuals representative of the target population; (8) review of the results of the pre-final version and finalization, by performing the necessary alterations; (9) final review; (10) final report.

**Results:** The methodology established for the translation and cultural adaptation of the instrument was concluded. The title of the instrument in European Portuguese is “*Perfil do Impacto da Dificuldade Auditiva no Parceiro Comunicativo*”.

**Conclusion:** *The Hearing Impairment Impact – Significant Other Profile* was translated and culturally adapted into European Portuguese. Validation of the instrument is currently underway.

**Conflicts of interest:** The authors declare that there are no conflicts of interest.

### Free Papers 04 - Auditory Processing Disorders I

ID: 03942

### Normalization and evaluation of the UCAST-FW - an adaptive low-pass filtered speech test of APD

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**Keywords:** auditory processing disorder, low-pass filtered speech test

**Background:** Low-pass filtered speech tests, in which stimuli are degraded using a low-pass filter (LPF), are one class of low-redundancy test commonly used in the diagnosis of auditory processing disorder (APD). One example of this type of test is the University of Canterbury Adaptive Speech Test – Filtered Words (UCAST-FW; O’Beirne, McGaffin, & Rickard, 2012). While the UCAST-FW is sensitive enough to discriminate between children with and without APD (Rickard, Heidtke & O’Beirne, 2013), the variance in the spectral content of its individual test items results in those items being heterogeneous in regards to performance under the same levels of filtering. To quantify and compensate for this inter-item variability, we developed a novel method of normalisation which takes into account both the SRT and the slope function for each test word, to ensure that a given level of low-pass filtering will produce the same average level of word recognition performance regardless of the test word. To establish normative data that would enable the test to be used clinically, we also sought to quantify the maturation effect identified by O’Beirne et al., 2012.

**Material and methods:** Thirty English speaking adult listeners with normal hearing were examined on their ability to discriminate low-pass filtered speech stimuli before

normalisation. Psychometric functions were generated for each word and used to calculate relative LPF adjustments, which were then assessed with a further 31 participants. To gather normative data for the normalized test, the performance of 143 normal-hearing English speaking children (aged 6 to 12) was examined.

**Results:** Test items that performed poorly were identified, enabling them to be removed from the test. After excluding outliers, normalization reduced the standard deviation of the midpoint LPF values (equivalent to the SRT) by 36% in the open-set condition, and by 46% in the closed-set condition. Regression analysis demonstrated a significant effect of age on the LPF score, and allowed the generation of age-appropriate normative data.

**Conclusion:** Results from this study show this normalization technique was successful in achieving a more homogenous word list for both open and closed set testing paradigms, resulting in a more normally-distributed cluster of psychometric functions.

**ID: 03958**

### Auditory Skills Informal Protocol: pilot study

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**Keywords:** Auditory Skills, evaluation, school children

**Background:** Auditory skills play an important role in reading and writing learning, so the identification of deficits in the auditory processing is central in children of school age.

**Material and methods:** Evaluation of Auditory Skills with the Auditory Skills Informal Protocol, with children of the 1<sup>st</sup> to the 5<sup>th</sup> grade, with no intellectual and hearing impairment. Data will be analysed in the IBM SPSS program (means, standard deviations, 25<sup>th</sup> and 75<sup>th</sup> percentiles, minimums, maximums, and others).

**Results:** A total of 100 children were evaluated (20 of the 1<sup>th</sup> grade, 21 of the 2<sup>th</sup> grade, 19 of the 3<sup>th</sup> grade, 21 of the 4<sup>th</sup> grade and 19 of the 5<sup>th</sup> grade). Some of them were excluded due to intellectual/auditory deficits.

**Conclusion:** Auditory Skills Informal Protocol showed to be a reliable instrument that allows an informal evaluation of children from 1st to 5th year, allowing the identification of children at risk for auditory processing disorder. After this evaluation it is possible to refer children at risk for a complete and formal assessment of auditory processing with a specialist in this area.

**ID: 03963**

### Characteristics of children who are referred to the Auditory Process Disorder (APD) clinic – the Nutfield experience

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**Keyword:** auditory process disorder, paediatric auditory service, paediatric auditory

**Background:** Referral criteria and diagnostic protocol for auditory process disorder service differ across clinical settings. We aim to evaluate the yield of our existing referral criteria along with the diagnosis tests protocol and multidisciplinary approach in our routine APD clinic to determine their effectiveness. The characteristics and psychometric profiles of the children in the clinic are also analyzed.

**Method:** Retrospective chart review of patients who were seen in a tertiary care highly specialized auditory process disorder clinic at the Nuffield Hearing and Speech centre for paediatric in Royal National Throat Nose Ear Hospital (United Kingdom) during January – June 2018 was conducted. The clinic was led by a highly specialized paediatric audiovestibular medicine consultant.

**Result:** A total of 28 patients were seen. 15/28 (53.6%) of the patients were diagnosed with APD. 15/15 (100%) of the cases fulfil the British society of Audiology diagnostic guideline for APD. 5/28 (17.8%) had auditory difficulty diagnosis (since only one category of APD test abnormality was found ie only non-speech or speech test). 2/28 of the cases needed further follow up to complete the tests battery due to contraindications e.g. such as otitis media. A total of 5/6 of the cases without APD diagnosis were referred for further assessment of other possible conditions: dyslexia (2), ADHD (2) and depression (1). A total of 12/15 cases with APD diagnosis had/were referred for further assessment of other conditions: learning difficulty LD(6), difficulty with working memory(5), autism(2), speech and language difficulty(4), anxiety(3), motor delay(1), neurodevelopmental delay(1).

**Conclusion:** By means of appropriate referral criteria and diagnosis tests protocol, paediatric APD clinical service can effectively identify patients with APD with high yield. Due to multiple co-morbidity of the patients, multidisciplinary team approach should be the best way forward in the standard of care for our paediatric APD population.

ID: 04031

## Comparison of auditory processing skills between children with unilateral hearing loss and children with normal hearing

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**Keywords:** Unilateral Hearing Loss, Central Auditory Processing Disorders, Cortical Auditory Evoked Potential, Frequency Pattern, Duration Pattern

**Background:** Unilateral hearing loss limits communication activities in noisy environments and can cause auditory processing impairments that may potentially affect language and communication development. The aim of our study is to compare auditory processing skills of children with unilateral hearing loss and children with normal hearing.

**Material and Methods:** 28 unilateral hearing loss individuals (mean age  $12.36 \pm 3.03$ ) and 26 individuals with normal hearing (mean age:  $11.96 \pm 2.76$  years) were included in the study that the ages are between 8-16. Both groups were assessed by the Matrix Test, Cortical Auditory Evoked Potential (CAEP), Frequency Pattern (FP) and Duration Pattern (DP) tests.

**Results:** Speech Reception Threshold (SRT) and Speech Discrimination Scores gave worse results in both the adaptive and nonadaptive conditions of the Matrix Test in children with unilateral hearing loss ( $p < 0,001$ ). There were significant delays in latencies of children with unilateral hearing loss than children with normal hearing in CAEP. In FP and DP tests, scores were significantly lower in children with unilateral hearing loss than in children with normal hearing ( $p < 0,001$ ).

**Conclusion:** The results showed that congenital unilateral sensorineural hearing loss could be a risk factor for auditory processing disorder. In order to ensure that these children are able to use their receptive language skills in the listening environment in noise, the necessary amplification methods and assistive listening devices should be used. It was observed that the need to focus more on unilateral hearing loss.

ID: 04076

## The possible effects on auditory processing skills due to conductive (fluctuating) hearing loss

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**Keywords:** Conductive Hearing Loss, Auditory Processing

**Background,** The effects of fluctuating hearing loss on auditory processing skills in children with and without otitis media with effusion (OME hereafter) remain underexplored and results rest unequivocal due to methodological differences and documentation of hearing loss usually accompanying OME. The current prospective investigation examined under a general umbrella project on the linguistic sequelae of OM, focused on auditory processing skills (AP) in youngsters with and without positive history of OM accompanied by fluctuating hearing loss. Given that a stable auditory/acoustic input during the critical years of language development is a precursor to the development of a stable and typical speech perception system, we hypothesized that children with positive OME history would differ significantly on AP parameters as compared to their typical non-OME controls.

**Method,** Participants were twenty subjects (+OME = 10; -OME = 10) aged between 8-10 years assessed on a number of AP testing parameters including Dichotic and Gaps in Noise. Tone and Speech Audiometry were also used in the assessment process.

**Results,** Preliminary data analyses suggested significant group differences and predicted. A more detailed analysis as a function of group and isolated parameters will be conducted in an attempt to examine specific effects of OME on particular AP skills between the two groups. Furthermore, several other variables will be examined including OME laterality, age of onset and the time lapse between onset and possible diagnosis and treatment.

**Conclusion,** it can be concluded therefore that the above possibly indicates the effects of fluctuating hearing loss in the children's auditory processing skills. This could possibly indicate an area of further research in terms of early intervention in such cases through auditory training therapies at the early stages of diagnosis, possibly leading to the avoidance or prevention of difficulties at a later stage of their learning.

ID: 04109

### Case report: The use of Musical Auditory Training for an actor with tuning and memorizing texts difficulties

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**Background:** For a satisfactory understanding of speech, specially with competitive sounds, it is necessary a good functioning of the peripheral, central system and superior functions like attention, memory and language. To improve the perception of the speech and music, the most important abilities of central auditory processing are figure-background and temporal patterns. Changes in these can affect the life of people with or without hearing loss. In the last decade, the use of music has increased in the auditory rehabilitation, generating good results in the improvement of the central auditory abilities. Based on this, Freire (2015) developed the Musical Auditory Training (TAM), a 100% online training, created to support central auditory disorders through the practice of challenging exercises which use instrumental sounds and music to train the brain to listen better. This study's goal is to check T.A.M.'s efficiency in an actor with normal auditory thresholds, but deficits in figure-background and temporal patterns, and complaints of out of tune and texts memorization.

**Material and Methods:** Transversal analysis of an actor with some difficulties related above. The training was performed in acoustic booth and free field using the T.A.M., involving abilities of figure-background, temporal processing and auditory memory. Training structure: 8 exercises with 1300 variations, 10 sessions, 1 hour, once a week, supervised by an audiologist, 30 minutes of daily training by the patient himself at home and a complementary exercise, reading aloud texts with competitive noise,

**Results:** Improvement in the figure-background ability, signal-to-noise ratio -15dB, from 50% to 70% in the right ear and from 40% to 80% in the left, the frequency pattern and temporal ordering in the naming pattern increased from 70% to 87%, when compared pre and post training. The duration-naming pattern achieved 77.5% of 100% of hits. The auditory ability of temporal resolution showed an average improvement from 5ms to 4.25ms, better results while performing in the theater, improvement in speech therapy for voice work, reaching tones that he could not reach before, singing has improved, communicates himself better especially in noisy environments, memorizing texts flow better, watching movies with subtitles feels safer and less anxious.

**Conclusions,** T.A.M. has proved to be an effective tool to be used in the therapeutic process of actors and musicians who have central auditory disorder processing and tuning difficulties.

Free Papers 05 - Age Related Hearing Loss

ID: 03780, 03801

### Can you hear me? Audiology protocols in diagnosis and treatment of aphasia

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**Background:** Stroke is a major cause for disability in adults, and its frequency increases with age. While stroke might cause hearing loss, usually, stroke that causes aphasia does not involve hearing loss, because the loci of lesions are different. However, since in many cases aphasia (due to stroke) occurs in old age, and because the prevalence of age-related hearing loss is high and increases with age, it is reasonable to assume that a large proportion of adults with aphasia may also have some degree of hearing loss. Difficulties and errors in perception and comprehension of speech are a major consequence of untreated hearing loss. Oral communication has a crucial role both in diagnosis and in language treatment. Thus, for aphasic patients with hearing loss, the assessment of language abilities might be inaccurate, and their difficulties during treatment can be more severe. Moreover, effective oral communication with post-stroke patients is relevant also in other rehabilitation treatments – physical therapy, occupational therapy, etc.

**Objectives:** The aim of the current study was to investigate the awareness of speech-language pathologists to the hearing status of patients with aphasia, and to map the actions taken to diagnose and rehabilitate hearing during language treatment.

**Method:** We applied clinicians, who work with people with aphasia, through professional social networks. Clinicians who gave their consent to take part in the survey were asked to answer a series of questions regarding their awareness of their patients' hearing status, and actions they take when hearing loss is suspected or identified. The questions referred to the existence of structured protocols for hearing screening, use of audiometers and providing amplification in the clinic when required. Fifty-two speech-language pathologists who work with patients with aphasia in rehabilitation hospitals, community rehabilitation centers and private clinics, filled out the questionnaires.

**Results:** The results indicated large variance in awareness and knowledge among speech-language pathologists regarding hearing impairments and amplification devices.

**Discussion and implications:** Many speech-language pathologists who work with aphasic patients are not aware of and do not consider the possibility that their patients might have hearing loss in addition to aphasia, and that evaluation of patients' hearing status is not included in the diagnosis and treatment protocols.

ID: 03912

## Cognition of older adults with late onset hearing loss compared to matched controls with age appropriate hearing

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**Keywords:** older adults, cognitive performance, hearing impairment, age appropriate hearing, depressive problems.

**Objective:** To evaluate the cognitive performance of older adults with late onset hearing loss in comparison to peers with age appropriate hearing. Additionally, we explored whether the extent of the hearing loss predicted the cognitive performance and whether cognitive differences between both groups are mediated via depression.

**Methods:** The study group of this prospective cohort study consisted of 30 older adults with a hearing loss from adulthood on and a clear indication for cochlear implantation. A nonclinical, matched control group consisted of 30 peers with age appropriate hearing. Medical and audiometric examinations, neurocognitive tests and an assessment of anxiety and depression were performed. Primary outcome was a potential cognitive difference between both groups. Secondary outcomes were a potential associations between hearing loss and cognitive performance and the mediator quality of depressive status

**Results:** Participants with and without hearing impairment did not differ significantly in the Mini Mental State Examination as our inclusion criteria demanded, and in the figural memory tasks. However, hearing impaired older adults performed significantly worse in the Clock Drawing Test, verbal memory, Stroop task and Trail Making Task (TMT). In the TMTB specific impairment in conditions involving cognitive flexibility was observed. Cognitive test scores in the hearing impaired were not related to the extent of their hearing loss. However, hearing-impaired participants were more depressed than normal hearing older adults. The specific impairment in cognitive flexibility in the TMT was mediated via the severity of depressive problems.

**Conclusion:** Older adults with late onset of hearing loss show widespread impairments in cognitive performance, specifically when verbal stimulus material is considered. Additional impairments in cognitive flexibility can be attributed to depressive problems.

**Conflict of interest statement:** This study was supported by grants of the International Hearing Foundation and by Cochlear™.

ID: 03936

## Age-related changes in the auditory function studied by extended audiometric examination

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**Keywords:** presbycusis, central hearing loss, temporal processing, software-based audiometry

**Background:** Presbycusis, a common sensory deficit in the elderly, is associated mainly with peripheral ailment manifested in elevated hearing thresholds. However, the often-reported deterioration of speech understanding cannot be completely explained by worsened audiograms, thus a central component of the hearing pathology is proposed. We aim to better characterize the presbycusis with respect to both peripheral and central pathologies using an extended battery of tests.

**Material and methods:** Elderly subjects with various degree of hearing loss underwent several audiometric tests (high frequency audiograms in quiet and noise, speech recognition thresholds in quiet and noise, recognition thresholds of gated speech, sensitivity to interaural disparities, detection thresholds of frequency modulation, detection thresholds of gap in noise, difference limen for intensity). Average values were compared with those obtained in young healthy volunteers. In addition, correlations of selected parameters were studied to reveal possible presbycusis subtypes.

**Results:** To perform the measurements, a universal extensible audiometric apparatus was designed and constructed, based mostly on commercially available components. This device is controlled by modular software solution offering a wide variety of tests and measuring conditions. The comparison of results obtained in young and elderly groups shows an age-related decline in auditory parameters associated with both peripheral and central functions. However, elderly subjects may suffer from ailments at different levels of the auditory system – we identified those with functionally almost intact periphery, as well as those with almost unaffected central processing. Furthermore, importance of temporal processing for comprehension of speech (especially in difficult conditions) is apparent.

**Conclusion:** Age-related hearing loss is a complex ailment affecting various parts of the auditory system. Despite that

worsened audiograms, suggesting mainly peripheral disorder, remain its most common expression, central auditory processing is also influenced to different degrees. Furthermore, the peripheral and central aspects of the age-related deterioration of hearing seem to be largely independent on each other. The results accentuate the importance of more complex auditory examinations extending beyond the routine pure-tone audiometry.

**ID: 04105**

### Age-related treatment effect on sudden hearing loss

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**Keywords:** sudden hearing loss, medical treatment, age, hearing loss configuration

**Aim:** To investigate the age on the results of treatment in patients with idiopathic sudden hearing loss (SHL).

**Material-Method:** 40 patients who were diagnosed with SHL were retrospectively reviewed. Twenty patients under the age of 40 (group 1) and 20 patients over the age of 40 (group 2) were included in the study. Patients were evaluated in terms of age, degree of hearing loss and configuration. The healing rate criteria for the patient's hearing loss before and after treatment were specified by the Special Committee of the Ministry of Health, Labor and Social Security of Japan (Ad Hoc Committee of the Japanese Ministry of Health, Labour and Welfare/MHLW). IBM SPSS 20 version was used for statistical analysis.

**Results:** The average age of the 40 cases in total comprising of 14 women and 26 men is  $46.45 \pm 2.1$  (average of the 1st group, younger than 40 is  $24.8 \pm 2.1$ ) and  $54.2 \pm 1.3$  (average of the 2nd group is  $54.2 \pm 1.3$ ). All the cases have unilateral hearing loss with involvement of right ear in 11 out of 20 patients and left ear in the remaining 9 patients within the 1st group and involvement of right ear in 12 out of 20 patients and left ear in the remaining 8 patients within the 2nd group. Upon examination of all the patients, involvement of right and left ears was diagnosed respectively in 23 and 17 of them. Involvement of right and left ears was seen respectively in 23 and 17 out of the all cases. Audiometric configuration was seen respectively at rising type in 8 patients (40%), flat type in 9 patients (45%), sloping type in 3 patients (15%) out of 20 within the 1st group and at rising type in 4 patients (20%), flat type in 12 patients (60%) and sloping type in 4 patients (20%) out of 20 patients within the 2nd group. In total, flat type, rising type and sloping type audiometric configurations exist respectively in 21, 12 and 7 ears. According to the criteria determined by MHLW, complete recovery, significant recovery, moderate recovery and no recovery were seen respectively in 9 patients (45%), 6 patients (30%) and 3 patients (15%) and 2 patients (10%) out of 20 patients within the 1st group and significant recovery, moderate recovery and no recovery were seen respectively in

5 patients (25%), 10 patients (50%) and 5 patients (25%) out of 20 patients within the 2nd group.

**Conclusion:** it was found that there was a statistically significant improvement of the rate of recovery with patients under 40 years of age, while the rate of recovery in patients over 40 years was found to be lower. There was no significant difference between audiologic configuration and healing in sudden hearing loss.

**ID: 04139**

### Identification of hearing loss through a single question

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*Erasmus MC*

**Objective:** As hearing loss (HL) is a frequent problem in the elderly, it is investigated in many cohort studies. Pure tone audiometry, the gold standard, is time-consuming and costly. We investigated how well two single questions correlate with, and are able to identify pure-tone audiometry defined HL.

**Methods:** This study was done within 4,906 participants of the Rotterdam Study. Q1: 'Do you have any difficulty with your hearing (without hearing aids)?'; Q2 'Do you have any difficulty with a conversation with 3 or more persons?', with the following possible answers: never, sometimes, often and daily. Univariable linear regression models were fitted with hearing threshold (pure-tone average 0.5, 1, 2 & 4 kHz) and Q1 or Q2. Subsequently in a multivariable linear regression sex, age and education were added. The clinical ability of either question to identify HL (pure-tone average  $\geq 25$ dB), taking sex, age and education into account, was investigated through a logistic regression model creating prediction estimates which were plotted in receiver operating curves.

**Results:** The variance explained ( $R^2$ ) by the univariable regression was highest for Q1 (0.36) than for Q2 (0.13). When adding sex or educational level to the regression the  $R^2$  did not change, age increased the  $R^2$  (Q1: 0.55 and Q2: 0.36, respectively). When all three factors were added the  $R^2$  slightly increased (Q1: 0.56 and Q2: 0.39 respectively). The identification of clinically significant HL of Q1 was better than Q2 (AUC: 0.77 (95%CI: 0.75, 0.78) and 0.64 (95%CI: 0.62, 0.66) respectively). The ability to identify HL substantially increased, with AUC-values up to 0.85 (95%CI: 0.84, 0.87) and 0.82 (95%CI: 0.80, 0.83) respectively, when sex, education and age were added.

**Conclusions:** Q1 has a high discriminatory value to detect hearing problems in older adults, in combination with most importantly age, and additionally sex and educational level. This question might be a valid alternative to estimate or screen for hearing loss if audiometric testing is not possible.

ID: 04150

## Restoration of sensory input may improve cognitive and neural function

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**Keywords,** Amplification; Hearing aids; Cortical auditory evoked potentials; Older adults; Age-related hearing loss; Frequency Following Response

**Background,** Age-related hearing loss (ARHL) is one of the most prevalent chronic health conditions among the elderly and its incidence is expected to increase with the aging of the population. Hearing loss is independently associated with accelerated cognitive decline. Specifically, working memory performance declines with age, and the decline is accelerated with hearing loss. What remains unknown is the mechanistic basis of the association between hearing loss and decreased cognitive function and the potential for offsetting cognitive decline through hearing rehabilitation. To that end, we asked whether the restoration of sensory input through the use of hearing aids would improve cognitive and auditory neural function.

**Materials and Methods,** 32 older adults with age-related sensorineural hearing loss between the ages of 62-82 with no prior history of hearing aid use were fit with hearing aids. The experimental group wore the hearing aids for a period of six months and the control group did not use their fitted hearing aids during this period of time. All participants were tested with the same pre-test measures and were seen again for an identical post-test session after six months. Outcome measures included working memory assessments and electrophysiological cortical and mid-brain recordings to the speech sound /ga/ in quiet condition and noise conditions. Recordings were conducted in aided and unaided conditions.

**Results,** The use of hearing aids enhanced working memory performance and increased cortical response amplitudes. Midbrain peak latencies remained stable in the experimental group but were significantly delayed in the control group after six months. Significant correlations between behavioral and physiological changes were also observed.

**Conclusion,** These results suggest a neural mechanism for the sensory-cognitive connection and underscore the importance of providing auditory rehabilitation for individuals with age-related hearing loss to improve cognitive and neural function. The findings of the current study provide evidence for clinicians that the use of HAs may prevent further loss of auditory function resulting from sensory deprivation.

**Conflict of interest,** None to be disclosed.

Free Papers 06 - Audiologic Diagnosis

ID: 03784

## Can high-frequency audiometry “unhide” hidden hearing loss?

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**Key words:** high-frequency audiometry, hidden hearing loss, cochlear synaptopathy.

**Background:** Current audiological literature refers to a group of terms such as “hidden hearing loss”, “selective dysacusis”, “obscure auditory dysfunction”, “cochlear synaptopathy”, “King-Kopetzky syndrome”, “idiopathic discriminatory dysfunction”, “auditory processing disorder”, “auditory disability with normal hearing”, “speech perception in noise impairment with a normal audiogram”. All this rather uncertain terminology describes a certain patient that visits ENT outpatient wards complaining of hearing difficulty at conversational speech level with normal pure-tone audiogram. We aim at presenting the results of the evaluation of thresholds of high-frequency audiometry in such patients.

**Material and methods:** Patients visiting the ENT outpatient ward of General Hospital of Ikaria that were complaining of hearing difficulty either in noisy or quiet environments but proved to have thresholds in pure-tone audiometry within normal range underwent high-frequency audiometry. Our instrument was a clinical audiometer Orbiter 922, version 2 equipped with standard headphones TDH 39 and supra-aural earphones Sennheiser HAD 2000.

**Results:** Thirty-four patients and consequently sixty-eight ears fulfilled the above mentioned criteria and were therefore included in this study. The average observed thresholds for the frequencies of 10kHz, 12.5kHz, and 16kHz were 9.48dB, 15.35dB, and 29.17dB consequently. The extra time that took us to perform high-frequency audiometry was less than 7 minutes in all cases.

**Conclusion:** High-frequency audiometry is a fast reliable examination that can transform the subjective hearing difficulty of patients with normal pure-tone audiograms into objective measurements in every day audiological practice. The most sensitive frequency proved to be the 16kHz.

**Conflicts of interest:** none.

ID: 03847

## Hearing effects of prolonged exposure to the hyperbaric environment in professional divers

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**Background:** Professional divers are exposed to major changes in atmospheric pressure. The structures of the whole ear are subjected to strong pressure. The middle ear needs to compensate for this pressure to maintain isobaric balance through the correct functioning of the Eustachian tube.

**Objectives:** The objectives of this study were to verify the effect of continuous exposure to the hyperbaric environment in the ear, and consequently the hearing, through an audiological study before and after the frequency of a diving course and to verify if it is possible to detect early lesions in the auditory system due to the hyperbaric environment in order to minimize its consequences.

**Material and methods:** Tympanogram, acoustic reflexes, simple tonal audiogram and otoemissions by distortion products (OEAPD) were carried out on 15 students of the Diving School of the Spanish Armada. The examinations were carried out before and after the frequency of the diving course. The students included in the study had no prior exposure to the hyperbaric environment or otologic background.

**Results:** The participants reported that during the course they felt otalgia (53.33%), tinnitus (20%), nausea and imbalance (20%). At the end of the course, the thresholds of stapedic reflexes and auditory thresholds were higher than at the beginning of the course, with statistically significant differences. There were no changes in the tympanogram or in the DPOAE.

**Conclusion:** Given the results of this study, it can be stated that the hyperbaric environment produces changes in the auditory system since the first exposures. Conducting audiological examinations from the start of the exposure can help prevent serious damage to the auditory system.

ID: 03870

## Accuracy of contralateral occlusion test in conductive hearing loss

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**Keywords:** conductive hearing loss, audiometry, tuning forks, ear canal, occlusion.

**Background:** The contralateral occlusion test (COT) has the potential to allow the quantitative evaluation of unilateral conductive hearing loss. The purpose of this study

was to determine the accuracy of the test in predicting the degree of hearing loss.

**Material and methods:** Fifty-three subjects with unilateral conductive hearing loss were recruited from an otolaryngology department of a tertiary hospital. The COT was performed using 128, 256, 512, 1024 and 2048 Hz tuning forks with the non-affected ear canal totally occluded to determine lateralization. Pure-tone audiometry was performed to establish the presence and degree of the air-bone gap (ABG) and the pure-tone average (PTA). The tuning fork responses were correlated with the ABG and the PTA to determine their accuracy.

**Results:** The COT showed a better association between hearing loss and the lateralization response using the 512 Hz tuning fork ( $p = 0.001$ ). The sensitivity of the 512 Hz fork in detecting a PTA of at least 35.6 dB was 94.6% and the specificity was 75.0% for a positive predictive value of 89.7% and a negative predictive value of 85.7%, assuming a pretest prevalence of 69.8%.

**Conclusion:** The overall accuracy of the COT in predicting the degree of unilateral conductive hearing loss was significant. The COT had significant power in one direction: if lateralization to the affected ear occurred, it was almost certain evidence of a moderate or severe conductive hearing loss.

**Conflicts of interest:** None to declare.

ID: 03946

## Feasibility of high frequency bone conduction thresholds for up to 16 kHz using the Westra KLH96 bone conduction transducer

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**Keywords:** High Frequency Bone Conduction Threshold Audiometry

**Background:** Standard diagnostic audiometry tests include measurements of the hearing threshold for air conduction (AC) up to 8000 Hz, and bone conduction (BC) measurements up to 4 kHz. Thresholds for higher frequencies i.e. 8 kHz to 16 kHz, can be measured using air conduction; however possible (temporary) conductive hearing losses can influence these measurement results. This is unfortunate because the thresholds at high frequencies can be of special interest in certain specific hearing losses e.g. ototoxicity.

**Material and Methods:** We have calibrated and characterized three different types of high frequency BC transducers; the B71 (Radioear), the discontinued KH 70 (Präcitronic) and the KLH 96 (Westra) using an artificial mastoid (Bruel & Kjaer 4930). For these BC transducers the frequency response was measured. The distortion at all octave frequencies has been determined using at 5 dB loudness increments from 0 dB HL to the maximum output of the transducer. We will perform hearing threshold measurements on 60 ears of 30 healthy hearing subjects (aged 18 to 29 years; currently

we have included 22 subjects, we plan to include all 30 before March 2019.). For each test subject pure tone thresholds are obtained from 125 Hz to 16 kHz using AC transducers (Sennheiser HDA200). The BC, pure tone thresholds are obtained from 250 Hz to 8 kHz for the B71 transducer, and from 250 Hz to 16 kHz for the KLH 96 and KH 70 transducers. The obtained thresholds are compared between AC and BC transducers, from 250 Hz to 16 kHz. Influence of the transducer placement is investigated by purposefully repositioning the transducer and comparing the pure tone thresholds

**Results,** The KLH 96 shows highest output characteristics for the high frequencies (from approximately 5 kHz) and distortion measurements are not significantly different to the B71 and KH 70 Our preliminary test subject results show that measurements at high frequencies (>4 kHz) are possible using the KLH96 and KH70 bone conductors with reasonable accuracy. Re-positioning the transducer increases the standard deviation of the measurements to approximately 5 dB above 10 kHz.

**Conclusion,** Our preliminary results show that measurements at high frequencies (>4 kHz) are possible using the KLH96 and KH70 bone conductors. Technical comparison of the KH 70 and the KLH 96 shows a larger output in the frequencies above 5 kHz for the KLH 96.

ID: 04017

### Interpretation of wide-band tympanometry using automated pattern recognition

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**Keywords:** tympanometry, pattern recognition, middle ear pathology

**Background:** In clinical practice tympanometry absorbance is typically presented as a function of pressure. With the introduction of wide-band tympanometry (WBT) the absorbance is additionally measured as a function of the frequency between 226 and 8000 Hz. This 3D dataset (pressure, frequency, absorbance) represented as a surface plot in one commercial system (Titan, Interacoustics, Denmark) is difficult to use for clinical interpretations. An alternative representation using 2D color plots could aid the clinician recognize the classical tympanograms types A, B and C. The additional information provided by frequency specific data might be used as an improved diagnostic technique in future. In this study we investigated an automated classification of type A, B and C and sought regions of the WBT which have the most impact on the classification.

**Material and methods:** Conventional tympanometry and WBT was acquired in 97 ears from patients using a commercial device (Titan, Interacoustics, Denmark). The conventional tympanograms were classified into A (N=52),

B (N=26) and C (N=19) by a clinician. The WBT were exported, anonymized and analyzed in Matlab. For automated classification of the WBT data we used the so called "random forest" algorithm.

**Results:** The area under curve for the A, B and C classifiers were 0.91, 0.90 and 0.91 which corresponds to a correct classification of greater than 90%. The selected fields for all classifiers was absorbance in the pressure range between -75 and 75 daPa and in the frequency range between 400 Hz and 1900 Hz.

**Conclusion:** In contrast to conventional tympanometry higher frequencies than 226 Hz are more useful for automated classification of type A,B,C type tympanograms using WBT. One reason might be that the maximal absorption level at low frequencies is significantly smaller than the maximal absorption level at higher frequencies.

**Conflicts of interest:** There are no conflicts of interest. Neither of the authors received grants or funding from a third party.

ID: 04068

### Test-retest reliability and validity of ultra-high frequency audiometry without a sound-treated environment in healthy adults and multi-drug resistant tuberculosis patients

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**Background:** Accessibility to reliable extended-high frequency audiometry in resource constrained contexts is limited due to the need for expensive, acoustically controlled test environment (audiometric booth) with acceptable levels of ambient noise to make sure that background noise does not influence the hearing tests. This study aimed to determine the test-retest reliability and concurrent validity of ultra-high frequency [UHF] (9-16 kHz) audiometry conducted outside of an audiometric sound booth using a computer-based audiometer with a passive noise attenuation.

**Material and Methods,** A within-subject repeated measures design was used to determine and compare air conduction hearing thresholds measured with a conventional diagnostic audiometer in an audiometric booth with thresholds measured in an ordinary room that is not sound treated using a computer-based audiometer. Forty-one (40) participants aged 18-55 years old: 21 (healthy, normal hearing participants) and 20 multi-drug resistant tuberculosis (MDR-TB) patients undergoing treatment that included kanamycin.

**Results:** Average intra-session differences between hearing thresholds obtained via computer-based audiometer varied between 0.12 and 3.78 dB and most of the hearing thresholds remained unchanged across sessions 1 and 2. With respect to assessment using the computer-based audiometer outside of an audiometric sound booth versus

those obtained via the conventional diagnostic audiometer, average hearing thresholds established with the two audiometers were within 10 dB of each other for both the healthy participants and MDR-TB patients.

**Conclusion:** UHF hearing thresholds established via a computer-based audiometer outside a sound treated environment were reliable and comparable to those obtained in an audiometric booth using a conventional diagnostic audiometer. There reliable and valid UHF hearing thresholds can be obtained outside of an audiometric sound booth or sound treated environment.

**ID: 04107**

## Development and validation of the Arabic CAPT

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**Keywords:** Arabic, speech, discrimination, test, children

**Background:** There is a significant lack of Arabic speech tests that allow the assessment of speech perception and monitor changes over time or after an intervention. The lack of speech perception tests in Arabic led to the development of the Arabic version of Hear Auditory Perception Test (CAPT), and accordingly normative data were obtained, test-retest reliability was assessed, and the effect of age on performance was evaluated.

**Material and methods:** This Arabic speech test was intended for use with children aged 5 to 11 years. The test was evaluated using normal-hearing children within the appropriate age range. The test utilized consonant-discrimination closed-set CVC or CVCC words in modern standard Arabic. Four lists of sixteen words were developed and arranged based on level of difficulty. Test was validated in two different settings, initially in sound field with a large group of children (n= 29), then individually under headphones (n=16). Each test was administered twice.

**Results:** All children were able to respond reliably using a computer input device or remote control to select one of four response options displayed on a screen. Assessment of test-retest reliability showed moderate to strong agreement. Within-subject ANOVA showed no significant difference between test and retest sessions. There was a significant correlation between age and performance. List difficulty was assessed; List 1 and List 2 were easier compared to List 3 and List 4. Normative data was established and critical difference was calculated.

**Conclusions:** The Arabic CAPT is appropriate for children as young as 5 years old. This test can reliably assess consonant perception ability and monitor changes over time or after an intervention.

**ID: 04111**

## The dynamic range of hearing in the high frequencies (9-16 kHz) in a population of normal hearing individuals

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**Keywords:** high-frequency audiometry, dynamic range, normal hearing

**Background:** High-frequency audiometry is used in Audiology to assess hearing thresholds at frequencies above 8 kHz. It has a number of clinical applications including diagnosis of early and asymptomatic signs of ototoxicity, detection of noise induced hearing loss and tinnitus assessment. The existing research concerned with high-frequency audiometry focuses predominantly on measurements of absolute threshold of hearing. There is no evidence regarding uncomfortable loudness levels (ULLs) despite early reports that these can be in close proximity to the threshold at high frequencies. The aim of this study was to establish the extent of the dynamic range of hearing at high frequencies (9 kHz to 16 kHz) in participants with normal hearing.

**Material and methods:** A total of 68 adults (13 males and 55 females) aged 19-59 were assessed. All participants had (1) self-identified normal hearing (2) Type A tympanograms and (3) hearing within normal limits (absolute threshold  $\leq 20$  dB HL) across the conventional frequencies (0.5 - 8 kHz). The absolute thresholds and the ULLs were first measured across the conventional frequency range and then at high frequencies (9, 10, 11.2, 12.5, 14 and 16 kHz). A clinical high-frequency audiometer (AC-40) fitted with Sennheiser HD-200 headphones and the modified Hughson-Westlake procedure were used for testing.

**Results:** The present study identified a significantly narrower dynamic range at high frequencies compared to conventional frequency range. The dynamic range measured at conventional frequency range was stable and no difference between frequencies was observed. In contrast, the dynamic range at high frequencies narrowed as a function of frequency resulting from both absolute threshold increases and ULLs decreases. The variability in the results between subjects also increased with increased frequency and overlap between absolute thresholds and ULLs was observed at 14 and 16 kHz.

**Conclusion:** The dynamic range is significantly narrower at high frequencies compared to standard frequencies in adults with normal hearing. The close proximity of absolute threshold and ULLs at high frequencies may be of concern particularly for the assessment of high frequency hearing thresholds in clinical settings.

ID: 04122

**Multi-frequency technology for acoustic reflexes****Russell Higgs, Andre Ludwig***Path Medical GmbH***Keywords:** Multi frequency acoustic reflex

**Background:** During acoustic reflex testing, stimulus is presented to the ear in addition to the probe tone either as an ipsilateral or contralateral presentation triggering the stapedius muscle of the middle ear, whilst a compliance trace is recorded. The stimulus can also be provided electrically by a cochlea implant. Similar to tympanometry testing, the use of alternative probe tone frequencies other than 226 Hz can help detect the reflex in certain middle ears.

**Material and methods:** Since the sound level / phase change due to the reflex, as recorded by the probe microphone, is small, detecting the acoustic reflex is somewhat sensitive to artifacts. This includes both acoustic noise and test setup related effects, such as probe movement during recording. By presenting 226, 678, 904, and 1130 Hz tones simultaneously, there is no additional test time involved but more information is gathered for comparison.

**Results:** The use of more than one frequency (Multi-Frequency) to detect the reflex provides faster detection of the acoustic reflex and is much more robust against artifacts.

**Conclusion:** The presentation will explore the use of 4 test frequencies, 226, 678, 904, and 1130 Hz and demonstrate how significantly lower stimulus levels can be utilized providing greater comfort for young children and patients with Hyperacusis.

**Free Papers 07 - Vestibular Disorders:  
Diagnosis and Therapy I**

ID: 03860

**Normalization of galvanic vestibular evoked myogenic potentials in healthy individuals****Nizamettin Burak Avci<sup>1</sup>, Zahra Polat<sup>2</sup>, Ahmet Ataş<sup>3</sup>**<sup>1</sup> Department of Audiology, Faculty of Health Sciences, Trakya University, Edirne, Turkey<sup>2</sup> Department of Audiology, Faculty of Health Sciences, Istanbul University-Cerrahpasa, Istanbul, Turkey<sup>3</sup> Department of Otolaryngology, Cerrahpasa Medical Faculty, Istanbul University-Cerrahpasa, Istanbul, Turkey

**Keywords:** vestibular evoked myogenic potentials, galvanic VEMP, galvanic vestibular stimulation, normalization, P1-N1 latencies

**Background:** Vestibular evoked myogenic potentials (VEMPs) are used clinically to assess vestibular function. VEMPs are divided into three groups according to stimulus as acoustic (air conduction), mechanical (bone conduction) and galvanic(galvanic vestibular stimulation-GVS). Galvanic VEMP(gVEMP) evaluate vestibular nerve responses by records collected from the sternocleidomastoid muscle. It helps in differential diagnosis of labyrinthine and retro-labyrinthine lesions when used with acoustic VEMP. The aim of this study was to obtain normative data on healthy adults with no history of hearing loss or dizziness and to help diagnosis by creating clinical norms.

**Material and methods:** 100 participants (200 ears) with normal hearing(50M and 50F),between 18-65 years(mean age 39.7±13.9), were included in the study. All participant were evaluated with immittansmetric measurements and pure tone audiometry. VEMP via GVS(current 3mA; duration 1ms) was performed each participant who had normal hearing thresholds for both ears randomly(left or right side). SPSS 15.0 software was used to analyze.

**Results:** gVEMP waveform was elicited from all participants. The gVEMP parameters(latencies of P1 and N1, P1-N1 amplitude) did not demonstrate any significant differences between female-male and left ear- right ear. The gVEMP parameters demonstrated significant differences among different age groups (p<0.001). The latencies of N1 and P1 were observed to prolong in the elderly group compared to the younger groups (p<0.001). Amplitude values were also decreased in the elderly group compared to the younger groups (p<0.001).

**Conclusion:** The results of this study showed that differences in gVEMP parameters occurred with age. As age increased, latencies were prolonged and amplitudes were decreased gradually. Furthermore larger standard deviations were observed in amplitude values, whereas smaller standard deviations were observed in P1 and N1 latencies as in acoustic VEMP values. Galvanic VEMP helps differentiation of retrolabyrinthine lesions from labyrinthine lesions in vestibular system, when used with acoustic or mechanical VEMPs.

ID: 03941

**Auditory-evoked neurophonic responses recorded using a novel signal processing technique****Greg A. O'Beirne<sup>1,2</sup>, Alison M. Cook<sup>1,2</sup>, Ashleigh J. Allsop<sup>1</sup>**<sup>1</sup> University of Canterbury, Christchurch, New Zealand<sup>2</sup> Eisdell Moore Centre, Auckland, New Zealand

**Keywords:** electrocochleography, neurophonic potential, signal processing

**Background:** With changes to cochlear implant candidacy and improvements in surgical technique, there is a need for accurate intraoperative assessment of low-frequency (LF) hearing thresholds during implantation. In

electrocochleography (ECoChG), onset compound action potentials typically allow estimation of threshold for frequencies above 1 kHz, but are less accurate at lower frequencies. Auditory nerve neurophonic (ANN) waveforms may overcome this limitation by allowing phase-locked neural activity to be tracked during prolonged LF stimuli rather than just at their onset. Here we present neurophonic measurements made in awake human participants using a novel signal processing technique that halves the recording time.

**Material and methods:** Patients underwent transtympanic ECoChG as part of diagnosis for suspected Ménière's disease. Responses were recorded at 360, 525, and 760 Hz, using our custom-written intraoperative monitoring software, which provided real-time extraction and display of the putative neurophonic.

**Results:** We present ANN input/output functions and waveforms from one representative participant, and demonstrate that our novel signal processing technique halves recording time with no reduction in waveform quality.

**Conclusion:** Incorporating neurophonic measurement into standard ECoChG protocols may offer an attractive method for objectively estimating the sensitivity of the apical portions of the cochlea. However, until we improve our ability to separate the ANN from non-neural sources (i.e. the cochlear microphonic), and ensure their frequency specificity (i.e. that they originate at the cochlear apex), the neurophonic must be interpreted cautiously.

**ID: 03969**

### Static and dynamic balance in school children with sensorineural hearing loss

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**Keywords:** sensorineural hearing loss, balance assessment, postural control

**Background:** The cochlea and the vestibular system are very to each other in the anatomical position. Therefore, children with some injuries to the cochlea can develop vestibular problems together with sensorineural hearing loss. The balance can be provided statically or dynamically in two ways. Static balance is the ability to maintain a constant position about the center of gravity. Dynamic balance is the ability to sustain stability depending on position changes. Balance control is a fundamental requirement for children's daily activities. This control is provided by motor reactions generated by central processing systems through inputs from the visual, vestibular, and proprioceptive systems. The aim of the study was to assess static and dynamic balance of school children with and without hearing loss.

**Material and methods:** A total of 40 children, 20 in the group with hearing loss and 20 in the group with normal hearing, were included in this study, aged between 6 and 10 years, of both genders. One Leg Stance Test (Eyes

Opened and Eyes Closed), The Timed Up and Go Test and Pediatric Berg Balance Scale were used to assess static and dynamic balance.

**Results:** School children with normal hearing were more successful in performing balance tasks compared to school children with hearing loss, and there were significant differences between the groups. For One Leg Stance Test (Eyes Opened and Eyes Closed) and Pediatric Berg Balance Scale p values were  $p < 0.01$ ; for The Timed Up and Go Test p value was  $p < 0.05$ .

**Conclusion:** Children with hearing loss perform poorly on static and dynamic balance tests compared with their normal hearing children. Therefore, it is important that balance assessment in children with hearing loss should be included as routine evaluation.

**ID: 04119**

### Evaluating the effectiveness of virtual reality (VR) game systems in vestibular rehabilitation in motion sickness

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**Keywords:** motion sickness, virtual reality, vestibular rehabilitation

**Introduction:** The main reason of Motion Sickness (MS) is the mismatch of inputs from visual and vestibular afferent. The conventional rehabilitation methods are time-consuming and costly. Their success depends on follow-up of correct and regular performance of the exercises by the patient. The aim of this study is to evaluate the effect of virtual reality (VR) game systems on rehabilitation of the patients with MS.

**Method:** The study group suffering from MS consisted of 19 individuals (12 females, 7 males), while the control group 20 individuals (10 females, 10 males), aged between 18 and 40 years. A new anamnesis form prepared based on the presence and the severity of the 12 most frequent MS symptoms and a Motion Sickness Susceptibility Questionnaire-Short Form (MMSQ) were used besides the audiological and vestibular tests. A roller coaster game named "Roller Coaster Dreams" in PlayStation VR systems was used for both provocation and rehabilitation.

**Results:** The severity of all of the symptoms stated to exist by the participants in the study group decreased after the rehabilitation ( $p < 0.001$ ). There was a significant increase ( $p < 0.001$ ) in the composite scores of the SOT in the first posturography (pre-provocation) compared to that of the last one (after the 6th session). Upon comparison of the sensory analysis results of the SOT of the first one and the last one, the visual and vestibular sensory system functions were found to have increased significantly ( $p < 0.001$ ;  $p < 0.005$ ).

**Conclusion:** Rehabilitation with VR gaming systems will accelerate the rehabilitation process by making it fun, which will also reduce the risk of ignorance of exercises by the patient. It may also reduce rehabilitation costs.

**ID: 04120**

### What are the differences between canalolithiasis and cupulolithiasis in patients with BPPV: latency, direction, duration and age distribution

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**Key Words:** Benign Paroxysmal Positional Vertigo, Canalolithiasis, Cupulolithiasis, Nystagmus, Latency

**Introduction:** The diagnosis criteria for canalolithiasis and cupulolithiasis can be sometimes challenging. In this study, we aimed to investigate the differences between those criteria in Benign Paroxysmal Positional Vertigo (BPPV) patients in terms of direction (ageotropic-geotropic), duration and latencies of nystagmus as well as age distributions.

**Method:** Patients diagnosed with BPPV and aged between 18-60 were evaluated retrospectively between 2010-2018. Recordings via Dix-Hallpike and Roll tests were made with the Micromedial Technologies Visual Eyes 4 Channel model device. Patients with BPPV were investigated in terms of direction (ageotropic-geotropic), duration and latencies of nystagmus and also age distributions.

**Results:** There were a statistically significant relation between the duration and latencies in Canalolithiasis ( $p < 0.05$ ) and a statistically significant difference in the duration of nystagmus between Canalolithiasis and Cupulolithiasis ( $p < 0.05$ ). The average age was found to be 54. Seasonal effects on symptoms were mostly observed during the winter, spring, autumn and summer respectively.

**Conclusion:** We obtained results that support canaloithiasis and cupulolithiasis theories. Positive differences were found in maximum nystagmus duration.

### Free Papers 08 - Development of hearing throughout life

**ID: 03807**

### Towards predictions of individual benefits with real hearing aids

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**Keywords:** Hearing Impairment; Hearing Aids; Speech Reception Threshold; FADE; Modeling

**Background:** Accurate individual predictions of the benefit of hearing aids in terms of speech recognition performance can be used for a systematic development and fitting of hearing aids by facilitating to understand the interaction of the factors that influence speech recognition performance. The Framework for Auditory Discrimination Experiments (FADE) was shown to accurately predict the speech recognition threshold of 50% correct answers (SRT) of hearing-impaired listeners and it was used to predict the benefit of binaural preprocessing algorithms. However, several hours of processed signals are required for each prediction, which is obstructive for predictions with physical hearing aids. Hence, the amount of processed data needs to be reduced, to enable individual predictions of the benefit of commercial devices.

**Material and Methods:** To decrease the amount of processed signals and to keep the predictive power of FADE, the framework was optimized to simulate speech recognition with an adaptive search pattern across training and testing signal-to-noise ratios (SNRs). This procedure enables the number of training sentences for the automatic speech recognition system of FADE to be reduced from 960 in the original non-adaptive approach to 120 sentences. The original approach searches across a broad range of SNRs for the SRT. Here, an adaptive search paradigm for the SRT was introduced to minimize the number of training and testing sentences. Predictions with the new approach were then compared with the original approach in aided and unaided listening conditions for different degrees of hearing loss.

**Results:** The real-time data optimized approach, referred to as fast FADE, requires about 45 minutes of real-time data for SRT simulations of hearing impaired listeners using the Matrix Sentence Test. As a trade-off, the variance of the simulated SRT in a fluctuating masker increased from about 0.2 dB (original) to about 1.0 dB. This increased variance is within the range of test-retest reliability of the test and therefore in an acceptable range. The average predicted SRTs were similar to the predictions with the original approach. Individual predictions for real devices with recorded data are planned.

**Conclusion:** The fast FADE simulations could become a valuable objective measure to evaluate and individualize signal processing strategies for listeners with impaired hearing.

ID: 03846

**Personal stereos and adolescence: pleasure or risk**Carla Bahillo-Neves*Audiotex***Keywords:** Hearing; Evaluation; Health Education, Hearing Habits, Personal Stereos**Background:** Personal stereos are used by a large part of the population. Despite this, little or nothing is known about the effects that improper use of personal stereos may entail. Noise-induced hearing loss is irreversible and untreatable. It is only by knowing the risks offered by personal stereos and by knowing the protective measures against exposure to dangerous sounds that we can really protect the “Ipod generation”, thus avoiding a future.**Objective:** To know the auditory habits related to the use of personal stereo and to measure the auditory thresholds of the young participants of the research.**Material and method:** Cross-sectional study. Auditory health education program implemented from the 6th to the 9th year of primary education in private schools in the city of Belo Horizonte / MG, in the years 2011 to 2013. The questionnaires of previous history of hearing health answered by the students were analyzed. audiometry of them. The chi-square test was used to analyze the correlation between the use of personal stereos and the presence of auditory and / or tinnitus alterations, and for the answers of the questionnaires that were found to be within the normal range were evaluated by the t-student test.**Results:** There was a statistically significant association between the use of headphones and the presence of tinnitus ( $p$ -value  $<0.0001$ ), between the use of headphones and changes in the audiometric test ( $p$ -value  $<0.001$ ) and between presence ( $p$ -value  $<0.0002$ )**Conclusions:** It was verified that adolescents are assuming auditory habits that are dangerous for their future, and that this dangerous exposure is largely due to a lack of information about the use of hearing aids. even, evidencing the need for hearing health education programs that privilege protective attitudes toward dangerous sounds.

ID: 03930

**Evaluation of verbal working memory and phonemic analysis skills in adolescents with cochlear implant - a preliminary study**Nuriye Yildirim, Bülent Gündüz, Hakan Tutar, Recep Karamert, Şadiye Bacik Trank<sup>1</sup> *Gazi University, Faculty of Health Sciences, Department of Audiology*<sup>2</sup> *Gazi University Faculty of Medicine, Department of Otorhinolaryngology*<sup>3</sup> *Gazi University, Faculty of Health Sciences, Department of Speec and Language Therapy***Objective.** Cognitive skills are closely associated with language development in children with hearing loss. There are many researches about memory among the cognitive skills and different language performances with cochlear implanted (CI) subjects, but there are a few of researches into the correlation between phonemic analysis skills and verbal working memory of adolescents with CI in the literature. This study aimed to obtain preliminary information about this correlation and suggest some critical findings for optimum re-habilitation plans of subjects with CI and for further researches.**Methods.** 10-18 year-old 18 subjects with CI were included in this study. Pure tone and speech audiometry were performed with CI and without CI. Meaningless word repetition test in Turkish language (MWR) was used as verbal working memory test, while the Phonemic Analysis (PA) subtest of TOLD-P4 Turkish version was assessed the language skills of the subjects with CI.**Results.** The mean value of age was  $14.55 \pm 2.33$  for the all subjects. The hearing thresholds with CI (averaged of 500 Hz, 1000 Hz, 2000 Hz) of the early implanted subjects (before 24 months) were about the 17.30 dB HL, but 22.12 dB HL in the other group. There were statistically significant differences between two groups in MWR and PA test according to age of implant ( $p=0.047$  for PA and  $p=0.018$  for MWR). The mean value of PA test for all the subjects was  $17.38 \pm 2.25$ , but  $30.22 \pm 5.67$  was in the MWR test. There was a statistically significant correlation between PA test and MWR test in adolescents with CI ( $r=0.729$ ).**Discussion.** The study shows that verbal working memory among the cognitive skills is very remarkable for language performance in adolescents with CI. Surely, early intervention is very important for development of language and memory skills of children with hearing loss. Also further studies, including extensive test battery for audiological and language-cognitive performance assessments, are needed to make some suggestions for optimum auditory and language development.**Keywords.** verbal working memory, adolescents, cochlear implant, language

ID: 03957

**Neurodevelopmental aspects of hearing-in-noise in 5 to 11 year-old children****Jeremie Ginzburg, Lesly Fornoni, Justine Popieul, Caroline Pierre, Anne Caclin, Annie Moulin***Lyon Neuroscience Research Centre, Brain Dynamics and Cognition Team, Perception Attention and Memory group, CNRS UMR5292, INSERM U1028, Claude Bernard Lyon 1 university, Lyon University, F-69000, Lyon, France***Keywords:** Central auditory processing disorders; Speech-in-noise; Phonological distance; Speech language impairment.**Background:** Difficulties in hearing occurring specifically in noisy environments, with otherwise normal auditory thresholds in children, are very often associated with speech language impairment and certain forms of dyslexia. Unfortunately, those disorders are rarely diagnosed before 8 years of age, when the difficulties in learning to read are pointed out. The aim of this study was to characterize the development of auditory processing capabilities in noise in young children, aged from 5 to 11 years of age, in order to develop a hearing-in-noise test, suitable for young children, before reading age, able to screen specific difficulties in hearing in noise.**Material and methods:** We adapted a four alternative force choice auditory perception task (Audimage) for young children, using a touchpad (ipad). Four cartoon objects are presented simultaneously on the screen whilst a female voice names one of these objects. The child has to choose the corresponding cartoon. The cartoons were specifically designed for young children, and the task presented 2 levels of difficulties according to the phonological distance between the words presented, phonologically close words (for instance: bat/rat/cap/cup) being harder to distinguish than phonologically-distant words. 4x12 trials were presented binaurally via headphones, in a continuous Cocktail Party noise, at +3 dB and -3 dB signal/noise ratio. A group of 22 normally hearing young adults went through the same task.**Results:** Ninety-Six children from 5 to 11 years old underwent the task, and were easily able to perform the task including 5-year-old children. The results show a significant evolution of the performance across age ( $F(15.6) = 10.69$ ,  $p < 0.001$ ), far from being equal to adult's performance even in the eldest children. With a 3 dB SNR, 5 years old children didn't reach the performances of young adults at -3 dB SNR, showing a difference of more than 6 dB SNR. As expected, the performance was systematically poorer for the condition with phonologically close words, especially for the youngest children (5 to 7 year-olds).**Conclusion:** Neural networks involved in auditory perception in noise are still in maturation at 11 years of age. Those data represent a first step to establish normative values in hearing in noise in children, with the final aim to establish a tool for screening purposes.

ID: 03983

**DHH students perception of school inclusion through different school environments****Edyta Tominska<sup>1</sup>, Anna Zwierzchowska<sup>2</sup>, Agata Kruzynska<sup>2</sup>, Aleksandra Zebrowska<sup>3</sup>**<sup>1</sup> UER PS, Haute Ecole Pédagogique du Canton de Vaud, Lausanne, Switzerland<sup>2</sup> Department of Special Education, the J. Kukuczka Academy of Physical Education, Katowice, Poland<sup>3</sup> Department of Physiological and Medical Sciences, the J.Kukuczka Academy of Physical Education, Katowice, Poland**Keywords:** Perception of Inclusion Evaluation, PIQ, DHH students**Background:** Inclusive education was defined as an ongoing process aimed at offering high quality education for all and respecting diversity, different needs and abilities, characteristics and expectations of students and communities, eliminating all forms of discrimination. In the Polish context this process is carried out in special kindergartens, special primary, vocational and secondary schools, as part of individual teaching and in other organizational forms determined by the type, degree of disability and age of the student. We will investigate this process in the DHH Students school trajectory in different environments: 1) regular classes of mainstream school, 2) integrative classes in mainstream school or 3) special school.**Material and Methods:** This preliminary study takes part of a biggest research programme (Zwierzchowska et al. 2018). The first objective of the main study is the validation of the data collection instrument-PIQ in Polish educational context, in particular in DHH education.For this study the group of 55 of DHH students (9-18 y.o.; divers type of deafness and hearing aids) enrolled in the special school (in Katowice) are responding to the *Perception of Inclusion Questionnaire, PIQ* (Venetz et al., 2015). This questionnaire aims the responses from three points of view: pupils, parents and classroom teachers; to evaluate three scholar capacities: cognitive, emotional and social one.**Results:** This preliminary study (one type of school environment) compare the responses of the children, parents and teachers (SPSS quantitative data) to evaluate the importance of cognitive, emotional and social capacities in perception of inclusion in this educational context for DHH children. The conditions of this type of schooling will be described by the qualitative research about the methods of teaching – learning materials, aids and strategies used in this context.**Conclusions:** The first utilization of the PIQ permit to validate this instrument in the environment of inclusion of the pupils with special educational needs context in a mainstream school classes (Zwierzchowska et al. 2019). We will use them to large vision of schooling of DHH children in Poland, in different types of didactic and social environments, to compare them, to investigate the conditions and the needs of these children in the contemporary transformation of the Inclusive School.

ID: 04078

**The association between age-related hearing loss: body composition and diet**André Goedegebure, Pauline Croll, Trudy Voortman, Meike Vernooij, Arfan Ikram*Erasmus MC*

**Background** Obesity and diet quality have been suggested to play a role in the etiology of age-related hearing loss. We aimed to investigate independent associations of body composition and diet quality with age-related hearing loss in a large population of older adults.

**Methods** We performed cross-sectional and longitudinal analyses (follow-up: 4.4 years) in the population-based Rotterdam Study of 50 years and older. At baseline (2006–2014), 2,906 participants underwent assessment of body composition, diet, and hearing. Of these 2,906 participants, 636 had hearing assessment at follow-up (2014–2016). Association of body composition and of diet quality with hearing loss were examined using multivariable linear regression models.

**Results** Cross-sectionally, higher body mass index (BMI) and fat mass index were associated with increased hearing thresholds. One point higher BMI was associated with a 0.53 dB (Confidence interval: 0.04, 1.01) increase in hearing thresholds across all frequencies. These associations did not remain statistically significant at follow-up. We found no associations between overall diet quality and hearing thresholds.

**Conclusions** This study shows that a higher body mass index, and in particular a higher fat mass index, is related to age-related hearing loss, suggesting that vascular mechanisms are involved in developing hearing loss at older age.

**Free Papers 09 - Audiological rehabilitation**

ID: 03828

**Presbycusis: auditory rehabilitation influence in loneliness and depression in older people**Tatiana Marques<sup>1</sup>, Filipa D. Marques<sup>2</sup><sup>1</sup> Instituto Politécnico de Coimbra, ESTESC-Coimbra Health School, Audiologia, Portugal; OuviSonus<sup>2</sup> Instituto Politécnico de Coimbra, ESEC, Gerontologia; CINTESIS

**Keywords:** Presbycusis; Aging; Depression; Loneliness, Hearing Rehabilitation

**Background:** Presbycusis, which is age-related hearing loss, has consequences in the older people communication, reducing social relations and increasing the perception of loneliness. Associated with hearing loss, depressive symptoms can also appear, resulting from frustration and social and emotional difficulties. However, the emotional

and social effects manifested in individuals with Presbycusis can be lessened through the reestablishment of hearing and, consequently, of communication. To this end, hearing rehabilitation through hearing aids is considered in this study. The present study assesses the influence of auditory rehabilitation by the use of hearing aids in loneliness and depressive symptoms in older people with Presbycusis.

**Material and Methods:** The sample selection was for convenience, consisted on 31 individuals aged 65 years and over with presbycusis and preserved cognitive functions, who attended a hearing rehabilitation clinic. Data collection includes the application of the following instruments: sociodemographic questionnaire, University of California Los Angeles (UCLA), and the Geriatric Depression Scale (GDS) - 30. This is a pre-experimental study of a single case design with pre and post-test, occurring the intervention by the adoption of hearing aid. In the pre and post-test, the perception of loneliness and depression was evaluated, with a time interval of one month.

**Results:** The results showed a positive influence of auditory rehabilitation, with a decrease in the perception of loneliness ( $p=0,020$ ) and depression levels ( $p=0,007$ ) after one month of use the hearing aid, without influence from the degree of hearing loss and gender.

**Conclusion:** It is concluded that the recovery of the communication capacity through the use of hearing aids determines the reestablishment of social relations and, as such, less loneliness and depression. Auditory rehabilitation in the older people is highly complex because the CNS (Central Neural System) is less functioning and less plasticity, resulting in difficulty in the adoption process and also in vocal gain, emphasizing the importance of early intervention and the establishment of social and health policies.

ID: 03863

**Is serious game-based learning a good therapeutic option in adult cochlear implantees? Preliminary results from an intensive listening-in-noise training program**Pierre Reynard<sup>1,2,3</sup>, Virginie Attina<sup>1,2,3</sup>, Evelyne Veuillet<sup>1,2,3</sup>, Hung Thai-Van<sup>1,2,3</sup><sup>1</sup> Department of Audiology and Otoneurological Evaluation – Lyon University Hospital, France<sup>2</sup> Claude Bernard Lyon 1 University, France<sup>3</sup> Lyon Neuroscience Research Center, Inserm U1028 CNRS UMR5292 France

**Keywords:** Auditory training, cochlear implant, serious game

**Background:** Listening-in-noise remains challenging for cochlear implant (CI) recipients even in those with prolonged auditory experience. We aimed at evaluating the efficiency of a serious-game-based intensive auditory training program in noise.

**Methods:** 28 adult cochlear implantees with at least 9 months of CI experience participated to the study. They were divided into a control (no-training, n=15) and experimental (training, n=13) group. The trained group underwent auditory training sessions of 20 minutes each, 5 days a week over a period of 5 weeks. The serious game consisted in specific tasks targeting various auditory skills: detection, attention, discrimination, identification, and categorization. For this, sound material from a large custom database (noise, musical, animal and speech sounds) was played in the presence of background noise (white and babble noise, everyday life auditory environments) with varying signal-to-noise ratios.

**Results:** Every participant from each group was tested before and after the 5 week-period (with/without training) using the sentence recognition in noise Fr-Matrix test and Speech Spatial Quality questionnaire. Compliance with the protocol was excellent and most patients were found to be highly motivated. Results show a significant improvement in sentence recognition in noise after training ( $p<.001$ ). Self-reported benefits were positive even though no significant change was found for the questionnaire. There was no statistical difference between pre and post-test in the control group ( $p=0.6$ ).

**Conclusion:** Listening-in-noise training via adapted serious game can improve auditory perception performance in adverse environments for CI recipients, and thus enhance their quality of life and maximize the benefits of their implants.

**ID: 03906**

### Test-retest reliability of a modern Greek speech audiometry test for adults

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**Keywords:** Greek, Speech Audiometry, Word Lists, Test-Retest Reliability

**Background:** Word recognition score (WRS) is one of the most frequently used measures for speech audiometry. The purpose of the present investigation was to establish the test-retest reliability of a Modern Greek word recognition score test developed by Trimmis et al (2006). The test consists of four phonemically balanced lists, each of which contains 50 open-set bisyllabic words. Monosyllabic words were not included because few exist in the Modern Greek language.

**Materials and Methods:** The study population was comprised of four different groups: 242 adults with normal hearing, 116 adults with conductive hearing loss, 227 adults with cochlear and 38 adults with retrocochlear involvement. All subjects were native speakers of Modern Greek. Testing was performed in a single-walled Industrial

Acoustic Company booth. The prerecorded digital materials were administered at 10-dB sensation level (SL) increments to all subjects. Retesting was performed between one and six weeks for all subjects. The test-retest scores were analyzed to estimate the test-retest reliability of each list and at each SL.

**Results:** The test-retest reliability coefficients of the four lists ranged between 0.94 to 0.98 for the normal hearing group, 0.89 to 0.95 for the conductive hearing loss group, 0.88 to 0.94 for the sensorineural hearing loss group and 0.72 to 0.86 for the retrocochlear pathology group. Also, test-retest reliability was found to be high at most SLs and increased as the presentation intensity increased.

**Conclusion:** The results of this study indicate that the word lists of the test used in this study are reliable for suprathreshold word recognition score testing, thus increasing support for its use in the clinical setting.

**ID: 03966**

### Audiological classification of patient data using expert-based Common Audiological Functional Parameters (CAFPAs)

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**Keywords:** CAFPA; Audiological Classification; Clinical Decision Support System

**Background:** The Common Audiological Functional Parameters (CAFPAs) were introduced for the purpose of combining audiological expert knowledge and providing it to the ENT community in a condensed, illustrative way (Buhl et al. 2018, in press). The CAFPA are abstract parameters that were designed to describe the most relevant functional aspects of a patient's hearing abilities by summarizing and integrating audiological knowledge from different measurement procedures. The ten parameters describe, e.g. the individual hearing threshold, suprathreshold deficits, or binaural hearing. They act as „bottleneck features“ and are aimed to be interpretable by humans as well as machines. The long-term goal of the approach is to set up an audiological diagnostic support tool, i.e., a computer program that supports the ENT specialist with easily accessible statistical information about a large number of patients similar to the patient under consideration.

**Material and methods:** In a survey, experts classified cases from the Hörzentrum Oldenburg database by determining audiological findings, treatment recommendations, and CAFPA for single patients. The collected data is used to determine conditional probabilities with the use of Bayes' rule, e.g., the probability of different treatment recommendations, given the audiogram of a patient.

**Results:** With these probabilities, questions like „Does a patient need a hearing aid or not?“ can be answered based on the audiogram or a subset of CAFPAs. Thereby, a baseline for a classifier is set which maintains interpretability of intermediate results throughout the model, but is also extendable in many directions. For example, the influence of combinations of different audiological measurements or CAFPAs on the recognition performance can be evaluated, i.e., which measurements are needed to determine audiological findings or treatment recommendations with a specific certainty.

**Conclusions:** Comparing the performance, it can be shown if the abstract CAFPAs encode the relevant information, which is an important requirement for their usage as database-independent parameters.

ID: 03994

### Speech perception in noise by school-aged children with dyslexia: Is there a benefit of envelope enhancement?

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**Keywords:** Dyslexia, speech perception, phonological processing, temporal processing, signal processing

**Background:** Dyslexia, a developmental disorder in learning to read and/or spell, is commonly viewed as a phonological deficit. However, there is growing evidence that subtle speech perception deficits precede the phonological difficulties that are typically observed in dyslexia. Recent theories attribute impaired speech perception in dyslexia to altered processing of dynamic features of the speech envelope, such as slow amplitude fluctuations and transient acoustic cues. Therefore, if speech perception deficits in dyslexia indeed stem from faulty speech envelope tracking, then consequently enhancing the envelope might improve speech perception by children with dyslexia. Therefore we implemented an envelope enhancement strategy (EE) to amplify specific amplitude transition in the envelope, without affecting other parts of the speech signal (Koning and Wouters 2012). We hypothesized that emphasizing these challenging dynamic features might strengthen information processing of syllable onsets and phoneme discrimination and in turn ameliorates speech perception for children with dyslexia.

**Material and methods:** Speech perception was assessed in 60 children, age 9 to 12 years, with and without dyslexia using a sentence repetition task in a speech-weighted background noise. We tested speech perception in four different conditions: natural speech, vocoded speech and their enhanced versions. These conditions were used to assess both the nature of the speech perception deficit and the effect of the EE-algorithm on speech perception. Additionally, cognitive tests of phonological awareness, language skills, verbal

short term memory and working memory were administered to investigate possible confounding effects.

**Results:** Preliminary results show that children with dyslexia indeed have subtle speech perception deficits when listening to both natural and vocoded speech. More importantly, our results show that EE instantaneously improves this atypical speech perception by children with dyslexia. Hence, EE seems to normalize speech reception thresholds for children with dyslexia in adverse listening conditions.

**Conclusion:** The benefit of envelope enhancement reduces the gap in speech performance between children with and without dyslexia. These results provide a brand new perspective for passive and instantaneous intervention strategies.

ID: 03998

### Experiences of an Internet-based aural rehabilitation (IAR) program for hearing aid users: a qualitative study

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**Keywords:** Qualitative study, Internet-based aural rehabilitation, Internet interventions

**Background:** Internet interventions for hearing aid (HA) users have been shown to be effective in helping persons with hearing problems. As earlier research refers to objective data on these effects, little is known about how participants experience the Internet interventions subjectively. The aim of the present study was to explore participants' experiences of an Internet-based aural rehabilitation (IAR) program for HA-users, and to explore the possible subjective benefits of such a program.

**Material and methods:** A qualitative exploratory design was implemented involving semi-structured telephone interviews. The interviews were transcribed and analysed using content analysis. Interviews were conducted with 20 participants (9 men and 11 women) who had completed an IAR program for HA-users. The participants were 57–81 years old and had used HAs for 2–25 years.

**Results:** The overall results indicate positive experiences of the IAR program, and an overarching theme of increased self-esteem was identified. The results are organized in three (1-3) main categories: 1. General experiences associated with participating in the program, 2. Knowledge obtained from the program, and 3. Perceived impact of taking part in the program. Many participants described the program as a source of knowledge with positive effects on their self-esteem. These positive effects triggered participants to apply gained or revisited knowledge practically in everyday life. However, a majority of the participants did not report increased HA-use, in terms of hours per day, rather they reported increased confidence in how

to deploy new or revisited knowledge practically related to their everyday HA-use.

**Conclusion:** The program underlines the ability of HA-users having confidence in how to deploy new or recognised knowledge practically, i.e. enhancing empowerment, and shows the participants what they can do rather than what they cannot do. In conclusion, our recommendation for future efforts when developing and modifying Internet interventions is that theory and practice must go hand in hand.

**Conflicts of interest (if any):** None.

**ID: 04016**

### A systematic review on maternal verbal interaction and the effects on language outcomes in children with hearing loss

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**Keywords,** hearing impairment, children, language input, maternal interaction, language development

**Background:** This review considered the literature from 2006 to 2016, examining the quantity of language input and style of interaction in naturalistic environment and the association with receptive and expressive spoken language in CWHI. Three research questions will be addressed: (1) when interacting with adults, how does the amount of verbal language input compared between children with normal hearing (CWNH) and CWHI? (2) What association is there between the amount of adult verbal language input and language outcomes in CWHI? (3) What association is there between the style of verbal interaction and language outcomes in CWHI?

**Methods,** The five phases of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed to conduct the search: identification, screening, eligibility, inclusion, and analysis (Moher et al. 2009). A total of nine full text articles were sorted into two categories. Category 1 consisted of five articles that examined the amount of verbal language input and category 2 consisted of three articles that examined style of verbal interaction. One other article provided data for both categories.

**Results:** Compared to CWNH, CWHI were exposed to increased number of adult words (three studies) and conversational turns (three studies) during mother-child interactions. Increased conversational turns between adults and the child was associated with better receptive and expressive language. Low-level evidence from three studies showed that open-ended questions, expansion, recast, and parallel talk are effective interaction styles for developing receptive/expressive language.

**Discussion and conclusion:** Overall, low level evidence was found. The quality of the studies was limited by sample size, sample selection, duration of observations, measurement tools, effect size, and effects of confounding variables.

Findings were difficult to compare because of variations in observation methods and tools. Overall, substantial variations in CT rates were noted across studies and between CWHI and CWNH. Lack of information on type, amount, and duration of therapy made inferences difficult. This review provides evidence for mothers to engage in interactions that encourages speech and language development. Future studies should account for the limitations identified in this review to yield higher quality data.

### Free Papers 10 - Recruiting the other ear in SSD and bimodal fitting

**ID: 03810**

### Loudness scaling and localization of cochlear implant users with contralateral hearing aid

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**Keywords:** Bimodal CI, loudness scaling, localization

**Background** In bimodal (CI and hearing aid) fitted patients, differences between the loudness perception of the ear using a cochlea implant and the hearing aid ear may occur. Especially for hearing in noise, as well as for localization, there might be a loss in performance due to these discrepancies in loudness perception. The aim of this study was to compare the loudness perception of different acoustic signals for the hearing aid ear and the CI ear of bimodal fitted patients, and to investigate the localization capabilities of these patients.

**Patients and Methods** Ten adult experienced cochlear implant listeners with contralateral hearing aid had been enrolled in this study. Hearing aids had been checked technically by a hearing aid technician. All patients had been fitted with a CP910-soundprocessor (Cochlear™), and used ACE as speech coding strategy with 8 maxima, 900 Hz and the same acoustic dynamic range (T-SPL 25 dB, C-SPL 65 dB). Loudness-growth functions were obtained both for the CI fitted and for the hearing aid fitted ear using five different stimuli (CCITT noise, FASTL noise, Oldenburg sentences, Oldenburg noise, 1 kHz narrowband noise). Localization measurements were performed in the bimodal condition using a German sentence in a free-field for 50 dB, 65 dB and 80 dB SPL.

**Results** Comparing the CI to the hearing aid side, differences in the loudness judgements especially for the 1 kHz narrowband noise were observed, whereas the broadband signals showed no significant difference in loudness for both ears. Localization capabilities were poorer for higher sound pressure levels: mean angle deviations of  $17,8 \pm 8^\circ$  for 50 dB,  $20,1 \pm 8,5^\circ$  for 65 dB and  $30,3 \pm 14^\circ$  for 80 dB sound pressure levels had been measured.

**Conclusion** Loudness perception of the CI ear and the hearing aid ear in patients is similar for broadband signals. Localization capabilities are best for lower sound pressure levels. Nevertheless, these bimodal fitted patients have decreasing capabilities in localization especially for higher sound pressure levels. For our patients, we did not find any hint that differences in loudness perception between CI and hearing aid ear result in reduced localization skills.

**ID: 03861**

### Comparing the effect of different hearing aid fitting methods in bimodal cochlear implant users

**Jantien Vroegop, Gertjan Dingemans, Marc van der Schroeff, André Goedegebuure**

*Erasmus MC*

**Keywords:** Bimodal hearing, hearing aid fitting, cochlear implant, speech perception in noise

**Background:** Bimodal hearing has shown to improve speech recognition in quiet and in noise and to improve sound localization compared to unilateral cochlear implant use alone. Fitting the cochlear implant (CI) and hearing aid (HA) separately has been described well, but HA fitting for bimodal CI users is less researched. The aim of the study was to investigate the effect of 3 hearing aid fitting procedures on provided gain of the hearing aid in bimodal cochlear implant users and their effect on bimodal benefit.

**Material and methods:** This prospective study measured hearing aid gain and auditory performance in a cross-over design in which 3 hearing aid fitting methods were compared. Hearing aid fitting methods differed in initial gain prescription rule (NAL-NL2 and Audiogram+) and loudness balancing method (broadband vs. narrowband loudness balancing). Auditory functioning was evaluated for speech-in-noise. Fourteen postlingually deafened adult bimodal cochlear implant users participated in the study.

**Results:** No differences in provided gain and in bimodal performance were found for the different hearing aid fittings. For all hearing aid fittings, a bimodal benefit was found for speech in noise.

**Conclusion:** Our results confirm that cochlear implant users with residual hearing in the contralateral ear substantially benefit from bimodal stimulation. However, on average, no differences were found between different types of fitting methods, varying in prescription rule and loudness balancing method.

**Conflicts of interest:** This work was supported by Cochlear Ltd and GN Resound Ltd.

**ID: 03987**

### Benefit of balanced sound processing and matched automatic gain control in bimodal cochlear implant users – final results

**Diana Arweiler-Harbeck<sup>1</sup>, Anna Möller<sup>1</sup>, Heike Bagus<sup>2</sup>, Thomas Scholz<sup>2</sup>, Stephan Hans<sup>1</sup>, Laura Holtmann<sup>1</sup>**

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<sup>2</sup> Cochlear Implant Center Ruhr Essen Germany

**Background:** Patients with single-sided deafness and residual hearing on the contralateral ear can benefit from a cochlear implant on one side and a hearing aid on the other. However, hearing benefits among these patients are heterogeneous. This may be caused by a mismatch of cochlear implant and hearing aid as well as discrepant signal processing. Creating a balanced sound processing and a matching automatic gain control may help to improve hearing and speech perception.

**Methods:** 12 patients using the AB Naída CI Processor and a conventional hearing aid were enrolled and baseline measurements were obtained. A Phonak Naída Link hearing aid had been adjusted to the patient and linked to the cochlear implant. After six and twelve weeks pure-tone audiometry and localization tests were performed. Speech perception was determined in quiet and noise. To evaluate the subjective listening comfort two questionnaires (Oldenburger Inventar and HISQUI19) were assessed.

**Results:** Twelve weeks after the fitting of the new hearing aid an improvement of hearing and speech perception could be determined. Especially, speech perception in noise had improved significantly: Directed suppression of noise helped to segregate the target speech signal from a mixture of sounds or competing speakers (Zoom-Control-Function). Evaluation of the questionnaires revealed a positive subjective hearing experience not after six but after twelve weeks.

**Conclusion:** The combination of balanced Sound Processing and matched gain control can improve hearing and speech perception in noise significantly, however to obtain enhanced outcome a detailed patients' introduction to the new hearing aid is needed at the beginning.

**Conflict of Interest:** Hearing aids were provided by Phonak Company for the time of study.

ID: 04045

**10 years of cochlear implantation in single sided deaf patients - a critical review****Anja Kurz, Marius Grubenbecher, Maren Zanzinger, Rudolf Hagen, Kristen Rak, Kühn Heike***Department of Otolaryngology, University Hospital Würzburg, Comprehensive Hearing Center*

**Background:** For 10 years, single sided deaf (SSD) patients in Würzburg have been treated with a cochlear implant with a great variability in individual performance. The presentation will discuss different clinical evaluation procedures and factors influencing performance.

In the period 2009-2016 a total of 61 patients were implanted and speech perception was routinely measured with Freiburg monosyllables and the HSM (Hochmair-Schulz-Moser)-sentence test in quiet and background noise, at intervals of 1, 3, 6 and 12 months after initial activation. The data analysis of this period shows a significant influence on the duration and the cause of deafness.

In a recent experimental study, these patients were invited for binaural measurements (head shadow effect, squelch, binaural summation, spatial release from masking). A total of 31 patients participated, the remaining patients were asked about their current hearing ability using questionnaires or telephone interviews. The results of the audiological measurements as well as the subjective self-assessment will be presented.

Since mid-2016, all unilaterally deafened patients have undergone a changed clinical schedule. A test trial with a CROS hearing aid and a Baha on the SoundArc/headband is now carried out as standard before each cochlear implantation. Binaural measurements are repeated at 6 and 12 months after the decision for CI implantation and the localization ability is measured. First results of the new test battery on 20 patients are presented.

**The results** of the three data analyses are critically examined and discussed on the context of existing findings. Furthermore, the optimal clinical procedure and the influencing factors will be established.

**Free Papers 11**

ID: 03776

**The adhesive bone conduction system, ADHEAR – performance, physics and clinical evaluations****Patrik Westerkull***Otorix Research / Chalmers University of Technology*

**Background** There is a significant need for a well-functioning non-surgical solution for conductive hearing loss,

especially in pediatrics but also for adults. An adhesive bone conduction concept called ADHEAR was developed and evaluated.

**Material and Methods** The new adhesive bone conduction concept was based on a small non-invasive adhesive attachment placed behind the ear, and a bone conduction audio processor that can be connected to the adhesive attachment. The parameters behind an efficient non-surgical bone conduction transmission that works any pressure against the skin were investigated as well as the long term adhesive skin interaction. The objective was also to evaluate the audiometric performance of this innovative arrangement and to evaluate the clinical performance in terms of medical aspects, audiological performance, user-friendliness, wearing comfort and practical handling.

**Results and Conclusions** The results showed that the ADHEAR bone conduction concept performed equivalent hearing stimulation as traditional headband or soft-band arrangements. The concept was found to be a practical arrangement with excellent wearing comfort without any pressure against the skin and was also found cosmetically superior to traditional bone conductors. The clinical results showed excellent user satisfaction, and the patients are now using it on a regular basis. The first patients that were fitted have now used the concept for more than four years. The new arrangement offers significant advantages since it does not include any pressure against the skin and no bulky headband arrangements is required.

ID: 03789

**Vestibular function in children with neurodevelopmental disorders: a systematic review****R. Van Hecke<sup>1</sup>, M. Danneels<sup>1</sup>, I. Dhooge<sup>2,3</sup>, H. Van Waelvelde<sup>1</sup>, J.R. Wiersema<sup>4</sup>, F.J.A. Deconinck<sup>5</sup>, L. Maes<sup>1,2</sup>**<sup>1</sup> *Ghent University, Department of Rehabilitation Sciences, Ghent, Belgium*<sup>2</sup> *Ghent University Hospital, Department of Otorhinolaryngology, Ghent, Belgium*<sup>3</sup> *Ghent University, Department of Head and Skin, Ghent, Belgium*<sup>4</sup> *Ghent University, Department of Experimental-Clinical and Health Psychology, Ghent, Belgium*<sup>5</sup> *Ghent University, Department of Movement and Sports Sciences, Ghent, Belgium*

**Keywords:** Systematic review, vestibular function, neurodevelopmental disorders, children.

**Background:** Emerging evidence suggests that a vestibular dysfunction may considerably influence children's development and may result in motor, cognitive, educational and/or psychosocial symptoms which tend to overlap with symptoms found in children with neurodevelopmental disorders (NDDs). Furthermore, several children with NDDs are known to have postural and/or motor disturbances. Evidence whether these balance problems are accompanied with a vestibular dysfunction is limited. Therefore,

to examine the potential link between vestibular function and neurodevelopmental disorders and to investigate the presence and characteristics of vestibular dysfunctions in this population, a systematic review was performed.

**Materials and methods:** MEDLINE, EMBASE, Cochrane Register of Controlled Trials and reference lists of all included studies were screened by two independent researchers. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines were followed. Risk of bias was verified using the Newcastle-Ottawa Scale and interrater reliability was established using Cohen's Kappa.

**Results:** Twenty studies, discussing vestibular function in children with NDDs were retained for synthesis. Several authors suggested a possible vestibular involvement in patients with NDDs since in a subset of these patients central and/or peripheral vestibular aberrations were found. These alterations may result in symptoms of distorted motor coordination or postural instability, respectively, and might explain the balance problems observed in some of these children. However, current findings are ambiguous and mainly based on evaluation of the horizontal semi-circular canals alone.

**Conclusion:** High-quality studies with an extensive vestibular test battery are required to further characterize the vestibular function in children with NDDs. Importantly, since comparable symptoms may occur in both groups, clinicians should be aware of these similarities when establishing the diagnosis in these patients.

**ID: 03872**

### Selection of material for speech audiometry testing in young Greek-speaking children

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**Keywords:** Speech audiometry, Greek, Parts of Speech

**Background:** It is difficult and in some cases impossible for young children to maintain their attention in order to cooperate sufficiently for a pure-tone audiometric test. Although pure-tone thresholds are extremely important, we can gain critical information from speech recognition testing as well. It has been established from several studies that there is a high correlation between speech recognition threshold testing and pure-tone threshold testing. Additionally, it may be helpful to do speech recognition testing to rule out particular pathologies that need special attention. However, construction of speech recognition test materials for young children has encountered major problems. A primary difficulty has been how to obtain test materials that are not influenced by normal developmental differences in language skills. The aim of the present study was to investigate the eleven parts of speech in Greek that young children use, in order to develop appropriate materials for speech recognition tests.

**Materials and Methods:** Three hundred children aged 3 to 6 years old participated in this study. All children were divided into three age groups (3–4, 4–5 and 5–6 years old) with on hundred subjects in each group and equal gender distribution. All children were native speakers of Greek and judged by the investigators to have speech and language within normal limits for their age-group. A sample of speech was acquired from each child by presenting picture stimulus cards that portrayed everyday situations, with several actions on each card. The first two hundred and fifty words from each child's sample were used for later analysis.

**Results:** Analysis revealed the following mean percent scores: noun 22.65%, verb 22.25%, pronoun 12.64%, article 11.98%, conjunction 10.84%, adverb 10.34%, preposition 4.69%, adjective 3%, particle 1.17%, interjection 0.27% and participle 0.16%. The most frequently used part of speech is the noun. Specifically, the 3–4 years old children used 24.25% nouns, the 4–5 years old children used 22.59% and the 5–6 years old group used 21.10%. Although there were significant differences among the groups for eight parts of speech, there were no significant differences between the genders for nine parts of speech.

**Conclusion:** the results of this study can aid in the development of speech perception assessment materials (words and sentence lists) for young children.

**ID: 03943**

### Development of a paediatric version of the University of Canterbury Auditory-Visual Matrix Sentence Test.

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**Keywords:** speech audiometry, paediatric audiology

**Background:** Speech recognition measures are a fundamental component of the audiometric test battery, providing valuable information regarding an individual's communication difficulties, extending beyond that conveyed by the audiogram. The University of Canterbury Auditory-Visual Matrix Sentence Test (UCAMST) was developed in New Zealand English (O'Beirne, Trounson, McClelland, Jamaluddin, & Maclagan, 2015; Trounson, 2012) with the goal of affording an accurate portrayal of these difficulties encountered in real world scenarios. However, we found that the five-word matrix sentence format (particularly in closed-set response mode) imposed significant cognitive demands on paediatric, and some elderly, participants. In contrast, paediatric matrix sentence tests such as the Oldenburger Kinder-Satztest (OLKiSa) utilise 3-word pseudo-sentences (e.g. number, adjective, object), enabling their use with younger children (Neumann et al., 2012). We describe here the development and evaluation of a paediatric version of our matrix-sentence test, the UCAMST-P.

**Material and methods:** The 5x10 word matrix of the UCAMST was modified to generate the 3x6 word matrix of the UCAMST-P. Forty-three normal-hearing adult participants were used to gather psychometric data for 160 pseudo-sentences for the UCAMST-P in the auditory-alone, open-set response mode. To gather normative data for the UCAMST-P, the performance of 144 normal-hearing English speaking children (aged 6 to 12, 86 M, 58 F) was examined in this condition.

**Results:** The psychometric data gathered from the 43 normal-hearing adult participants enabled the generation of twelve sub-lists of ten pseudo-sentences each, with a mean ( $\pm$  SD) SRT of  $-6.30 \pm 0.66$  dB SNR. Subsequent testing with the 144 normal-hearing children showed a significant effect of age on SRT, with monaural open-set SRTs ranging from  $-4.4$  dB SNR for 6 year olds to  $-6.6$  dB SNR for 12 year olds. There was no significant effect on SRT of household income, ethnicity, presence of disability, or whether the participant was meeting educational standards.

**Conclusion:** The UCAMST-P shows clinical promise as a diagnostic speech test in New Zealand paediatric populations.

**ID: 04042**

### Assessing gross motor skills of children with cochlear implants and children with normal hearing

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**Key Words:** Motor development, hearing loss, cochlear implant

**Background:** Hearing loss is known to adversely affect the development of children. Most of the children with hearing loss display delays in motor development. The aim of our study was to assess gross motor skills of normal hearing children and children with severe to profound hearing loss and cochlear implants.

**Material and methods:** Our study was conducted in Hearing and Speech Centre of Istanbul University Cerrahpasa Medical Faculty. Control group 21 normal hearing children and study group 20 children with hearing loss aged between 3-7 years were recruited. All participants underwent hearing screening and their gross motor skills were assessed by BÜKBÖT (Gross Motor Skills Assessment Test) which is gross motor development test.

**Results:** In the control group, better scores were obtained in locomotor total and object control total scores. In locomotor total p value was 0.0 and in object control total p value was 0.001. Gross motor skills of cochlear implanted children were found to be significantly worse than normal hearing children ( $p < 0.05$ ).

**Conclusion:** In hearing screenings, hearing loss is detected and intervened and focuses on language development. Motor development and vestibular system are not discussed. Because of many children with vestibular insufficiency develop their ability to walk, their inadequacies are not recognized and prevented. The findings of our study suggests that it would be beneficial for rehabilitation programmes to include modules targeting gross motor skills of cochlear implanted children.

**ID: 04046**

### Classical play audiometry versus animated play audiometry

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**Keywords:** pediatric audiology, play audiometry, hearing loss

**Background:** In children, it is generally difficult to test behavioral hearing threshold. Early diagnosis of hearing loss in children has significant implications for a child's social, cognitive and speech development. For this reason, we attempted to develop a behavioral audiological test which can facilitate children's attention and adaptation to the test. Thus, children can complete the test reliably and quickly, while having fun.

**Material and methods:** 30 children (13 male, 17 female; mean age: 5,2 years old; age range: 2,6-7 years) with normal hearing and normal developmental stage were included in the study. All subjects were tested twice, in alternating order. These two methods were compared in terms of test duration and hearing thresholds (at 1000, 2000 Hz). A calibrated TDH-39 speaker, AC-40 audiometer, with "warble tone" stimulus were used in a quiet cabin. Three different animation software, namely, Unity, Adobe Photoshop CS6 and PicsArt applications were used to create for the animated method. The laptop screen was used to display the program. The program starts with the cartoon and game section appears on the screen. Pre-defined social media character (i.e. mickey mouse) "directs" subject tested such as: "Listen and put the toy in the box". Threshold estimations were performed in this manner with a newly designed test. Using this test method, responses of the child evaluated by the audiologist. Animation characters and game screen were used to provide feedback from the audiologist.

**Results:** While conditioning the child, there was a significant difference between the mean test duration of the two methods ( $p < 0.05$ ) and animated play audiometry testing

time was shorter. There was no significant difference between mean hearing thresholds obtained by both tests ( $p > 0,05$ ). However, after conditioning, the mean test duration of the classic method was shorter ( $p < 0.05$ ).

**Conclusion:** Both of the compared hearing threshold test methods are reliable despite the quick completion of the test with the animated play audiometry. The animated method was particularly effective during adaptation and conditioning but it should be improved by speed up the response by the character. This study suggests that animated play audiometry may be useful as a faster and more effective testing preschool children`s hearings.

**Conflicts of interest,** There are no conflicts of interest for any of the authors.

**ID: 04086**

### Assessment of reading ability in fourth grade elementary school children with hearing loss and normal hearing

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**Key Words:** Cochlear implant, hearing loss, language development, reading, reading comprehension

**Background:** Reading is the most important requirement for learning. Many studies have shown that children with hearing loss experience difficulties and delays in reading. The aim of this study is to compare reading comprehension ability of children with hearing loss in fourth grade with children with normal hearing in fourth grade.

**Material and methods:** Fifteen normal hearing children (aged between 111 - 138 months) and 30 (16 CI, 14 HA) children with hearing loss were included in this study. Reading comprehension measure tool, Bender Gestalt Visual Perception Test, Turkish Expressive and Receptive Language Test (TIFALDI), the number of words read per minute, punctual misunderstood inventory and oculomotor tests were applied to the children. Besides, medical, audiological, social and educational data were collected from the children.

**Results:** Significant differences were found between the normal and hearing loss groups (HA, CI) in the analysis of reading comprehension scores, TIFALDI scores, the number of words read per minute and word comprehension levels. The results of cochlear implant group were found to be lower than the other groups. ( $p < 0.05$ )

**Conclusion:** It has been shown that reading and language skills of children with profound/severe hearing loss are adversely affected as they are implanted late. It is thought that our research will exacerbate early implantation discussions. The early provision of an auditory input and the addition of studies to improve reading skills in the educational process are essential for children with hearing loss in terms of catching their peers.

**ID: 04110**

### Protocol for early detection and management of hearing loss from bacterial meningitis in children

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**Key-words:** bacterial meningitis – pediatric hearing loss

**Background:** Bacterial meningitis is the most common cause of acquired hearing loss in children. Permanent sensorineural hearing loss affects up to 35% of patients after bacterial meningitis. Fibrosis and calcification of the cochlea can be fast, *Streptococcus pneumoniae* being the most important pathogen involved, hence the need for prompt diagnosis. In Portugal, a guideline for Screening and Treatment of Pediatric Deafness with cochlear implants, updated in 2017, advocates that children with bacterial meningitis should undergo hearing evaluation before hospital discharge. However, there is no standard protocol for the management of these children.

**Material and methods:** Review of all patients admitted to the pediatric ward of a level 2 portuguese hospital with the diagnosis of bacterial meningitis, for a period of three consecutive years. Audiologic evaluation and follow-up were assessed. Following this case series, a protocol for the management of hearing loss in children with bacterial meningitis was drawn.

**Results:** Nine patients were identified with bacterial meningitis during the studied period. Median age was 9 months and mean age was 4 years (from 6 days to 17 years old). The most prevalent causative agent identified was *Streptococcus agalactiae* (33%). Six patients (66,6%) were referred to an otorhinolaryngologist, with a mean time between hospital discharge and observation of 73 days. Five children underwent hearing assessment through brainstem auditory evoked potentials, one of them before discharge from the hospital. Two had unilateral sensorineural hearing loss: one of them profound and irreversible and the other mild, that reversed after 15 months.

**Conclusion:** Greater awareness for the risk of hearing loss from bacterial meningitis is needed among health care professionals. The authors propose a protocol for hearing evaluation and referral of children with meningitis, in order to improve early detection and management of hearing loss.

The authors declare that there are no conflicts of interest.

## Free Papers 12

ID: 03951

**Individualized models of the auditory nerve response to cochlear implant stimulation****Bernhard Seeber, Marko Takanen, Kauê Werner***Audio Information Processing, Technical University of Munich***Keywords:** Cochlear implant, model, ECAP, individualization, auditory nerve

**Background:** Cochlear implants (CIs) restore hearing for profoundly deaf people by stimulating the auditory nerve fibers (ANFs) directly with electrical pulses. Several stimulus-, electrical field- and ANF- properties affect the responsiveness of the ANF to a particular stimulation pulse, with pulses of a sequence interacting in a complex fashion. Optimization of the CI's stimulation pattern for its ANFs response thus holds great potential for improving CI stimulation strategies.

**Material and methods:** We present a functional model for the ANF response to single pulses and pulse-train sequences and show that it can reproduce the most relevant aspects of the ANFs response. The model builds on the biphasic leaky integrate-and-fire model by Horne et al. (Front. Comput. Neurosci., 2016) which we have extended to include elements that simulate refractoriness and facilitation/accommodation by affecting the model's threshold value momentarily after supra- and subthreshold stimulation. Together with an electrical field propagation model and a nerve density estimation the model can predict the response of tonotopically arranged nerve fibers to stimulation on multiple CI electrodes. The model features a limited set of parameters which can be estimated from two-pulse masking measurements using evoked compound action potentials (ECAP) and psychophysical threshold and loudness growth measurements in patients.

**Results:** We show that our revised model can reproduce neurophysiological data from single-neuron recordings considering refractoriness, facilitation, accommodation and spike-rate adaptation phenomena that affect the responsiveness of the ANF to ongoing pulsatile stimulation. The model can be fitted to published ECAP and psychophysical data of individual patients and reproduce them.

**Conclusions:** The new phenomenological ANF model capable of reproducing spatio-temporal interaction effects at nerve level for multi-electrode electrical stimulation can be fitted to the individual characteristics of patients. The model thus paves the way for future detailed analysis of evoked nerve activity, loudness and binaural modeling and the prediction of inter-individual differences. In future work, modeling psychophysical behavior will permit the evaluation of individual stimulation parameters with the aim to improve CI strategies.

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ID: 03952

**Objective measures to characterize the electrical properties of the cochlear implant (CI) electrode array and the surrounding tissue****Goetz Brademann<sup>1</sup>, Angel Ramos de Miguel<sup>2</sup>, Juan Carlos Falcon<sup>2</sup>, Timo Stoeber<sup>3</sup>, Manuel Manrique<sup>4</sup>, Robert Cowan<sup>5</sup>, Ulrich Hoppe<sup>6</sup>, Matthias Hey<sup>1</sup>, Uwe Baumann<sup>7</sup>, Alicia Huarte<sup>8</sup>, Tim Liebscher<sup>6</sup>, Riaan Rottier<sup>9</sup>, Nicole Neben<sup>10</sup>, Angel Ramos<sup>11</sup>**<sup>1</sup> *Department of Otorhinolaryngology, Head and Neck Surgery, Christian-Albrecht-University of Kiel, Kiel, Germany*<sup>2</sup> *Acoustic lab - Audiology, Complejo Hospitalario Universitario Insular Materno-Infantil de Gran Canaria, Las Palmas, Spain*<sup>3</sup> *Otorhinolaryngology - Head and Neck Surgery, Klinikum der J.W. Goethe-Universität, Frankfurt, Germany*<sup>4</sup> *Otorhinolaryngology - Head and Neck Surgery, Clinica Universidad de Navarra, Pamplona, Spain*<sup>5</sup> *HEARING CRC, University of Melbourne, Carlton, Australia*<sup>6</sup> *Audiology, Universitätsklinikum Erlangen, Erlangen, Germany*<sup>7</sup> *Audiology Klinikum der J.W. Goethe-Universität, Frankfurt, Germany*<sup>8</sup> *Audiology, Clínica Universidad de Navarra, Pamplona, Spain*<sup>9</sup> *Sound Processors and Clinical Care, Cochlear, Sydney, Australia*<sup>10</sup> *Clinical Studies, Cochlear, Hannover, Germany*<sup>11</sup> *Otorhinolaryngology - Head and Neck Surgery, Complejo Hospitalario Universitario Insular Materno-Infantil de Gran Canaria, Las Palmas, Spain*

The ECAP of the auditory nerve is suitable to verify the CI integrity, nerve excitability and gives an indication for the proper positioning of the CI array in the cochlea. Gold standard to verify the correct intra-cochlear CI array position is radiological imaging (cone beam CT, CT scan). It is most useful to confirm the electrode position intra-operatively, directly after insertion of the electrode array, but it is time consuming, costly and exposes the patient to radiation. Therefore a reliable objective measurement to characterise the position of the CI array while avoiding radiological imaging would be advantageous for the procedure and benefit the patient. This clinical investigation gathers ECAP as well as other objective measurements intra- and post-operatively to characterise the electrical properties of the electrode array in the cochlea after insertion.

154 Cochlear Nucleus® CI512 and CI532 cochlear implant recipients were enrolled over a period of 15 months from centres in Germany, Spain and Australia. Objective measures such as ECAP, electrode impedances, trans-impedance matrix (TIM) and intra-cochlear voltage measurements as well as radiological imaging were obtained. The test battery was conducted intra-operatively, during first activation and 3 months post-operatively to explore the association between the TIM measurements, ECAP thresholds and the radiological findings.

In general TIM measurements were reliable. Inter-individual variations in measurements were observed for trans-impedance matrix measurements. These variations are

potentially caused by anatomical differences of the cochlea and geometrical position of the electrodes. First results indicate coherence between the study measurement and state of the art clinical routine verification methods as radiological imaging and spread of excitation to identify intra-cochlear electrode position. The absences of CI electrode tip fold-overs were detected correctly.

The outcome suggests that intra-operative objective measurements can detect some of the CI electrode array position variations that traditionally required radiological imaging. Thus these measurements could be useful for confirming the correct positioning of the CI system and might replace or avoid radiological imaging during a cochlear implant surgery. The absence of CI electrode folds can be detected intra-operatively without radiological imaging.

Rottier & Neben are employees of Cochlear Ltd. The other authors report no conflict of interest.

**ID: 03954**

### Short-term and long-term hearing performance in 150 subjects provided with a Ci532

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**Background:** The Nucleus® CI532 cochlear implant with Slim Modiolar electrode combines a slim electrode array with a modiolar near placing. This study is going to concentrate on audiological outcomes. In a retrospective multi-center study we investigated routine audiological outcomes in a group of 150 adults. Finally, benchmark data should be established.

**Objectives:** The aim of this study was to assess hearing performance and electrophysiological characteristics for a large cohort of German speaking adults provided with a CI532.

**Methods:** Hearing thresholds, speech recognition in quiet and in noise were measured in unaided and aided conditions. Audiological data were acquired pre-operatively as well as 3 and 6 months post-operatively in 150 CI532 recipients. In addition, medical history and recipients' electrode-specific objective and subjective measures (impedances, T-NRT, T- & C-Levels) and data logging were evaluated.

**Results:** CI aided speech understanding in quiet and in noise at six months post activation improved over pre-operative baseline performance by a clinically relevant and statistically significant amount. The proportion of the recipients' cohort examined showing a post-operative improvement for test and listening condition is 96 % for the 6 months post-operative visit. The mean T-NRT profile reflects the close proximity of the CI532 electrode array to the modiolar while showing increased threshold levels towards the basal part of the cochlea.

**Conclusion:** Our study presents sufficient evidence on the high level of outcome performance with CI532 assuring close proximity to the modiolar.

**ID: 03959**

### Investigation of electrically evoked auditory brainstem responses changes in children with sequential bilateral cochlear implants

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**Keywords:** eABR, Cochlear Implant

**Background:** Many cochlear implant (CI) users receive auditory brainstem stimulation, including the first moment of electrical stimulation from a CI, and this stimulation can be traced as an electrically evoked auditory brainstem response (eABR) wave. For this reason, the eABR test can be used for functional assessment of the auditory system at the time of CI activation and after long-term CI use. Long term unilateral hearing is thought to be effective on the maturation of the auditory system. The aim of this study, in subjects who received sequential bilateral CI, to investigate whether continuous auditory stimulation in the second ear caused a difference in eABR measurements between the two ears over time.

**Material and Methods:** In this study, we have included 13 subjects under 5 years old who used Cochlear or MED-EL implants for at least 6 months in the first ear and a second implant to the other ear sequentially. Post-implant evaluations are conducted on the 1st, 3rd and 6th months of the implantation in the basal, medial and apical electrode positions. The recording was started with the second implant, then the first ear was tested. eABRs are measured by using high stimulation levels recorded (200 CL for Cochlear, 800 CU for MED-EL).

**Results:** eABR results indicate when eV wave latencies are examined for all electrode positions; second ear is significantly higher than the first ear ( $p < 0,05$ ). When eV wave amplitudes are examined for all electrode positions; first ear is significantly higher than the second ear ( $p < 0,05$ ). eV latencies and amplitudes changes between the ears have been

examined up to 6 months after implantation. Statistically significant changes were observed in basal ( $p < 0,05$ ), medial ( $p < 0,05$ ), apical ( $p < 0,05$ ) electrode positions for eV wave latencies, and only in medial electrode ( $p < 0,05$ ) position for eV wave amplitudes. These changes have decreased over time.

**Conclusion:** The postoperative eABR test is a valuable test battery that provides the clinician with important ideas about the estimated threshold, comfortable audible sound level, CI performance and auditory pathways up to brainstem. In our study, evaluations made at the end of 6 months; that the latency difference between the ears is less pronounced in the basal electrode position than in the medial and apical electrode position. Since the maturation is still ongoing, a longer period than 6 months may be needed to evaluate the difference properly.

**ID: 03989**

### The impact of low rate stimulation on speech understanding and sound perception using the ACE strategy

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**Background:** Low rate stimulation in cochlear implant (CI) subjects has gained interest recently, as the development of smaller speech processors is increasingly challenging. Due to the transcutaneous wireless signal and power transmission, the power consumption of CI systems is inherently high. Subsequently, the relatively large battery occupies a significant amount of space inside the external speech processor. With lower stimulation rates, a significant reduction of the systems' power consumption could be achieved. However, former studies on performance at lower stimulation rates were not yet conclusive, so a new study investigating the effect of stimulation rate on speech understanding as well as frequency discrimination at lower rates was initiated. Frequency discrimination is an important aspect, as lower stimulation rates might hamper the perception of rate pitch, i.e. the perception of the fundamental frequency of different talkers in so called cocktail party scenarios.

**Method:** The study consisted of an active and a passive branch. Subjects with the latest generation of Cochlear devices using the ACE strategy were selected. In the active part, rates of 1200 Hz and 500 Hz have been compared with regard to frequency discrimination and modulation detection. In the chronic part, rates of 900 Hz and 500 Hz were compared to each other. Speech tests (Monosyllables and Oldenburg Sentence Test) as well as frequency discrimination have been examined at 900 Hz first. Subsequently, subjects have been sent home with a 500 Hz stimulation rate for accommodation and the test battery was repeated at 500 Hz three weeks later.

**Results:** The results show equal hearing performance at the different stimulation rates.

**Conclusion:** Lower stimulation rates in the range of 500 Hz are applicable without limitations in the clinical routine.

**ID: 04000**

### Influence of cerebral abnormalities in pediatric cochlear implant recipients on auditory perception and speech outcomes

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**Keywords:** cerebral MRI abnormalities, cochlear implant recipients, auditory perception

**Background:** Several studies demonstrated that certain CNS abnormalities and some white matter changes noted on MRI studies in children, may be associated with poor or delayed neurodevelopment. The objectives of our study is to determine the incidence of brain abnormalities as detected by preoperative brain MRI scans in pediatric cochlear implant (CI) candidates, to clarify their influence on hearing and speech outcomes after CI and to highlight whether these abnormalities should be viewed as contraindication for CI or not.

**Material and Methods:** Our study is a retrospective chart review to detect brain abnormalities in pediatric CI recipients with preoperative temporal bone and brain MRI scans. Progress in auditory perception and speech language outcomes were assessed for at least 2 years. Performance in patients with brain lesions was compared with the age- and sex matched control group.

**Results:** Among 197 pediatric CI recipients having preoperative temporal bone and brain MRI studies, 23 cases (11.4%) showed various brain abnormalities as follows:  $n=14$  (61%) white matter changes (focal vs diffuse);  $n=3$  (13%) ventriculomegaly;  $n=6$  (26%) extra-axial lesions. Of the 23 cases,  $n=19$  (82%) did expectantly with post-operative auditory perception and language development and  $n=4$  (18%) with diffuse white matter changes demonstrated significant delays and difficulties in rehabilitation.

**Conclusions:** MRI of the temporal bone as part of the evaluation protocol of cochlear implantation in children should include CNS screening. Pediatric CI recipients with brain abnormalities are not considered an absolute contraindication for CI. Patients and their families should be counseled about the possibility of less than ideal post-implantation outcomes of auditory perception, speech and language. We advise to implant them with an MRI-safe conditional CI device, enabling brain MRI follow-up scans without surgical magnet removal.

**No conflicts of interest**

ID: 04002

## Cochlear implantation in syndromic deafness: challenges, hearing and speech rehabilitation outcomes

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**Keywords:** syndromic deafness, auditory perception, speech outcomes

**Background:** Syndromic deafness form 30% of patients with prelingual genetic hearing loss. Over 400 syndromic form have been characterized. Cochlear implantation (CI) in syndromic children is a challenge for the implant team in both its surgical and rehabilitation aspects. This is because of the anatomical malformations (inner ear malformations, absent or hypoplastic cochlear nerve, abnormal course of facial nerve, excessive CSF leaking) and the unpredictable physiological benefit with auditory stimulation. In the literature, small series of cochlear implants in individual syndromes have been reported.

**Material and Methods:** Our work is a retrospective clinical study. We reviewed a total of 840 patients with pediatric cochlear implantations between 2011 and 2017. We report on twenty four cochlear implantation in syndromic pediatric patients with profound sensorineural hearing loss.

**Results:** The syndromes clinically identified were, Waardenburg syndrome (n=8) ; Usher syndrome (n=5); Jervell, Lange-Nielson syndrome (n=5); Pendred syndrome (n=2); Hutchinson-Gilford Progeria syndrome (n=2); Charge syndrome (n=1); Keratitis-Icthyosis Deafness (KID) syndrome (n=1). After a minimum of 18 Months following implantation hearing and speech perception results were assessed. There was significant variation of outcome between and within syndrome groups.

**Conclusion:** Additional disabilities are frequently encountered when considering children for cochlear implantation. In many cases, such disabilities will form part of a recognized syndrome. Additional disabilities are frequently encountered when considering children for cochlear implantation. In many cases, such disabilities will form part of a recognized syndrome. Knowledge of these syndromes can alert the cochlear implant team to potential difficulties that may be encountered such as anatomical abnormalities and potential anesthetic complications. The auditory perception and speech outcomes in such cases are often excellent but can be variable even within the same syndrome group, and such children are therefore assessed on an individual basis to ensure a realistic expectation.

ID: 04003

## Cochlear implantation in bilateral profound deafness after head trauma

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**Keywords:** cochlear implantation, bilateral temporal bone fracture, head trauma

**Background:** Head trauma with temporal bone fracture is one of the most common traumatic injuries that cause loss of auditory and vestibular functions. Temporal bone fractures that involve the otic capsule can cause destruction of the organ of corti, which results in sensorineural hearing loss. Even if a definitive fracture is not identified on CT scan, hearing loss can result from micro-fractures or cochlear concussion. Patients with profound bilateral hearing loss caused by temporal bone fractures may benefit from cochlear implantation if the functions of the auditory nerves and brain are intact.

**Material and Methods:** We report the cochlear implantation results (surgical, speech and language outcomes) of eight cases of postlingually deafened patients presented after bilateral cochlear trauma.

**Results:** All patients gained useful open-set speech perception, with hearing results comparable to implanted patients with other etiologies of deafness.

**Conclusion:** Cochlear implantation has been demonstrated to be effective for hearing rehabilitation in patients with bilateral profound sensorineural hearing loss caused by temporal bone trauma. It remains the standard hearing rehabilitation treatment for temporal bone fractures without compromise of the cochlear nerve.

**No conflicts of interest**

ID: 04022

## Objective help for CI fitting AutoART and applications

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**Keywords:** Auditory Nerve Response Telemetry, cochlear implant fitting, rehabilitation

**Background:** In optimal cases we cooperate with the patient during the soundprocessor fitting to be the most suitable for the patient. In order to get this it is necessary to identify the Most Comfortable Level (MCL). In literature and in our clinical experience it is efficient to approximate MCL Auditory nerve Response Telemetry.

**Materials and methods:** Auditory nerve Response Telemetry is integrated in the Maestro 7.0 software. In this program one can find the AutoART method, which helps in the parametrization of the measurement. We show this tool and our experiences with the ART fitting function in the case of 20 postlingual patients.

**Results:** The autoART measures the ECAP thresholds on every electrode with a high speed (approx. 2 min). The patients do not feel any discomfort or pain. We fitted the MCLs of the patients, than we performed an other MAP with ART fitting. We summed their observations.

**Conclusion:** With the information we got through these comparisons, we expect this method to be a base for the fittings with children. We can measure postoperative ART fast, therefore the children stay patient in the meantime. Combining with intraoperative evoked stapedius reflex measurement the soundprocessor can be programmed easily in the case of not cooperative patients and children.

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ID: 04030

#### The benefits of the cochlear implant in single sided deafness - event related potentials (ERP-P300)

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**Keywords:** Cochlear Implant; Hearing Deprivation; Event-Related Potentials-P300; Neuroplasticity

**Background:** Single Sided Deafness (SSD) has a significant impact on the life of the person, sometimes leading to social isolation. Current data show that binaural hearing is superior to monaural hearing in speech understanding in noisy environments as well as in the location of the sound source. In recent years, P300 has been emphasized in the investigation of the benefits of using the Cochlear Implant (CI) in the speech perception. The primary objective was to evaluate the benefit of the CI on the cognitive ability to differentiate verbal stimuli from background noise, in SSD, through P300. Following this, a specific objective was established: explore the effects of different time lengths of hearing deprivation and explore differences in speech perception with white noise and TTB (two talker babble).

**Material and methods:** It is a descriptive exploratory cross-sectional study. The sample contained two patients presenting with SSD and utilizing a CI (Cochlear Nucleus 6). The P300 was performed in a controlled setting, each time with the same methodology in four different conditions. The stimuli were presented in the Oddball Paradigm.

**Results,** The results show higher amplitudes in the P300 wave in the W/ CI condition compared to the amplitudes in the W/O CI condition in the majority of the electrodes. One can also observe differences between the TTB and

WN, there being a clear tendency for the TTB noise to affect the speech perception of the patients with CI more severely, than the WN. During the analysis of the topographic maps, it is observed that a greater activation corresponds to a higher amplitude, in the W/ CI compared to the W/O CI conditions.

**Conclusion,** SSD leads to extensive adaptation of the central auditory system and consequently reflects its representation in the brain. However, this adaptation can be reversed through auditory rehabilitation with the CI, or even prevented by early implantation in the case of children, whose benefit at a cortical level were verified through the results of the P300.

**Disclosure of Interest:** None Declared

ID: 04085

#### Sequential bilateral cochlear implantation in children: outcome of the second implant and long-term use

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**Background,** The benefits of bilateral cochlear implantation in congenitally deaf children mainly consist of better speech perception in the presence of background noise and the availability of directional hearing. It is widely agreed that sequential implantation at a younger age and with a shorter interimplant interval achieve better results, but exactly how long constitutes “too long” is less well defined. The aim of the present study is to evaluate the rate of speech recognition progress for the second implanted ear and with bilateral cochlear implant in sequentially implanted children.

**Methods** Retrospective review of our outcomes in tonal and speech perception tests in quiet of pediatric patients submitted to a sequential bilateral cochlear implantation since 1992 at our tertiary care center.

**Results** A total of 29 patients were eligible and included in the study. We defined a cutoff of 36 months for interimplant interval and separated patients in two groups according with their surgery intervals (Group 1 ( $\leq 36$  months); Group 2 ( $\geq 37$  months)). We had 23 patients in Group 1 and 6 in Group 2. Mean age at the second surgery was lower in Group 1 when compared with the patients of Group 2 (25,3 $\pm$ 11,7 months vs 99,9 $\pm$ 54,7 months, respectively). There was no difference between both groups in the tonal tests, with medium threshold being 30dB with both implants. When tested for discrimination with monosyllables, words, numbers and sentence we found a significant statistical difference ( $p < 0,05$ ) between Group 1 and Group 2, with Group 2 patients performing much worse.

**Conclusion** A major interimplant interval was associated with a worse outcome and patients receiving the second implant in the first 36 months after the first surgery achieved statistically better results in speech perception tests. However, even patients with a bigger interval between surgeries, good outcomes in the discrimination tests could be obtained when patients use a hearing aid during the interimplant interval. An extensive preoperative counseling and individualized evaluation are critical to ensure that patients and families understand the range of possible outcomes.

**ID: 04089**

### Swiss National Cochlea Implant Register: preliminary analysis of speech development

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**Keywords:** cochlear implant, children, speech development, grammar comprehension,

**Background:** The Swiss National Cochlea Implant Register contains all cochlear implants implanted or fitted in Switzerland. In addition to patient medical and technical data, logopaedic data is also collected. Here we present an analysis of grammar comprehension in speech of children with cochlear implants.

**Material and Methods:** The Implant Register contains data of all cochlear implant centres in Switzerland (Basel, Berne, Geneva, Lucerne, Zurich). For centres located in the German speaking part of Switzerland standardized test battery of speech development was established. One test used is the TROG-D [1] test, which is an adapted German version of the test for reception of grammar by Bishop [2]. We analysed 281 results of the TROG-D in terms of age in three groups 3.0 – 5.11 years, 6.0 – 8.11 years, 9.0 – 10.11 years.

**Results:** In 65% of the tests the TROG-D the provided a numeric age-related value (T-Value). The test results were heterogeneously distributed. 36% of the results were within the range for normal hearing children in the same age whereas 50% of the results were less than normal. Comparing the three age-subgroups the median value decreased stepwise with age. A Kruskal-Wallis-test showed a significant difference between the oldest and youngest group ( $p < 0.001$ ).

**Conclusion:** Grammar skills of children from all German speaking Swiss CI centres deviate with increasing age from the data of normal hearing subjects. A similar tendency is

observed for children with needs for speech therapy and children brought up with multiple languages [1]. One explanation for this result could be the performance of CI itself, as it is a prosthesis. Another factor might be the prominent difference between Swiss-German and Standard-German as well as the presence of multiple languages in Switzerland. Finally, entries in the Swiss CI database will need to be changed as the current use of the standard results from the TROG-D test leads 32% of test results with no quantitative value.

**Conflicts of interest:** The authors declare that there is no conflict of interest.

**ID: 04103**

### Objective and subjective results with two types of electrodes and the same cochlear implant electronics in pediatric subjects

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**Keywords:** cochlear implant, electrode, perimodiolar, objective testing

**Background** The authors' aim was to compare the influence of various electrode designs on selected objective and subjective clinical outcomes for cochlear implant recipients using the same model of receiver-stimulator, Cochlear™ Nucleus® Profile Series and sound processor.

**Material and methods:** A study with pediatric subjects with profound sensorineural hearing loss, who were implanted and followed up in a tertiary center. The subjects were implanted with Cochlear™ Nucleus® CI532 and Nucleus® CI512. Intraoperative electrophysiological tests (electrically evoked stapedial reflex threshold [ESRT], neural response telemetry threshold [T-NRT] and impedance), postoperative data (C-level, T-level, dynamic range, T-NRT and power consumption) and intracochlear position of the active electrode were analyzed with Nucleus Custom Sound 4.4 software.

**Results:** Outcomes for mean intraoperative ESRT, T-NRT and postoperative T-NRT values were lower in the CI532 group compared to groups using the CI512. Despite similar mean C-levels measured for groups using the CI532 and CI512, power consumption was significantly lower for CI532 users.

**Conclusion:** The Slim Modiolar electrode takes the position that is relatively closest to the modiolus, in turn, resulting in more efficient stimulation and reduced power consumption.

ID: 04108

## Predicting long-term speech and language outcomes in paediatric cochlear implant recipients

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**Keywords:** Implant, Children, Outcomes

**Background:** Paediatric cochlear implantation aims to develop age appropriate spoken language skills and intelligible speech. Much research excludes children with additional difficulties, and those whose home language is not the same as the test measures. It is essential to fully understand all the factors that influence long-term outcomes. With this information the rehabilitation and audiological pathways can be streamlined to focus resources where needed the most. This research was a service evaluation of all children implanted in a UK cochlear implant programme. Data from children over 5 years post implant was included. No child was excluded based on demographics.

**Objectives:** The goals were to: Describe the development of speech and language skills over time following implant activation. Understand the factors that influence rate and extent of speech and language acquisition. Develop a triage system to support the paediatric cochlear implant rehabilitation pathway

**Methods:** Longitudinal data was collected for children implanted between 1998 and 2013 with at least 5 years listening experience. Standard paediatric implant pathways were followed. Data was collected at: pre-implant, and post-implant at 1-, 2-, 3-, 5-, 7-, 10-years. Data will be presented from 5, 7 and 10 year intervals. There are datasets from 158 children at 5 years, 113 children at 7 years and 80 children at 10 years post-implant activation. The mean age at first implant was 45 months (median 35 months) ranging from 10 to 138 months. For device configuration there were 24 children implanted unilaterally, 14 with bimodal implants, 70 sequentially implanted and 50 with simultaneous implants. Outcome measures were the Speech Intelligibility Rating (SIR) and the Clinical Evaluation of Language Fundamentals (CELF).

**Results:** Improvements were observed over time for SIR and CELF scores. Analysis suggested that age at implantation, type of loss, device configuration and home language were main predictors of outcome. Findings will be explored to derive a triage system for rehabilitation and audiological pathways.

**Conclusion:** If simultaneously bilaterally implanted early with a good language models of the native language, many children would be expected to achieve speech and language abilities within the typical range. A triage system to determine families where additional support is required to optimise their child's outcomes is suggested.

**Conflicts of interest:** None

ID: 04115

## Outcomes and daily time use of cochlear implants in post-lingual adult patients

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**Keywords:** cochlear implants, adults, outcomes

**Background:** In literature, many studies have reported that duration of deafness, age at implantation, and preoperative residual hearing are important factors for postoperative auditory outcomes in adults with post-lingual deafness. However, the role of long-term deafness in cochlear implant performance, as well as the limits for implanting an auditory deprived ear are still not well established. In the present study, the authors aim to analyze cochlear implants outcomes and the daily use of the device in adults with long-term, post-lingual deafness.

**Material and Methods:** Retrospective data of post-lingual adult patients implanted in our center between 2016 and 2018 were analyzed. Age at implantation, sex, etiology of hearing loss, duration of deafness and the results of speech perceptions tests performed preoperatively and postoperatively have been collected. For the analysis, the patients were divided in two groups according to the duration of the hearing loss: group A (less than 20 years) and group B (more than 20 years). It was also analyzed the time of use of the cochlear implant per day.

**Results:** Preliminary data were available for 32 patients, and the mean age of implantation was 64,3 years. Duration of deafness was available for 24 patients: 14 patients in group A and 10 patients in group B and regarding speech outcome the two groups were similar. No differences were found between the groups in demographic variables. Patients used their cochlear implant for 11,8 hours (range 4,1 to 16,1).

**Conclusion:** Good outcomes are achieved in post-lingual adults, who consistently use their cochlear implants. The results suggest that the duration of post-lingual hearing loss didn't affect the cochlear implant use or the discrimination outcomes. Patients with severe-to-profound hearing loss who cannot have benefit from conventional hearing aids should proceed with cochlear implant.

ID: 04117

## Early fitting objective performance vs standard activation objective performance

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**Keywords:** cochlear implant; early fitting; electrode impedance

**Background:** Cochlear Implantation allowed the hearing re(ha)bilitation in case of severe to profound sensorineural hearing loss. The activation of the sound processor of the implant is a principle that among the years haven't change, and is usually made after 1 month of the surgery. Some centers are currently using a much smaller period (less than 8 days post op) to activate the processor. The objective of the study is to compare impedance level of the electrodes and audiometric results of patients after standard activation (1 month post op) and after early fitting (4 to 7 days post op), in Hospital Lusíadas Lisboa.

**Material and methods:** We performed a retrospective review of all cochlear implant patients who underwent standard activation in 2017 and cochlear implant patients with early fitting before the 8th day postoperatively during 2018, in our center. All patients were implanted with a Nucleus CI 522. Any discomfort or local healing complications were registered. Impedance measurements were obtained intraoperatively and on activation day, one and 3 months post processor activation. Audiometry results were obtained at 1 month and 3 months post processor activation.

**Results:** Twenty two patients were enrolled in the study, 8 from standard activation and 14 from early fitting. Impedance values usually dropped from activation to the first month measurements and then stabilized at the third month. Audiometry results indicate that in the early fitting group is more effective than in the standard group.

**Conclusion:** Early fitting was safe and allowed a good performance to provide early sound perception and speech recognition, although further experience is needed before it can be considered the standard procedure.

ID: 04125

## Cochlear implantation in patients with Ménière's disease

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**Keywords:** Ménière's Disease; Cochlear Implants; Hearing Outcomes; Data Logging

**Background:** Ménière Disease (MD), described in 1861 by Prosper Ménière, is a chronic disease that affects the inner ear and is characterized by a typical triad of symptoms. Despite multiple advances in the understanding of this disease, the etiology of MD remains unknown. With the passing of the years, there is a reduction in the impact of the symptoms, namely through changes in lifestyle and medical or surgical treatment. Cochlear implantation is widely accepted as an effective rehabilitation therapy for patients with severe to profound hearing loss. It has also been shown as a successfully effective rehabilitation therapy for patients with MD. However, there is a variability in rehabilitation outcomes after cochlear implantation, being the outcomes of cochlear implantation depend on several

factors. Currently, it is possible to measure auditory environmental factors, as well as the time of use, through the Data Logging.

**Material and methods:** A retrospective study that included adult patients undergoing cochlear implant surgery diagnosed with MD between May 2011 and July 2018, according to the criteria established by the AAO-HNS 1995. Using R software, with a significance level of  $<0,05$ , demographic variables age and sex, laterality of MD and Cochlear Implant (CI), hearing outcomes before and after surgery and daily time of use (DTU) of the CI were evaluated.

**Results:** Statistically significant differences were found when comparing pure tone average (PTA) Pre-CI and Post-CI. Statistically significant differences were also found when the discrimination in the speech audiogram was evaluated at 70dB Pre-CI and Post-CI. When the sample is divided into groups according to the DTU of the CI, there are differences, between groups, in the implanted ear when comparing PTA Pre-CI and Post-CI. Finally, differences are found for the contralateral ear, in the DTU, when compared the Pre-CI PTA and Post-CI PTA.

**Conclusion:** Cochlear Implantation is an effective and safe treatment for patients with MD. Patients with single-sided deafness or better PTA in the contralateral ear is estimated using fewer hours the CI. MD patients are "good users" of CI. In addition to speech discrimination, the DTU of the CI may be another useful tool in the evaluation and improvement of adaptation and gain in patients with MD.

**Conflicts of interest:** There are no conflicts of interest.

ID: 04137

## Personalized electrode array insertion for cochlear implantation

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**Keywords:** Cochlear Implant, Robotics, Atraumaticity

**Background:** The gold standard for cochlear implantation is an atraumatic procedure to preserve residual neuro-sensory structures and thus residual hearing. Using soft surgery, residual hearing can be preserved in nearly all the cases immediately after surgery although it will further decline leading to a total hearing loss in 50% of patients after 7 years follow-up (Kaplan Meyer analysis). In only 20% of them this could be accounted for by the natural history of individual deafness.

**Material and methods:** To achieve an atraumatic insertion several anatomical parameters should be evaluated for each cochlea and the choice of the electrode array should be made considering simulation of the electrode insertion in the defined cochlea together with the use of tools connected to a robot based navigation system.

**Results:** First step is to analyzed the cochlea in which the electrode will be inserted. The parameters defining the cochlea are calculated on CT Scan views and modeled. Second step is to calculate the optimal axis to insert the electrode array the closest as possible of the center line of the basal turn of the scala tympani considering the positioning of the fallopian canal in the posterior tympanotomy route. Third step is to simulate the electrode insertion on the modeled cochlea with the control of friction forces. During the simulation procedures the speed of insertion is evaluated to limit the friction forces on the lateral wall and/or basilar membrane and avoid any translocation into the scala vestibuli. At this stage, different kinds of electrode can be tested to choose the less traumatic. Fourth step is the electrode insertion using a motorized tool enslaved to an embarked force sensor and connected to a robot-based navigation system (Robotol) and taking into consideration all the parameters previously estimated for the proposed cochlea.

**Conclusion:** All these steps are available in the research laboratory although most of them are available today in the operating room.

No conflicts of interest

ID: 04140

### Influence of microphone directivity on static and dynamic localization and minimum audible angle with bilateral cochlear implant users

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**Keywords:** Natural Mode, Localization Error, MAA

**Background:** The Sonnet™ CI Audio Processor (Med-El) offers a setting to imitate the natural directivity of the Pinna (Natural Mode, NM). The aim of this prospective comparison study was to evaluate localization performance with an omnidirectional microphone mode (OM) and the NM setting.

**Material and Methods:** 12 good performing bilateral CI users and 12 normal hearing (NH) subjects were included. The static localization ability was tested with 12 non-visible loudspeakers equally aligned in a horizontal full circle. A total of 36 stimuli (pink noise, 200 ms, 60-70 dB SPL) were played. The minimum audible angle (MAA) was measured at 4 positions (front, back, left, right). A total of 24 stimuli per direction, with an intra-stimulus interval of 1 s, were used (pink noise, 200 ms duration, 65 dB SPL). Dynamic localization ability was evaluated with a hidden physically circular moving sound source continuously playing a stimulus (speed 7.4 degrees/s; pink noise, 65 dB SPL). Two movement trajectories were tested (T1:

90° with 1 change of direction; T2: 2070° with 32 changes of direction). Subjects were instructed to indicate the position of the sound source using a touchpad. The absolute error summed over time (in °s) was used to assess dynamic localization performance.

**Results:** The mean absolute localization error (MAE) including front-back-confusions (FBCs) improved from 49° in OM to 39° with NM ( $p < .01$ ); NH control group: 10°. The average number of FBCs decreased from 9 (OM) to 6 (NM) ( $p = .04$ ). After exclusion of the MAE between OM (32°) and NM (28°) was observed ( $p = .23$ ). For the MAA, measurements from the front (OM: 4.3° vs. NM: 4.1°,  $p = .78$ ; NH: 1.2°) or from the rear (OM: 7.0° vs. NM: 8.4°,  $p = .76$ ; NH: 2.6°) did not show major differences. In contrast, the NM strongly improved the MAA on the right side (OM: 71.9°, NM: 34.7°,  $p < .01$ ; NH: 6.5°) and the left side (OM: 79.0°, NM: 40.7°,  $p < .01$ ; NH: 7.5°). In the dynamic localization tests, the absolute error integrated over time for T1 was 4.6°s with OM and 4.2°s with NM ( $p = .38$ ). For test T2 the result was 3.5 °s with OM and 3.3 °s with NM ( $p = .34$ ).

**Conclusion:** Our data suggest that the pinna-imitating microphone directivity improves the localization performance of bilaterally implanted CI users by reducing FBCs and improving MAAs. Our dynamic localization tests showed small improvements with the NM compared with the OM setting.

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ID: 03882

### How to identify auditory neural energetic vulnerability

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**Keywords:** Fatigability, Auditory brainstem, Conduction velocity, Neurodegeneration

**Background:** The auditory brainstem responses (ABR) are conventionally used to evaluate neural conduction in the auditory pathways and to determine an auditory threshold (using either click or tone burst). It is also important to remind that this electrophysiological technique -based on the averaging- is the gold standard method to highlight any auditory neural dys-synchrony disorder. Auditory Neuropathy/Auditory Dyssynchrony (AN/AD) is a condition that affects the neural processing of auditory stimuli, characterized by absent, atypical or severely abnormal ABR but preserved otoacoustic emission and cochlear microphonics.

**Material and methods:** With commercially available equipment, we reported peculiar pattern of ABRs observed in some neurological disorders or deafness (Friedreich

ataxia, Congenital Fibrosis Of Extraocular Muscles / KI-F21A, pejvakine / DFNB59). The temporal dynamic ABR recording, with split into 250-epoch subaverages, reveal preservation of genuine waves in early split ABRs indicates that neuronal discharges remained synchronized for long enough to collect the sub-averages containing identifiable waves. In the same patients, the ABRs are typically flat or severely distorted with the conventional protocol recording of ABR (1000-epoch standard). These electrophysiological results lead a possible misdiagnosis of auditory neuropathy. Our recording protocol demonstrate the neural energetic vulnerability when acoustic stimulation was sustained.

**Conclusion:** It seems important to identify energetic vulnerability in auditory neuropathies due to neural disorders before a rehabilitation method is chosen. Indeed, we have also described in mice models that sustained electrical stimulation produces irreversible neuronal damage. The present work may inspire cautious guidelines for cochlear-implant fitting.

**ID: 03889**

### Artificial intelligence is effective in auditory brainstem response analysis

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**Keywords:** Auditory brainstem response, artificial intelligence, machine learning, neural networks.

**Background:** Accurate interpretation of auditory brainstem response (ABR) waveforms requires significant training and skill. Interpretation of ABR waveforms may vary considerably between clinicians. Objective measures can be used to assist clinical analysis, however, current objective correlation methods and power analyses have limited utility and overall interpretation largely relies on the subjective interpretation of the clinician. Machine learning, a branch of artificial intelligence, allows computers to perform complex tasks which would ordinarily require human intelligence. Machine learning, in the form of deep neural networks, has been successfully applied to a variety of clinical contexts, e.g. ECG interpretation, with machine learning models often able to match or exceed human performance.

**Material and methods:** ABR data from the Physiobank database was labelled independently by two audiological scientists into one of three categories: 'clear response', 'inconclusive', or 'response absent'. A deep convolutional neural network was fine-tuned using 10-fold cross-validation and subsequently trained on 190 paired ABR waveforms. Once trained, the neural network's classification performance was evaluated on a previously unseen test set of 42 paired waveforms.

**Results:** The trained neural network achieved an accuracy of 92.9% on the previously unseen test waveforms. The

sensitivity was 92.9% and the specificity 96.4%. Cohen's kappa was 0.893, indicating a very high level of agreement between the neural network classifications and those of the two audiological scientists. Learning curves indicate high variance and suggest that more training data would further increase model performance.

**Conclusion:** This study is the first to use a deep convolutional neural network in the interpretation of paired ABR waveforms. The high level of accuracy achieved suggests that a deep neural network may be beneficial in assisting audiologists with ABR interpretation, offering clinicians real-time assistance and reducing variability in interpretation. The model's performance is likely to be further improved with a larger dataset.

This research has been accepted for publication: McKearney, R.M. & MacKinnon, R.C. (in press). Objective auditory brainstem response classification using machine learning. *International Journal of Audiology*. DOI:10.1080/14992027.2018.1551633.

**ID: 03931**

### The investigation of the relationship between frequency-specific hearing loss and ALLR in normal hearing and hearing loss individuals: preliminary research

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**Keywords:** late latency responses, sensorineural hearing loss, P1 N1 P2

**Background:** The aim of this study is to investigate the frequency-specific effects of the hearing loss (HL) and get information about the results of the auditory deprivation at cortical level in the adult patients with slight, mild and moderate HL at high frequencies.

**Materials and Methods:** Participants were randomly selected from the patients came to Gazi University Otorhinolaryngology Clinic or Audiology Clinic for evaluation. 10 people with sensorineural HL for at least 2 years and 10 people with no history of HL were included in the study (age between 18-55). Within the scope of routine evaluation, otoscopic examination of the person, audiometric evaluation of air and bone conduction thresholds, speech reception and speech discrimination scores, tympanometric evaluation results and acoustic reflexes are obtained. In auditory late latency responses (ALLR) evaluation noninvasive, disposable electrodes were used with conductive gel. Noninverting electrode was placed on Fz, ground electrode was placed on Fpz and inverting electrode was placed on A1 or A2 (depend on record side). In scope of this study P1, N1 and P2 records were taken at 2 kHz, 4 kHz and 6 kHz by using toneburst stimulus and insert earphones while he/she was allowed to watch a video quietly at a suitable distance in the sitting position. The level of stimulus intensity to be presented for ALLR was 50 dB of the hearing threshold of 2 kHz, 4kHz and 6 kHz. The evaluations

were recorded at alternate polarity at a rate of 0.01-35 Hz in 200 sweeps at the rate of 1.1, and 600 ms (100 ms pre-stimulus, 500 ms poststimulus) time window. Two records were taken at each Hz for response reliability.

**Results:** Responses from the study group and control group were analyzed using Mann-Whitney U Test. ALLR were compared on the basis of latency and amplitude. The significant difference ( $p \leq 0.05$ ) was obtained between control and study group in P2 latency at 4 kHz. Statistically significant results were obtained in the amplitude of N1-P2 at 2 kHz ( $p \leq 0.05$ ) and P1-N1 at 6 kHz ( $p \leq 0.05$ ). However, the P1-N1 amplitudes of 2 kHz and 4 kHz were near significant value ( $p = 0.63$ ;  $p = 0.63$ ).

**Conclusion:** It is suggested that P1-N1-P2 responses may use to evaluate auditory deprivation in adults.

ID: 03940

### Electrophysiological and behavioral measures of some speech contrasts in varied attention and noise

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**Keywords:** Speech perception; Electrophysiology; Speech in noise; EEG microstates

**Background** The adjuvant effect of attention on scalp recorded auditory-cortical responses has been well documented. We examine this effect with contrastive speech features in relation to behavioral performance in no noise and noise backgrounds. Analysis includes electrophysiological markers of contrast perception and the net effect of attention, and correlations between electrophysiology and behavioral measures.

**Material and Methods** Normal-hearing subjects ( $n=20$ ) performed closed-set identification in no noise, 0, 4 and 8 dB signal-noise ratio (SNR). Stimuli were 8 consonant-vowel syllables in which were nested place of articulation, vowel length and voice-onset time (VOT) contrasts. The same syllables were used in two electrophysiology conditions, where subjects attended to the stimuli, and also while their attention was diverted to a visual discrimination task.

**Results** Sequential information transfer analysis showed that identification in noise decreased markedly for place of articulation, moderately for vowel length and marginally for VOT. Differences in global field power between the attention conditions from each contrast showed that the effect of attention was negligible for place of articulation. They implied offset encoding of vowel length and were early (starting at 117ms), and of high amplitude ( $>3$  microV) for VOT. There were significant correlations between the difference in syllable identification in no noise and 0 dB SNR and the electrophysiology results between attention conditions for the VOT contrast. Comparison

of the two attention conditions with microstate analysis showed a significant difference in the duration of microstate class D, which has been functionally linked to dorsal and spatial attention networks.

**Conclusions** These results show differential integration of attention and syllable processing according to speech contrast and they suggest that there is correspondence between the salience of a contrast in noise and the effect of attention on the evoked electrical response. The correlations between behavioral and electrophysiological measures are of potential interest, as they imply that the neuronal mechanisms that support attention perform a function that is similar to noise reduction. We discuss their clinical applicability as biomarkers of aberrant perception, or pathology

ID: 03944

### Estimation of the degree and configuration of hearing loss using ASSR evoked by amplitude modulated noise

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**Keywords:** steady-state response, hearing loss, screening

**Background,** Auditory steady-state responses (ASSR) are defined as the brain activity elicited by stimulus presentation at a sufficiently rapid rate, leading to time-overlapping responses. Recently, the use of ASSR obtained by frequency-unspecific stimuli, such as amplitude-modulated (AM) noises, has been studied. These stimuli activate a larger portion of the basilar membrane and presented faster response detection, which could improve hearing screening. This work aims at estimating the degree and configuration of hearing loss using ASSR evoked by AM noises.

**Materials and Methods,** Thirty one individuals (ages: 16-70 years old) were included in this study and all exams were performed at the Hearing Health Service of Hospital São Geraldo- HC/UFMG. Fifty two ears were evaluated, 32 with hearing loss of different degrees and configurations and 20 with normal hearing. The Audiostim system was used for stimulation and ASSR recording. Two different stimuli were employed: i) Wide-band noise (B1: 1 Hz–8 kHz); and ii) Two-band noise (B2: 1 Hz–1 kHz and B3: 2–8 kHz). Both stimuli were uniform white-noise filtered in the respective bands and AM between 77-110 Hz. A descending protocol was adopted to estimate auditory thresholds (initial intensity: 90 dB SPL, step: 10 dB SPL). ASSR detection was performed by Magnitude-Squared Coherence. Thresholds were statistically compared among

5 degrees (normal, mild, moderate, moderately-severe and severe/profound) for each frequency band (B1, B2 and B3) by Kruskal-Wallis Test and Tukey post-hoc. The same test was used to compare thresholds between audiometric configurations (flat and high-frequency loss).

**Results:** Thresholds by degree were: i) normal: about 40db-SPL; ii) mild: 50-65 dB SPL; iii) moderate, moderately-severe, severe, and profound: 70-80 dB SPL (for ears with response). However, about 40% of ears with severe/profound loss did not presented response. The auditory thresholds showed statistically significant difference among degrees of loss ( $p < 1.6755 \times 10^{-3}$ ). Thresholds by audiometric configuration were: i) flat: 60-75 dB SPL; and ii) high-frequency loss: 65-78 dB SPL. No statistical difference was observed for configuration.

**Conclusions:** ASSR evoked by AM noise was capable of distinguishing, with statistical basis, thresholds of ears with normal hearing and mild losses, confirming the potential of such response for early identification of hearing loss.

**ID: 04029**

### Assessment of auditory functions in patients with diabetes

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**Keywords:** Diabetes Mellitus, High Frequency Audiometry, DPOAE, Chirp ABR.

**Background:** Diabetes Mellitus (DM) is a metabolic disease arising from high blood sugar due to reduced insulin production or using the produced insulin inefficiently. Insulin deficiency causes defective utilization of carbohydrate, fat and protein; therefore, several complications arise. Cochlea and auditory nerve are affected from nutrient and oxygen insufficiency resulting from high blood glucose. The aim of our study is to research peripheric and central effects of diabetes on auditory system.

**Material and Methods:** In this study; auditory results of 30 patients 40 years and above diagnosed with Type 2 DM and of 29 healthy individuals 40 years and above with no hearing problems are compared. Every individual was evaluated tympanometry, acoustic reflex, pure tone and high frequency audiometry, speech audiometry, DPOAE and ABR tests following otorhinolaryngologic examination.

**Result:** While generally observed in every frequency in pure tone audiometry, threshold increase was observed considerably ( $p < 0.05$ ), especially in right ear and high frequencies. A decrease was observed in DPOAE values in every frequency ( $p < 0.05$ ), more notably in right ear and high frequencies. ABR test revealed prolongation of III-V interpeak latency range in the right ears ( $p < 0.05$ ). In speech audiometry, considerable correlation was observed

between PTA and SRT values ( $p < 0.05$ ), while no considerable difference was observed in SDS values ( $p < 0.05$ ).

**Conclusion:** The result of the study revealed that diabetes has effects on both peripheral and central auditory system. In addition to the conventional audiometric evaluation, it would be useful to apply DPOAE to monitor cochlear dysfunction together with diabetes types and disease duration. In the study, high frequency hearing thresholds were increased, which showed that high frequency audiometry would be of great importance in the early diagnosis of hearing loss in patients with DM. Even in the absence of specific symptoms, the ABR test can be performed in diabetic patients as a simple, noninvasive method to detect early deterioration of the acoustic nerve and central hearing pathways, and involvement of the central neural tract can be detected earlier. In patients with diabetes, considering the advanced ages (especially in the geriatric population), there is also the risk of developing presbycusis, for this reason regular hearing tests are becoming important.

**ID: 04043**

### EEG findings in different listening condition of individuals who have normal hearing

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**Keywords:** listening effort, EEG, environmental sounds, noise

**Background:** Cognitive auditory science has evolved in understanding the language spoken and understanding that auditory and cognitive functions are interdependent during many listening tasks. Many people with and without hearing loss have great difficulty in speaking, in the presence of noisy listening, especially in the presence of complex stimuli. Background noise, complex conversations, or foreign accented speakers are among the environmentally challenging listening source. In difficult listening conditions, the individual should try to listen more accurately process the auditory signals. For this reason, the aim of this study is to investigate the effects of listening difficulties and effort in different listening conditions on the EEG criteria in normal hearing adults and to examine the difficulties and differentiated efforts of the participants in different listening and to determine whether there is an objective measurement that can be used to evaluate the listening effort.

**Material and Methods:** The study conducted in Ankara Hacettepe University Department of Audiology. We recorded the electroencephalogram (EEG) in 15 normal-hearing participants while they were listening different types of environmental sounds under white noise with different SNR (-2.5, 0, +2.5). EEG data analysis focused on alpha, theta and gamma band activity. Participants were informed to pay attention to the environmental sounds and were informed that they would be questioned about

which type of sound they listened. The different type of environmental sounds were also presented separately during a resting period where participants were asked not to pay attention to the sounds.

**Results and Conclusion:** Preliminary data analyses (N=15) indicate that there is a statistically significant differences were noted among alpha, theta and gamma power levels when presenting different types of environmental sounds under white noise with different SNR compared to the quiet condition. When the noise level was increased, the listening effort of the participants with normal hearing increased and correlated with the increase in activation of EEG. These results support that the EEG can be effective in assessing the listening effort objectively. The results will be compared and discussed in detail.

**ID: 04056**

### ABR in preschool children with speech disorders

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**Keywords,** ABR, preschool age, speech pathology

**Background,** This retrospective study investigated how auditory brainstem potentials differ in patients with clinically different types of speech developmental pathology, supposing that it will give information about the maturity of certain neural structures involved in auditory processing.

**Material and methods,** The participants were 130 children of preschool age (2-6 years) that went through extensive medical diagnostic procedure, and after that they were divided in following groups: 1. Specific language development comprehension problems, 2. Speech delay connected to mental retardation, 3. Speech delay connected to autism spectrum disorder 4. Children under 4 years with significant, but non specific speech delay (they could not fit in above mentioned groups), and 5. Control group of normally developed children. All of the children had normal hearing threshold, and normal tympanometry. The ABR was performed in sleep with sedation, 70 dB above the threshold, with 11 and 65 Hz clics.

**Results,** Interpeak latencies are found to be longer in all groups comparing to controls, but especially in group with comprehension problems and autism spectrum disorder. The differences are more apparent in more difficult task, with 65 Hz clics.

**Conclusion,** These results indicate the differences in sound processing in the brainstem area in certain types of speech pathology.

**ID: 04082**

### Objective measures of the auditory discrimination abilities in young children with CI

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**Key words,** children, cochlear implant, cortical auditory evoked potentials (CAEP), electroencephalography

**Background,** Nowadays, children that are congenitally deaf can regain their hearing in a very young age via a cochlear implant (CI). The knowledge about the neural development of children's auditory and linguistic skills after the implantation remains, however, scarce. Cortical auditory evoked potentials (CAEPs) allow for measuring the neural correlate of preattentive auditory discrimination - mismatch response (MMR). There are only few studies that examine how MMRs in response for speech-like stimuli develop in time in a group of early implanted children. Thus, it is not much known how discrimination abilities develop in such clinical group.

**Material & Methods,** Twenty-four children with bilateral congenital hearing loss that received a unilateral CI between 0.7 and 2.5 years, participated in a longitudinal CAEPs study. The passive oddball paradigm with /ga/ and /ba/ phonemes as auditory standard and deviant stimuli was used to record MMR wave. The mismatch responses' amplitudes and latencies at each time interval were analyzed. Measurements were undertaken at three time points after cochlear implantation (approximately 5, 9 and 14 months after switch-on).

**Results,** In the studied group of children with CI the mismatch responses with proper morphology and explicit amplitude were identified at each time interval. During the first months after implantation the significant increase of MMR amplitude was reported ( $p < 0.05$ ). Its amplitude was the highest at the last time interval (14 months after CI).

**Conclusions,** The gradual increase in MMR amplitude in first 14 months after cochlear implantation show in an objective way that children's auditory discrimination abilities systematically improve. Further research is needed to establish how their development differ from their typically hearing peers. This research is funded by the National Science Centre (2013/08/W/HS6/00333).

ID: 04083

### Adults cochlear implant (bionic ear) users: effect on signal to noise ratio in investigation of the auditory cortical responses

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**Key Words:** Cochlear Implant, Auditory Cortical Responses, Signal-Noise Rate

**Background:** The prevalence of congenital hearing loss in our country is computed as 0,2%. This prevalence is higher than many congenital disease or disorder. Cochlear implant is one of the most important treatment protocols worldwide that used to solve problems, which occurs because of hearing loss. The aim of our study is to research the auditory cortical responses of adults in silent and noisy environments.

**Material and Methods:** 20 subjects who has profound hearing loss in postlingual process, had cochlear implant operation and has the normal speech development were included for the study. Auditory cortical responses were recorded, Frye Hearlab ACA version 1.0. The stimuli were presented from 1-meter distance with 0° azimuth. The phonemes of /m/, /t/, /g/ were presented first at 75 dB-SPL in silent environment, then with the same intensity with 75dB SPL cocktail party noise (S/N=0dB), and finally at the same intensity (75dB SPL) with 65dB SPL cocktail noise (S/N=+10dB) with appropriate loudspeaker. Every single condition was compared to each other.

**Result:** All of the phonemes of /m/, /t/ and /g/ in silent environment with the condition of SN=+10dB and SN=0dB, negative correlation were observed between wave morphology and amplitudes ( $p < 0.001$ ).

**Conclusion:** In our study, when SN = 0dB, the decrease or absence of the P2 wave amplitude shows that in the school environment, adults will have problems in their daily life skills, especially in noise, in skills such as understanding, distinguishing between speech and in their academic skills. To eliminate this situation, to ensure maximum benefit of children and adult cochlear implant users in the school environment to regulate class acoustics, to increase the signal-to-noise ratio in favor of the signal, the use of auxiliary listening devices (FM system, loop systems, etc.) to make arrangements such as; It was thought that the use of cochlear implants would increase the comprehension skills of children and adults, especially in noise, and that it would be in favor of this group in conjunction with the cochlear implant as well as noise studies in auditory rehabilitation practices.

ID: 04121

### C-VEMP test parameters in patients with motion sickness: latency, amplitude and asymmetric ratio

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**Key words:** C-VEMP, Motion Sickness, Latency, Amplitude

**Introduction:** The main purpose of this study is to investigate c-VEMP parameters latency, amplitude and asymmetric ratio for patients with Motion Sickness (MS).

**Method:** 20 patients with Motion Sickness and 20 healthy individuals between the ages of 18 and 30 were involved according to the Motion Sickness Susceptibility Questionnaire (MSSQ). These subjects underwent c-VEMP test and their c-VEMP results were evaluated in terms of latency, amplitude and asymmetric ratio.

**Results:** The latency and asymmetric ratio of the C-VEMP test parameters for the right and left ears did not differ significantly both in patient and healthy groups, but their amplitudes were found to be significantly different. It was observed that the amplitudes of healthy individuals were higher. According to the MSSQ grading system, patients scoring 30%, 60%, 80%, 90%, 100% are respectively equal to 10%, 5%, 15%, 5%, 65% of the patients.

**Conclusion:** The c-VEMP amplitude of patients with motion sickness is lower compared to the healthy individuals.

## Free Papers 15 - Auditory Processing Disorders II

ID: 03778

### Electrophysiological characteristics in children with listening difficulties, with or without auditory processing disorder

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**Keywords:** Auditory processing disorder, electrophysiology, pediatric

**Background:** To investigate the relationships between auditory processing (AP) test performance and auditory evoked potentials (AEP) and the diagnosis of auditory processing disorder (APD) to determine the usefulness of AEP's in the clinical assessment of AP.

**Material and method:** Forty-six children aged 8-14 years underwent an AP assessment and were divided into three groups: children with reported listening difficulties fulfilling APD diagnostic criteria, children with reported listening difficulties not fulfilling APD criteria, and normal hearing children. Participants were assessed using tests measuring auditory processing performance and electrophysiological recordings measuring auditory middle latency responses (AMLR), auditory late latency response (ALLR), and auditory P300.

**Results:** Na latency and P300 latency and amplitude were found to be sensitive to listening difficulties but not to APD. Low to moderate correlations were observed between P300 and behavioural AP measures.

**Conclusions:** Impaired cortical and cognitive function, including auditory attention and memory, may contribute to difficulties discriminating speech and non-speech sounds. Clinicians should consider abnormalities in AEPs as being indicative of broader listening problems as a whole, rather than an APD diagnosis. AEPs should be used to describe central auditory nerve system function in support of an evidence based approach to address the patient's specific needs.

**ID: 03820**

### A functional model for understanding the “process” of processing

Jeanane Ferre

*Jeanane M Ferre, PhD*

**Abstract:** Understanding central auditory processing disorders may be complex but it need not be complicated. Session will describe the neuroscientific foundations of auditory processing and the continuum of skills encompassed by that term. Topics include development of processing skills, assessment techniques for differential diagnosis of central auditory processing disorders (CAPDs), impact of processing disorders on academics, communication, and life skills, and deficit-specific (differential) intervention, including classroom and in-home management strategies and treatment goals for improving specific auditory perceptual skills and related functional listening and learning skills.

**Introduction:** This section will review the neuroscientific bases of the continuum of auditory processing skills including the neuro-geography of central auditory processing and related phonologic-linguistic and neurocognitive skills. Section will include brief overview of neurodevelopment of these skills.

**Deficits in AP skills:** Section will discuss specific types of auditory processing deficits based on best practices for differential diagnosis and will include discussion of the deficit's impact on a listener's communication, academic success, and psychosocial well-being.

**Intervention for APDs:** Section will provide an overview of deficit-specific management strategies that can

be used at home, the workplace, or in school to address functional listening and communication challenges experienced by individuals with diagnosed central auditory processing disorder. Discussion will include accommodations and use of assistive technology. Section also includes discussion of research examining effectiveness of deficit specific aural rehabilitation, e.g., auditory training to reduce/resolve specific auditory impairment and ameliorate functional impact.

**ID: 03821**

### Beyond preferential seating: deficit-specific management strategies for central auditory processing disorders (CAPDs)

Jeanane Ferre

*Jeanane M Ferre, PhD*

**Key words:** auditory processing disorders, management, intervention

**Abstract:** Session reviews acoustic, linguistic, and cognitive processes needed to use verbal information and impact of deficiencies in any process on communication, academics, and sense of self. Differential intervention is discussed emphasizing evidence-based deficit-specific management strategies, including environmental modifications, educational accommodations, and use of assistive technology.

**Background:** Our ability to use spoken language requires the complex interaction of an array of acoustic, phonologic, linguistic, and cognitive processes, all subserved by the peripheral and central nervous systems. A deficiency in any process may result in a diagnosis of auditory processing disorder, central auditory processing disorder, language processing disorder, phonologic processing disorder, or other type of deficit. It is important for SLPs and Audiologists to understand the nature and interaction of the skills involved, impact of a deficiency in one or more skill sets, and the kinds of classroom and workplace management strategies available to listeners with auditory processing challenges. Too often, these management strategies are little more than generic lists of accommodations with little or no consideration given to the specific nature of the auditory-language processing impairment that has been diagnosed – which is critical in order to choose effective management strategies.

Speech-language-hearing specialists are uniquely qualified to diagnose verbal processing deficits and provide recommendations for intervention as they relate to functional listening and learning skills and psychosocial well-being. By understanding the underlying mechanisms and the differential diagnostic process, functional deficit-specific intervention plans are developed that minimize deficit's adverse effect on the listener's life.

Session reviews the array of and underlying bases for skills needed to process spoken language and impact of deficits in specific skill sets. Management strategies are presented for use at home and school that minimize impact for all types of impaired auditory processing as well as

those strategies that are deficit-specific and meet a client's unique needs, including environmental modifications, classroom and workplace accommodations, and use of assistive technology.

**ID: 03822**

### The M3 model for treating central auditory processing disorders

Jeanane Ferre

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Key words, auditory processing disorders, treatment, auditory training

**Abstract.** One cannot treat effectively a disorder that has not been diagnosed specifically. This is especially true of central auditory processing disorders (CAPDs). Although part of the audiologic landscape for over 60 years, there continues to be debate regarding treatment for central auditory processing disorders among school-age children. This presentation will demystify central auditory processing, clarifying its place within the “process” of processing as well as the educational significance of providing intervention for these disorders. Session briefly reviews types of central auditory processing deficits and focuses on an evidence-based aural rehabilitation model that includes both bottom-up and top-down therapy goals that reduce/resolve specific auditory impairment, are in line with educational standards, and meet the client's functional needs.

**Background.** Our ability to use spoken language requires the complex interaction of an array of acoustic, phonologic, linguistic, and cognitive processes, all subserved by the peripheral and central nervous systems. A deficiency in any process may result in a diagnosis of auditory processing disorder, central auditory processing disorder, language processing disorder, phonologic processing disorder, or other type of deficit. It is important for SLPs and Audiologists to understand the nature and interaction of the skills involved, impact of a deficiency in one or more skill sets, and extent to which aural rehabilitation can be implemented in order to reduce/resolve the processing deficit and minimize deficit impact on the listeners functional communication skills. Session reviews the array of and underlying bases for skills needed to process spoken language and impact of deficits in specific skill sets. This session describes the skills needed to process spoken language, the impact of deficits in specific skill sets, and an evidence-based treatment model that is specific to a client's needs/deficit and is effective for improving target skill(s) and minimizing impact on listener's life. Discussion will include goals that are measurable, achievable within a student's educational environment, and evidence-based as well as effectiveness of computer-based auditory training in remediating auditory processing disorders.

**ID: 03879**

### Evaluation of central auditory processing in normal hearing young adults by using dichotic listening tasks in Turkish language

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**Keywords.** Central Auditory Processing, young adults, dichotic sentence, speech in noise

**Objective.** Central auditory processing disorders (CAPD) are remarkable issue for researchers due to their adverse effects on some skills such as listening performance, speech perception in noise, auditory attention and memory. There is little research into the dichotic sentence listening skills of normal hearing young adults in addition to CAPD test battery in literature. This study sought to examine these findings and introduce some critical suggestions about listening performance in daily life and academic activities.

**Methods.** The study included 18-25 year-old 32 subjects who have normal hearing thresholds and some of them complain about sometimes listening problems. All the subjects underwent pure tone and speech audiometry, tympanometry and acoustic reflexes, transient evoked otoacoustic emissions. In CAPD test battery, Dichotic Competing Sentences Test (DCS) and Auditory Figure Ground Test (AFG) were performed for evaluate dichotic listening skills and speech perception in noise.

**Results.** The hearing thresholds of the subjects were lower than the 20 dB HL at all frequencies. The speech audiometry scores, otoacoustic emissions, acoustic reflexes were normal and all of the subjects had Type A curve tympanogram. There was no statistically significant difference in all tests according to gender and age parameters. In left ear AFG test, the mean value of all of the subjects was  $18.40 \pm 1.82$ , but  $19.12 \pm 2.02$  was in the right ear scores. There was a statistically significant difference between right and left ear AFG test scores of all the subjects. Likewise, the mean values were  $27.96 \pm 1.57$  in the left ear and  $28.81 \pm 1.22$  in the right ear for DCS test all of the subjects.

**Discussion:** The study indicates that some of the young adults have normal hearing thresholds, but still have lower scores in speech perception in noise. Also they were good at dichotic sentence listening, may be because of auditory closure skills or bottom up processing achievements. There is a need for more studies, including comprehensive test battery for audiological and CAPD performance, to make some suggestions for optimum listening performance and auditory processing skills.

ID: 03884

## The Cantonese Pediatric Lexical Tone Dichotic Listening Test -CaPeLeToDLT detects abnormal auditory processing and within-participant ear advantage in very young children

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**Keywords:** Dichotic listening, auditory processing disorders, preschool children, Cantonese

**Background:** Auditory processing disorders (APD) hamper auditory learning in children. Suitable APD tests for preschool children are unavailable worldwide due to confounding factors in language, motor speech, attention, working memory, and cognition. To minimize these confounding factors, *CaPeLeToDLT* was developed as a computer game-based assessment which involves a non-verbal picture-selection task to assess young children's normative developmental dichotic listening (DL) profiles: (1) top-down instruction-driven directed attention (Dr), and (2) bottom-up stimulus-driven divided attention (Dv).

**Materials and Method:** In each test item, the same monosyllable which carries three different Cantonese lexical tones were identified as test stimuli, e.g. the three monosyllabic words with lexical tones 1, 2, and 6 carried by the same syllable /sy/ represents three different words - *book, mouse, and tree*, respectively. Two words were each played on one headphone side simultaneously. The third word was not played and pictures of all three words were shown on screen for the participant to touch-select. A cartoon face was shown on each side of the screen. During the test item presentation, before the test stimuli were played, the carrier phrase "Where is?" was played as an auditory cue and cartoon face "talked" as a visual cue, from both sides for the Dv conditions, and from only the right side and only the left side for the Right Directed condition (RDr) and the Left Directed condition (LDr), respectively. A total of 119 test items were tested on 22 preschoolers with typical language and cognitive development.

**Results:** In each test condition, out of the 119 items, the 30 items that could best bias the 22 preschoolers to respond to the stimulus presented from the same side, i.e. with the highest logit weightings by the item response theory model, were selected to create the clinical version and validated in over 200 typically-developing children from 3.5 to 9 years. This response-side bias nature of the selected test items narrows the normative score range which made the test conditions sensitive to (1) detect subtle abnormality,

and (2) delineate within-participant ear advantage via the binomial distribution model.

**Conclusions:** *CaPeLeToDLT* opens an unprecedented window to identify atypical dichotic listening profiles and within-participant ear advantage of preschoolers which is an innovative step for assessing young children with suspected auditory processing disorders.

**Conflicts of interest (if any):** Nil

ID: 03892

## Auditory Processing Disorder in children: interest of a multidisciplinary assessment

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**Key words:** Auditory Processing disorder (APD), children, APD behavioral tests, auditory training, central auditory nervous system

**Background:** Auditory Processing Disorder (APD) would affect 0.5-7% of the pediatric population. This disorder is responsible for the child's low hearing ability. The diagnosis of APD is difficult because of polymorphic symptoms possibly entangled with other difficulties (learning, communication, attention ...). There is currently no gold standard in the literature for diagnosing APD. A multidisciplinary consultation was opened for the children suspected of APD. The purpose of this study is to analyze this multidisciplinary assessment.

**Material and Methods:** 32 children benefited from a multidisciplinary consultation with:

- targeted behavioral assessment APD: speech-in-noise perception, phonemic identification and discrimination, dichotic listening test, temporal processing tests.

- psychometric assessment: assessment of visual and auditory working memory, visual and auditory attention, study of cognitive functions.

- ENT examination with otoscopy, tonal and vocal audiometry and ABR recording.

**Results:** The main reason for consultation was difficulties to understand in the noise for 52% of patients. A diagnosis of APD was made in 9 children (39% of cases), this diagnosis was ruled out for 11 children and remained doubtful in 3 cases. The average age was 10 years old. 9 patients were excluded from the study. Associated disabilities were found in 65% of the children. The three most sensitive tests for the diagnosis of APD were: the dichotic listening test, the temporal processing test (frequency) and the auditory attention assessment.

**Conclusion:** Auditory Processing Disorder is a common pathological condition that remains difficult to diagnose. This diagnosis is based today on a bundle of arguments, facilitated by a multi-disciplinary approach, allowing to propose an adequate remediation.

**Conflict of interest:** no

### Free Papers 16 - Hearing and Cognition

**ID: 03802**

#### The effect of hearing aid use in older adults on auditory processing: cognition and gait

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**Background:** Degraded hearing in older adults has been associated with reduced postural control and higher risk of falls. Gait requires a delicate equilibrium between automatic and executive control. In young healthy adults walking is mostly automatic, but in older adults it is characterized by reduced automaticity and greater reliance on executive resources. One result is that less attention resources are available for other tasks, which are often performed while walking. In turn, hearing impairment increases the demands for attention resources for perception of environmental auditory cues and processing auditory information. Thus, the ability to divide attention between walking and listening tasks is reduced, and fewer resources may be available for walking and mobility.

It is not clear whether hearing rehabilitation can reduce the risk of falls. Hearing aid induced plastic changes in the auditory system were observed in older adults. We now ask whether these improvements can be manifested in more ecological situations such as dual tasks with walking, and whether hearing rehabilitation can improve attention, walking and activities of daily living.

**Method:** 25 older individuals (age  $70.4 \pm 5.3$  years) with mild to moderate hearing loss and no prior experience with hearing aids were recruited from hearing clinics. A series of motor (walking), auditory (speech perception in noise, dichotic listening) and cognitive (serial subtraction by 3) tasks were administered as single tasks and as dual tasks with walking. The tasks were tested before hearing aid fitting, immediately after fitting, and again after two months of hearing aid use. Aided and unaided conditions were tested. In addition, cognitive tasks (MoCA, Stroop, Trail Making and recall) and questionnaires (instrumental activity of daily life [IADL], depression, anxiety, fear of falls and HHIE-S) were administered before hearing aid fitting and at the end of the study.

**Results:** Significant improvements were observed (in aided and unaided conditions) in the auditory tasks and in the majority of the cognitive tasks, in single and in dual tasks. While walking speed did not improve, significant improvement was observed in IADL.

**Conclusions:** Auditory and cognitive functions can improve after relatively short use of hearing aids. Lack of improvement in gait may be because changes in walking might need longer time to emerge or because walking should have been trained during hearing rehabilitation.

**ID: 03823**

#### The link between hearing loss: vestibular loss and cognition

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**Keywords:** cognition, hearing loss, vestibular loss, bilateral vestibulopathy

**Background:** Several studies have demonstrated cognitive deficits in patients with bilateral vestibulopathy (BVP). So far, hearing status has not been considered when evaluating cognition in this population. Given the well-established link between sensorineural hearing loss (SNHL) and cognitive decline and the high prevalence of SNHL in BVP patients, it remains unclear if the cognitive deficits in BVP patients are solely due to their vestibular loss or might be, partially, explained by a concomitant SNHL.

**Objective.** To evaluate the link between cognition, hearing and vestibular loss in patients with BVP.

**METHODS.** Prospective cross-sectional analysis of cognitive performance in patients with BVP and control participants without vestibular loss. Both groups included subjects with a variety of hearing (dys)function. Cognition was assessed by means of the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing Impaired Individuals (RBANS-H).

**Results.** Sixty-four BVP patients were evaluated and compared with 83 control participants. Multiple linear regression models were fitted with both vestibular loss and hearing loss as main factors. All analyses were adjusted for age, sex and education. Hearing loss seemed to be associated with worse outcome on the total RBANS-H scale and subscales immediate memory and language. Vestibular loss, on the other hand, was linked to worse performance on the attention subscale of the RBANS-H. Furthermore we did not observe a correlation between saccular function and cognition.

**Conclusion.** This study has found general cognitive deficits in a large sample size of BVP patients. Multiple linear regression models revealed that both vestibular and hearing were associated with different subscales of the RBANS-H. Whereas hearing loss was associated with worse performance on total RBANS-H score, immediate memory and language, vestibular loss was observed to negatively affect attention performance on the RBANS-H.

ID: 03938

## Effects of task difficulty and signal processing on recall performance and recall strategy

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**Keywords:** hearing aid benefit, noise reduction, working memory, individual cognitive differences

**Background:** Despite technological advances aimed at compensating for hearing loss in challenging listening situations, complaints arise even in listening situations where aided speech understanding is good. These may result from problems other than audibility, such as high degree of listening effort. The Sentence-final Word Identification and Recall (SWIR) test (Ng et al. 2013) was designed to investigate the effect of hearing aid signal processing on memory for highly intelligible speech in noise. The task is to repeat every last word of sentences in a list and recall those words when the list is finished. Previous findings suggest that people with high cognitive capacity benefited more from advanced hearing aid signal processing than people with low cognitive capacity. However, people with low cognitive capacity showed benefit when a less demanding version of the test was used. Thus, excessive task difficulty could have prevented capturing potential benefit from signal processing. This study aims to continue developing the SWIR test by manipulating task difficulty, i.e. varying the list length (number of to-be-recalled words). We are also comparing whether knowing the total number of to-be-recalled words before a list affects recall performance and recall strategy. The effects of noise (four-talker babble and speech-shaped noise) and noise reduction on recall are investigated.

**Material and methods:** Native Swedish speakers aged 40–70 years are recruited. All participants have moderate to moderately-severe adult-onset symmetrical sensorineural hearing loss and minimum one year of hearing aid experience. Hearing aid signal processing is provided via a hearing aid simulator. Besides the modified SWIR test, the Hearing in Noise Test and various cognitive tests are administered.

**Results/Conclusion:** The preliminary results showed a main effect of list length, which suggests recall performance decreased with increasing list length. The preliminary results also showed a main effect of noise reduction, indicating that recall performance was higher when noise reduction was on in comparison to when it was off. We will further analyse this benefit based on list length and individual cognitive capacity. The results may give insight into how memory resources are allocated depending on the task difficulty, which sheds light on theoretical understanding of recall strategies.

ID: 03962

## Development of computer based cognitive screening tool for the hearing impaired older adult population

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**Keyword:** cognitive screening, dementia, hearing and cognition

**Background:** Existing cognitive screening tools assume intact hearing, in that clients are assumed to be able to hear the instructions and test stimuli clearly. However, as 1/3 of older adults aged over 65 have hearing problems, these tests may be confounded by hearing loss and not accurately test cognition in people with this condition. We aim to develop and validate tools to accurately assess cognitive function of the hearing impaired which can be used in clinical setting such as hearing aids center to screen for early dementia.

**Method:** The Montreal cognitive assessment (MoCA) tool has good sensitivity in detecting early changes in cognition in the older adult. We have adapted a MoCA computer-based tool using only visual input to make it suitable for older adults with all severity of hearing loss. The tool is also developed according with guidance for the visually impaired population to ensure good visibility for the older adults with possible visual and hearing impairments. Moreover, a version of the General Practitioner Assessment of Cognition (GPCOG) was also developed in a similar manner to be used as a fast screening in the hearing aids centre. The opinions from all related parties were incorporated into the development process. The feedback from the healthcare providers including psychiatrists, clinical psychologists, audiologists, hearing aids centre manager, otolaryngologists, audiological medicine physicians (users) and older adults with hearing impairment (clients) along with older adult with dual sensory impairments were also included.

**Result:** These computer-based cognitive assessment tools for the hearing impaired older adult population are have been very well accepted by clinicians and patients. Currently, we are validating the diagnostic utility of these tools on a cohort of hearing impaired older adults with normal cognition, mild cognitive impairment and dementia.

**Conclusion:** We are validating a hearing impaired version of the MOCA and GPCOP. Both tools are highly acceptable to patients. The computer-based short screening version (GPCOG) which only takes a few minutes to complete may also be practical in a busy routine hearing aids clinic setting.

ID: 03995

## Can you feel the effort? Listening in ecologically relevant environments

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**Keywords,** audio-visual, multitasking, listening effort, ecologically relevant

**Background,** The need for a *true-to-life* or *ecologically valid* auditory assessment paradigm that mimics real-life listening situations in a controllable way and captures both auditory functioning and listening effort is high amongst researchers and clinicians. Therefore, we present AVATAR: Audio-Visual True-to-Life Assessment of Auditory Rehabilitation, a behavioral assessment paradigm that is complementary to classic speech-in-noise measurements. With AVATAR, we aim to 1) simulate real-life listening situations and get an estimate of the cognitive load during speech understanding by means of a behavioral multitask test paradigm and 2) differentiate between individuals of different ages and hearing profiles, based on their cognitive and auditory abilities.

**Material and methods,** AVATAR minimizes the differences between real-world environments and laboratory test conditions by reconstructing external demands of everyday listening situations, including auditory-visual environments, visual speech cues, auditory spatial complexity and multitasking. To estimate the cognitive load during listening, we combined an auditory-visual speech-in-noise test with three secondary tasks on auditory localization and visual short-term memory to investigate multitask costs as a proxy for effort. Outcomes on self-reported effort and motivation as well as secondary measures of executive functions, including working memory and inhibition skills, were compared to AVATAR-outcome scores. Both groups of young and middle-aged adults were administered, as well as normal hearing and hearing impaired individuals.

**Results,** Results showed that speech intelligibility outcome measures were not affected by having to multitask, but required a higher cognitive load with increasing task complexity as reflected by higher multi-task costs on the secondary tasks. Both age and hearing impairment seemed to negatively effect the cognitive listening load, as well as self-reported measures and executive functions.

**Conclusion,** AVATAR provides additional information on both the auditory and cognitive functioning of individuals when having to listen in real-life listening scenarios. This opens avenues to close the gap between self-reported hearing difficulties and measurement outcomes and to improve individually tuned auditory rehabilitation.

ID: 04034

## Will hearing and vision enhancement improve outcomes for people with dementia?

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**Keywords:** dementia, hearing, vision, intervention

**Background/objective:** Hearing, vision and cognitive impairment commonly co-occur in older adults. Improving hearing and vision function may positively impact outcomes in people with dementia (PwD). We developed a 'Sensory Intervention' (SI) to support hearing and vision in PwD, which, in field trialling, has been shown to be feasible, acceptable, well-tolerated and safe. Here, we explore the impact of the intervention on key dementia-related outcomes. This information will provide the necessary data to inform a definitive, multi-site randomised controlled trial (RCT) of the intervention.

**Methods:** This was a single arm, open label, field trial with nested case studies involving 38 participants (PwD and their care partners) in three study sites. All PwD received an assessment of hearing and vision function and were then offered corrective devices in the form of glasses and/or hearing aids (the 'basic' SI). A subset of participants received additional weekly visits from a sensory support therapist in their own homes over a 12 week period, receiving assistance to: use and maintain the hearing aids and glasses correctly; develop a 'sensory-conductive' home environment; apply good communication practices; and access health and social services and leisure activities (the 'extended SI'). We undertook quantitative and qualitative exploratory analyses of a range of dementia-related, health utility and healthcare resource utilisation outcomes.

**Results:** Quality of life of PwD, assessed at baseline and post-intervention using the DEMQoL, revealed a mean improvement of 4.87 points. On all but two of the remaining outcomes, a modest improvement in absolute terms was noted post-intervention. For those receiving the extended intervention, synthesis of qualitative, diary and SST log-books findings clearly supported the intervention: PwD were more socially engaged, had less social isolation, improvements in functional ability and communication, and were less dependent on care partners. Care partners reported improved relationship quality.

**Conclusions:** This is the first study combining hearing and vision remediation in PwD and the positive findings suggest that a full-scale efficacy trial is warranted.

## Free Papers 17 - Hearing Aids

ID: 03875

**Hearing aid processing strategies for listeners with different auditory profiles: insights from the BEAR project**

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**Keywords:** Hearing aid fitting, individualisation, auditory profiling

**Background:** The Better hEARing Rehabilitation (BEAR) project pursues the development and evaluation of new, clinically feasible strategies for individual hearing loss diagnosis and hearing aid (HA) fitting. Two essential elements of this research are the design of a new diagnostic test battery for identifying different auditory profiles and linking those profiles to different HA processing strategies. The current study focused on establishing links between four auditory profiles and the benefit from six HA processing strategies.

**Material and methods:** Sixty older individuals with bilateral mild-to-severe sensorineural hearing losses from a clinical population of HA users participated. Speech-in-noise stimuli were generated with the help of a HA simulator that included directional processing, noise reduction and dynamic range compression. Stimulus presentation was via headphones. Six HA settings differing in terms of signal-to-noise ratio (SNR) improvement and temporal and spectral speech distortions were selected for testing based on a comprehensive technical evaluation of different HA parameter settings. Speech-in-noise perception was assessed at fixed SNRs that were chosen based on individual speech reception threshold measurements. In addition, overall preference and noise annoyance were assessed using a multiple stimulus comparison paradigm.

**Results:** We hypothesize that the perceptual outcomes from the six HA settings will differ across the different auditory profiles. More specifically, we expect listeners showing high sensitivity to temporal and spectral signal changes to perform best with and/or to prefer HA settings that preserve those cues. In contrast, we expect listeners showing low sensitivity to temporal and spectral signal changes to perform best with settings that maximize SNR improvement, independent of any additional signal distortions.

**Conclusions,** We anticipate that the findings from the current study will provide the basis for the implementation of more individualized HA fitting strategies to be tested subsequently in wearable HAs.

ID: 03950

**Speech intelligibility and loudness perception in realistic auditory scenes with the trueLOUDNESS fitting method**

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**Keywords,** Loudness, Speech Intelligibility, Auditory Scenes

**Background:** While pure tone threshold-based hearing aid prescription rules are well established and proven to improve speech intelligibility, problems---such as insufficient loudness perception---are still major reasons for hearing-impaired persons to reject wearing hearing aids. Oetting et al. (2016) found that the loudness perception for hearing-impaired subjects could be restored to normal with a monaural loudness compensation for monaural and narrowband stimuli. However, some hearing-impaired subjects showed an increased loudness perception at higher levels for binaural broadband signals. Based on these findings, the trueLOUDNESS fitting rule was developed, which includes binaural broadband loudness measurements as a basis for gain determination (Oetting et al., 2018). This study compares the speech intelligibility and loudness perception with trueLOUDNESS fitting to the standard threshold-based fitting rule NAL-NL2 in controlled laboratory conditions and realistic auditory scenes for subjects with and without increased loudness perception for binaural broadband signals.

**Material and methods,** Speech reception thresholds (SRTs) at 50% are measured in hearing-impaired subjects with the Oldenburg sentence test in anechoic and realistic test conditions. A test-specific, stationary masker and a fluctuating masker (ICRA5<sub>250</sub>) are used in the anechoic test conditions at 45 dB SPL and 75 dB SPL, respectively. To represent everyday listening situations, two different scenes available within the toolbox for acoustic scene creation and rendering (TASCAR, Grimm et al., 2015) are used. First, the relatively loud "cafeteria" scenario is used which provides an overall level of 75 dB SPL. In addition, the "nature" scene with a lower overall level of 51 dB SPL is tested. Adaptive categorical loudness scaling (ACALOS) is measured for both scenes to investigate the loudness perception. Hearing aid fitting is provided via the Master Hearing Aid (Grimm et al., 2006).

**Results:** The SRTs at test conditions with lower levels are expected to be lower (better) for trueLOUDNESS compared to NAL-NL2. Subjects with an increased binaural broadband loudness perception will likely show higher SRTs with trueLOUDNESS fitting at higher background levels than those who do not show that effect. A normalized loudness perception is expected with the trueLOUDNESS fitting in all listeners.

ID: 03964

## Towards a French language version of the Satisfaction with Amplification in Daily Life questionnaire (SADL)

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**Key-words:** Auditory rehabilitation, Hearing aids, Satisfaction with Amplification in Daily life questionnaire (SADL)

**Background:** The Satisfaction with Amplification in Daily Life questionnaire (SADL) created by R.M. Cox and G.C. Alexander in 1999 was developed to quantify overall satisfaction with hearing-aid and is composed of 15 items, grouped in four different subscales (positive effect; services and cost; negative features and personal image). For each item, patients have to choose, amongst 7 propositions, the one that reflects the most their general opinion about their hearing aids. Although since 1999 the questionnaire has been translated into many different languages, to our knowledge, no French language version has been established yet.

**Material and methods:** We followed the European guidelines concerning translation and cross-cultural adaptation of health questionnaires: 4 independent translations were assessed by a translation committee composed of a translator and hearing-aid specialists, who established a first translation. Some items have been slightly modified to be more in keeping of the modern hearing aids properties. This first translation was then proposed to a focus group of hearing-aid wearers. Each patient was invited to complete the F\_SADL and his/her hesitations, comments, questions about items were noted. The patients were given also a 7 item evaluation questionnaire, asking them their opinions about the SADL: length of test, clarity of the questions, clarity of the presentation, on a scale of 0 to 10. The results of the focus group triggered some minor changes and adjustments of the F\_SADL and this second version was then used in a validation study, involving comparison with the APHAB and the SSQ.

**Results:** In the focus group, 42 participants, aged 78 (SD=13.0) with an average hearing loss of 51 dB HL (SD=14.6) completed the questionnaire. The average global F\_SQDL score was 5,6/7 points (SD=0.49), representing high degree of satisfaction. The profile of responses across the 15 items correlated significantly with the profiles described in the literature with the SADL used in other languages. The F\_SADL was considered easy and short to complete (less than 6 minutes), and relevant to hearing-aid wearers, with an evaluation of 7.8 out of 10.

**Conclusion:** The SADL was very well perceived by all respondents and the profiles of responses given by the F\_SADL are in keeping with the profiles published for other language versions.

ID: 04079

## A study of better hearing rehabilitation in Denmark (the BEAR project)

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**Keywords:** Hearing rehabilitation, Hearing aid, Audiology, Clinical practice

**Background:** The overall vision of the project is to improve hearing rehabilitation through an evidence-based renewal of clinical practice. The structured approach comprise studies of the current practice in Denmark, considerations for new methods, experimental application and refinement of this, evaluation and implementation of the most promising renewals.

**Method:** The reference for existing practice is based on data for almost 2,000 patients, which have been fitted with hearing aids during 2017-2018 in two of the participating clinics. The considerations for new profiling methods are based on the analysis of prior studies including more diverse diagnostics than used currently. New fitting strategies are preliminarily tested using hearing-aid simulations in laboratory settings, in parallel to test trials of new aided-performance tests and paradigms for assessing user experiences in the field. These studies are all on going and will be reported in more detail in accompanying presentations. The experimental application of the novel fitting strategies is currently being planned, and will include the experimental application of the prospective strategy in real hearing aids. The refinement of novel strategies includes studies of the clinical efficiency, socio-economic trade-offs, options of out-of-clinic application, and attention to populations with low benefits. The evaluation and implementation includes proposals for future standardization, and the collection of any additional reference data for this effort.

**Results:** A clinical database for almost 2,000 patients has been established, which includes standard data supplemented with questionnaires for the assessment of outcome. The clinical practice has been examined for tacit knowledge in validation and assessment of user outcomes. A proposal for four differing hearing profiles has been developed, and six different fitting strategies is examined for their potential. A test battery for aided listening performance has been developed.

ID: 04088

## Investigation of the hearing aid user satisfaction levels and performance in noise reprogrammed based on real ear measurement (REM)

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**Keywords:** Hearing Aid, Satisfaction with Amplification in Daily Life (SADL), Real Ear Measurement (REM), Hearing in Noise, Matrix Test

**Background:** Hearing aids that are not individually programmable reduce the rate of hearing aid use and therefore affect the satisfaction from the hearing aids. The primary objective of this study is to create individual hearing aid programs and investigate the factors that affect users' dissatisfaction of the hearing device.

**Material and methods:** Twenty-six subjects aged between 18-77 (mean, 49.50 ± 16.71) were included in this study. All users had mild (n=17) and moderate (n=9) sensorineural hearing loss and had been using unilaterally (n=12) or bilaterally (n=14) hearing aid for at least 6 months. In the first session after the audiological evaluations, Turkish Matrix test was applied to evaluate speech comprehension skills in noise and Turkish version of SADL questionnaire were applied to all subjects with the current fitting. Then hearing aids were reprogrammed with Real Ear Measurements (REM). At least 3 months later, in the second session, the procedure that was performed at the first session was repeated. Turkish Matrix test procedures, the subscales and global scores of the SADL-TR, functional gains, SRTs and SDSs that were obtained before and after the REM were compared.

**Results:** Statistically significant differences were found between the results of hearing threshold measurements obtained at two different sessions. A statistically significant difference between the sessions was found at the results of Turkish Matrix Test Adaptive Procedure (quite  $p < 0.001$ ; noise  $p = 0.009$ ) and Non-adaptive Procedure (0 dB SNR  $p = 0.022$ ). The SADL-TR questionnaire was found to be statistically significantly differ between the sessions in terms of positive effects and negative features subscale scores ( $p < 0.001$ ).

**Conclusions:** Despite technological advances in amplification systems, problems with user satisfaction persist and individuals have very high rate of discontinuation of hearing aids. With the SADL-TR questionnaire, it is possible to determine the satisfaction levels of the users and the factors affecting them. In conclusion, user satisfaction and speech understanding in noise depends significantly on the use of REM during the hearing aid programming.

ID: 04097

## Real ear unaided response (Reur) and real ear coupler difference (Recd) in patients with tympanic membrane perforations

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**Background:** Tympanic Membrane (TM) perforation is a relatively common problem usually associated to varying degrees of hearing loss. Physical and acoustic characteristics of the ear canal are altered by TM perforations. In some patients with TM perforation hearing aids are recommended to improve communication.

**Material and methods:** In the present study Real Ear Unaided Response (REUR) and Real Ear Coupler Difference (RECD) were obtained in 25 patients with TM perforation and 28 patients with normal TM.

**Results:** The results obtained showed significant differences in REUR and RECD responses between both groups of patients. In perforated ears, the REUR obtained is characterized by a bimodal morphology with two peaks separated by a valley of approximately 10 dB. Lower values of RECD were observed in patients with TM perforations, especially at low frequencies compared to the control group. In order to assess the impact of the TM perforation on the amplification, the gain prescribed by NAL NLI was simulated with and without taking into account individual REUR and RECD measurements.

**Conclusion:** This study supports the need for individual REUG and RECD measures to be made, in patients with TM perforation, rather than using averaged REUG and RECD transform functions.

ID: 04116

## Audiology with two ears: Does binaural hearing influence the loudness mismatch between free-field and headphone presentation?

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**Keywords:** Loudness, fitting, headphone listening

**Background:** Fitting and evaluation of hearing aids is usually conducted on the basis of headphone measurements, although listening through headphones and hearing aids differs from free-field listening in many aspects. One of these differences is the phenomenon often referred to as the 'missing 6 dB': To create the same loudness, the level of a stimulus at the eardrum has to be about 6 dB higher

when presented diotically over headphones as compared to the same stimulus played over a free field source.

**Materials and Methods:** We present measurements that assess binaural factors that may influence the loudness perception in headphone listening, in particular monaural vs. binaural stimulation and the influence of interaural coherence. To this end, normal-hearing subjects adjusted the level of a stimulus presented over headphones to match the loudness of a free-field source playing the same stimulus with a constant level. To assess the influence of room acoustics and binaural parameters of the free field source, the experiment was conducted in different rooms (anechoic, office room, reverberation chamber), and using different narrowband and broadband noises.

**Results:** The level mismatch between free-field and headphone listening at equal loudness depends on the binaural stimulation mode. In particular, in the context of such loudness balancing experiments less level is needed in headphone presentation to create the same loudness when the stimulus is uncorrelated between the ears as compared to diotic stimulation. The observations depend on the room the experiment was conducted in.

**Conclusions:** Interaural correlation and other binaural parameters appear to be a considerable factor when loudness is assessed in headphone measurements, especially for transferring the headphone-based loudness ratings to free-field listening. The implications for loudness-based fitting of binaural hearing aids is discussed.

ID: 04118

### Loudness matching to measure spectral and binaural loudness summation in bilateral hearing aid fittings.

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**Background,** Aversiveness of loud sounds is a frequent complaint by hearing-aid users, especially when fitted bilaterally (Boymans et al. 2009, Hickson et al. 2010). Earlier research from Oetting et al (2016) and van Beurden et al (2018) indicated that the restoration of the narrow-band loudness perception in hearing-impaired listeners may not be adequate for the perception of loud broadband signals, presented bilaterally. Binaural and spectral loudness summation can be held responsible for this finding. However results show large inter-individual differences for binaural loudness perception especially for broadband stimuli and this should be taken into account in the hearing aid fitting procedure. Therefore, a fast clinical test is needed and this study focusses on the applicability of loudness matching.

**Materials and methods,** For the measurements we used widely used techniques “Adaptive Categorical Loudness Scaling” (ACALOS) (Brand and Hohmann, 2001) and loudness matching. Loudness matching was applied as a potentially faster technique to be used in a clinical setting.

Test conditions focus on spectral loudness summation (loudness differences between narrow-band and broadband signals), and binaural loudness summation (loudness differences between signals which are presented unilaterally and bilaterally)

**Results,** The results from loudness matching and ACALOS show a close correspondence and the test retest reproducibility are both relatively good. This indicates that loudness matching may be well applicable in a clinical setting. Results also indicate a large effect of the spectral shape, especially for low frequencies.

**Conclusion:** Information about loudness perception can complement the pure-tone audiogram and is relevant for the fitting and fine-tuning of hearing instruments

**Conflicts of interest:** None.

## Free Papers 18 - Implantable hearing devices

ID: 03859

### Measuring aided thresholds with active middle ear implants

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**Keywords:** Active Middle Ear Implant, outcomes, audiometry

**Background,** in conventional hearing aids, gain can be measured objectively, in a 2cc coupler or in real ears. In active middle ear implants (AMEI), the output signal is not accessible to objective measurements, so effective gain is usually determined psychoacoustically, by measuring aided sound field threshold and subtracting unaided threshold (sound field for SNHL, bone conduction for mixed HL). However, the measured “aided threshold” may be influenced by factors other than the patient’s hearing loss and AMEI amplification. These extraneous factors were investigated by modeling and by analysis of clinical data, and their impact on estimation of AMEI effective gain determined.

**Methods,** aided thresholds measured with the Cochlear™ Codacs™ System direct acoustic cochlear implant were compared to expected values derived from the known expansion settings of the device. Noise levels measured with the microphone as used in the fully implantable Cochlear™ Carina® System were compared to expected masking levels derived from known microphone specifications and skin attenuation.

**Results,** One confounding factor is the expansion programmed into the gain-vs-input behavior of the processor,

i.e. a prominent reduction of gain for input signal levels below the expansion kneepoint. This may or may not be accessible via the AMEI fitting software. The predicted impact on measured aided thresholds of the expansion kneepoint programmed into the Cochlear™ Codacs™ System direct acoustic cochlear implant matches data from a clinical study. Another confounding factor, for devices with a subcutaneous microphone such as the Cochlear™ Carina® System, is the intrinsic noise of the microphone, which is typically higher than for a hearing aid microphone in air. Here, measured “aided thresholds” may actually be masked thresholds, determined by the masking level of the microphone noise, rather than thresholds in quiet. The predicted impact on measured aided thresholds matched clinical observations.

**Conclusion,** These factors are irrelevant if the aided thresholds are only used to estimate outcomes for an individual patient, because they do reflect actual audibility. However, if aided thresholds are used to estimate AMEI device performance (gain), to make decisions regarding future patients, then these effects need to be taken into account.

ID: 03972

### Do ambient pressure changes impact coupling efficiency of a middle ear implant actuator?

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**Introduction:** One option to treat moderate-to-severe sensorineural (SNHL) and mixed hearing loss (MHL) is the implantation of an active middle ear implant like the Cochlear™ Carina®. The actuator of the implant is fixed firmly to the skull and stimulates the ossicular chain either by coupling to the incus body or to the long process of the incus, stapes head or round window. Clinicians and recipients need assurance that the coupling will be stable over time, even under movements of the ossicular chain caused by changes in barometric pressure. This has not been systematically investigated in experiments where the coupling itself can be challenged in a controlled and reproducible way. We designed a study to test whether pressure fluctuations to the middle ear expected from daily life events could potentially change coupling efficiency.

**Methods,** Experiments were performed on 10 ASTM compliant fresh frozen human temporal bones, of which 9 could be used for analysis. Two daily-life pressure events were tested by applying pressure to the tympanic membrane; repetitive Valsalva’s maneuvers (500 cycles of -40 hPa – +60 hPa) and jumping into a swimming pool and diving 3 meters deep (a step change of 300 hPa). Actuator coupling efficiency was measured before and after the pressure events through laser Doppler vibrometry of stapes motion for a frequency range between 100 Hz and 10 kHz comparing actuator output expressed as equivalent free field sound pressure levels at 1 V<sub>rms</sub> actuator input. Three

different coupling configurations were tested; (a) coupling to the incus body, (b) coupling to a small hole to the incus body made by a surgical laser (standard procedure at Hannover Medical School) and (c) coupling to the long process of the incus via an áWengen clip.

**Results,** After the 500 pressure cycles as well as the larger pressure event of 300 hPa, no reduction in coupling efficiency of >6 dB was observed in any of the TB in the frequency range 100-1000 Hz. Larger changes of 13-24 dB were seen in 2 temporal bones at frequencies >1000 Hz, which may be due to the well-known sensitivity of the LDV to rocking vs piston motion at higher frequencies.

**Conclusion,** All 3 coupling configurations connected the actuator securely to the ossicular chain, under variations of barometric pressure that can be expected in daily life.

ID: 03973

### Actuator performance for different coupling configurations of the Cochlear™ Carina® active middle ear implant

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**Background,** The Cochlear™ Carina™ active middle ear implant (AMEI) can be used to treat moderate to severe sensorineural (SNHL) and mixed hearing loss (MHL). The implant can be coupled to multiple places on the ossicular chain, like the short and long process of the incus and the stapes head, as well as the round window. The decision which coupling configuration will be used depends on the patient’s pathology; i.e. sensorineural or mixed hearing loss, ossification, absence of ossicles etc. More information about actuator output for each coupling configuration could help surgeons to make an informed decision on which type of coupling would most benefit their patients.

**Methods,** In 10 ASTM compliant fresh frozen temporal bones (TB), we measured actuator output for four coupling configurations: (a) coupling to the incus body, (b) coupling to a hole made with a surgical laser to the incus body, (c) coupling to the long process of the incus using an áWengen clip and (d) coupling to the stapes head using an áWengen clip. Actuator output was measured through laser Doppler vibrometric measurement of stapes motion for a frequency range between 100 Hz and 10 kHz. The actuator output was expressed as equivalent free field sound pressure levels at 1 V<sub>rms</sub> actuator input.

**Results,** For coupling to the incus body, with and without a laser hole, actuator output was approximately 120 dB SPL<sub>eq</sub> for the low frequency range between 100 and 1000 Hz. Above 1000 Hz actuator output varied between 100 and 140 dB SPL<sub>eq</sub> across temporal bones, mostly describing a gradual rise up to 140 dB SPL<sub>eq</sub> in output, followed by a dip at 6–8 kHz. Coupling to the long process of the incus resulted in more variable results, and coupling to the stapes was the most efficient. Coupling to the stapes

led to an actuator output of 130 to 140 dB SPL<sub>eq</sub> for the 100–1000 Hz range and up to 20 dB higher at frequencies higher than 2 kHz.

**Conclusion.** All 4 coupling configurations led to high actuator output with long-process coupling leading to variable results.

**ID: 03988**

### **Intraoperative determination of the coupling efficiency of the middle ear implant Carina(R) by means of auditory evoked potentials**

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**Keywords:** Middle Ear Implant, Acoustic Evoked Potential, Intraoperative Measurements

**Background:** The Carina<sup>®</sup> implant system from Cochlear is an active middle ear implant, which can be coupled intraoperatively to various structures in the middle ear, depending on hearing loss and middle ear physiology. The hearing improvement with implant depends on the coupling efficiency of the actuator. In particular, in patients with hearing losses close to the indication range sufficient coupling is necessary to ensure enough amplification to compensate the hearing loss effectively. So far, the coupling between the actuator and the respective middle ear structure is optimized intraoperatively indirectly by monitoring the electrical impedance of the actuator. However, it is not yet possible to make a statement on the ability of the implant to stimulate the hearing system or to verify the actual coupling efficiency.

**Material and methods:** In the present contribution, results for the intraoperative determination of the coupling efficiency of middle ear implants by means of auditory evoked potentials (AEP) are presented. For this purpose, AEP was registered and evaluated during the implantation. The stimulation was carried out with broadband chirp stimuli, which were presented starting from suprathreshold levels to below the registration threshold.

**Results:** Intraoperative ABR measurements show, in meanwhile seven patients, that it is possible to derive reliable AEP thresholds via the actuator of the implant. The postoperative comparison with the results of the postoperative OC- direct measurements and the preoperative bone conduction threshold confirm the intraoperative determined AEP thresholds with significantly lower variance.

**Conclusion:** The first results demonstrate that the direct actuator stimulation allows reliable intraoperative ABR measurements. The method can be used to estimate the coupling efficiency of the actuator and facilitates its positioning.

**ID: 04007**

### **Sound source localization in patients with cochlear implant and hearing aid with harmonized temporal processing of sound signals**

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**Keywords:** bimodal Hearing, cochlear implant, sound source localization

**Background:** Patients unilaterally supplied with cochlear implant (CI) are often wearing hearing aids on the contralateral ear. By this, the auditory system has access to binaural input and hence listening performance is often improved. Due to different processing and transfer of signals in the hearing aid in comparison to the CI speech processors a mismatch of both signals at the level of the auditory nerve occurs. One issue is timing of the two prostheses, whereas the hearing aid lags behind the CI by about 6 to 10 ms. Hence, binaural listening performance may be affected. The goal of the present study was to introduce a delay in the signal delivered by the CI in order to harmonize signal timing in bimodal listeners with CI and hearing aid. From this, an improvement of binaural hearing tasks such as sound source localization was expected.

**Materials and Methods:** The patients participating in the study were supplied with CI in one ear (MED-EL, Generation i1000/i1200) and were using a hearing aid on the contralateral side. All patients were required to have a considerable benefit in the aided condition, i.e. speech understanding in quiet better than 70% (Oldenburg Sentence Test in quiet at a speech sound level of 65 dB SPL). Prior to the tests, the processing time of the hearing aid was determined and used as reference zero for delaying the signal of the CI. With this modification, a series of sound source localization tests with various delays was performed.

**Results:** In general, the present group of bimodal listeners showed large deficits in sound source localization irrespective of delaying the CI signal. In particular, patients had great difficulties when sounds were presented directly from the front or from the left or right side. When sounds were presented at angles of  $\pm 30^\circ$  and  $\pm 60^\circ$  the judgements were more accurate. At these presentation angles the delay of the CI signal showed an influence on the corresponding angular localization error. In total five different delay times were tested, which were roved around the processing time of the hearing aid ( $\pm 2$  milliseconds).

**Conclusion:** A delay of signal processing of the CI seems to affect binaural hearing performance in listeners with bimodal supply (hearing aid and cochlear implant). The net effect was weak, at least in the small group of patients tested so far.

**Conflicts of Interest:** The authors declare no conflicts of interest.

ID: 04067

## Marker for microstructure destruction of cochlea with Slim Perimodiolar Cochlear Implant Electrode Array

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**Keywords:** cochlear implantation, cochlear microstructure, hearing preservation, perimodiolar electrode profile, soft surgery

**Background:** In several clinical studies have published that trauma of hair cells or supporting cells leads to a slow and incomplete retrograde degeneration of the auditory nerve, while the spiral ganglion cell bodies are relatively spared in the long run as mono-polar cells that have preserved their continuity with the central auditory pathways. Preservation of the mentioned cells after cochlear implantation could indicate measurable residual hearing.

**Material and methods:** Twenty-six patients with measurable residual acoustic hearing was implanted with a slim perimodiolar electrode. The follow-up period ranged from a minimum of 12 months up to at least 24 months and in some cases three years, regarded as a basis for subsequent separation. In all cases, genetic mutation screening was performed by direct sequencing of the coding regions and the flanking introns of GJB2, GJB3, and GJB6 genes; was supported by the grant EFOP-3.6.2-16-2017-00009.

**Results:** In our study group appealing results have been gained on long-term acoustic hearing sensitivity preservation within a wide range of the measured frequencies. The most vulnerable tones were the 8 kHz (total loss of sensitivity) and 1 kHz (average decrease: 15.55 dBHL), while outstanding hearing preservation could have been achieved at the mid and lower frequencies (at 500 Hz with an average decrease of 11.79 dBHL).

**Conclusion:** As well-preserved residual acoustic hearing could have been registered even years following the minimally invasive surgical techniques used in combination with the new type of Slim Modiolar electrode, the chance to preserve the structural and functional integrity of cochlear regions is a realistic expectation, that could serve a proper indicator for undamaged hair cell-spiral ganglion cell sequence either. The work was supported by the grant EFOP 3.6.3-VEKOP-16-2017-00009.

ID: 04074

## Case report of the change in in-situ microphone sensitivity of a patient implanted with a fully-Implantable middle ear implant

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**Keywords:** fully implantable middle ear implant, implantable microphone, microphone sensitivity

**Background:** The acoustic sensitivity of a fully-implantable sub-cutaneous microphone may change after implantation due to various factors: scar tissue formation, healing, skin thickness, and skin tension above the microphone. The aim of this study was to evaluate how the acoustic sensitivity changes over time. These measurements are part of a larger project investigating the sensitivity and directional response of a sub-cutaneous microphone. The ultimate goal is to develop guidelines for future fitting strategies.

**Material and Methods:** The acoustic sensitivity of the microphone of the Cochlear Carina Fully-Implantable Middle Ear Implant was measured in-situ in one patient in five different head positions at various time points after surgery.

**Results:** It is the first time that the in-situ sensitivity of the subcutaneous microphone was measured in a patient in the first weeks after surgery in a controlled way. We were able to successfully measure the microphone sensitivity week by week and follow the changes over time. In the first weeks after surgery the resonance peak of the microphone decreases after which it increases again. Around 8 to 9 weeks the sensitivity stabilizes.

**Conclusions:** The implantable microphone is one of the key components of a fully-implantable system. It is therefore important to understand how the microphone sensitivity changes over time to pick a suitable moment for the first activation of the middle ear implant. For a good and stable fitting of the implant it should only be activated once the microphone sensitivity is stable.

**Conflict of interest:** C D'hondt is an employee of Cochlear Ltd. She receives funding from the Flanders Innovation & Entrepreneurship for her PhD project.

## Free Papers 19 - Vestibular disorders, diagnosis and therapy II

ID: 03762

### Skull Vibration-Induced Nystagmus Test (SVINT) - a vestibular Weber

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Keywords: Vestibular – Children – Skull Vibration Induced Nystagmus – Cochlear Implant

**Background & Aim:** Skull Vibration-Induced Nystagmus Test (SVINT) is a non-invasive first line examination test that stimulates both otolith and canal structures. In adults this simple test determines an asymmetry of the vestibular function and the test is positive when the SVIN starts and stops with the stimulation onset and offset, beats toward the same direction, is reproducible on each mastoid, and has a slow-phase velocity (SPV) greater than 2%. This test has shown high efficiency in a diagnosis of unilateral weakness, Meniere and Semicircular Canal Dehiscence (SCCD). Our aim is to perform this test on children and see the efficiency of SVINT in implanted children.

**Material & Methods:** The results of 120 healthy children and 30 cochlear implant patients were studied with the Synapsys vibrator (100 Hz) applied on vertex and each mastoid and recorded under VNG 2D or 3D. Results were compared to video head impulse test (vHIT) and caloric test (CaT).

**Results:** The test is positive when it generates a VIN beating toward the same direction whatever the skull location, sustained, repeatable, starting with the stimulation and stopping with it. No responses are observed in bilateral symmetrical lesions. SVINT showed in normal children a great specificity 98% and was

**Conclusion:** SVINT is a global vestibular test for adults and children at 100 Hz and acts as a vestibular Weber test. It explores the vestibulo-ocular reflex and complements the CaT and vHIT in the vestibule multi-frequency analysis. SVINT is useful to detect instantaneously as a bedside first line examination test, a vestibular asymmetry pre and post implants.

ID: 03786

### Feasibility of extensive vestibular assessment in young children: recommendations for clinical practice

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Keywords: Vestibular assessment, children, pediatric

**Introduction,** Vestibular dysfunctions in children are not as uncommon as generally assumed and can compromise their development on many levels. Unfortunately, vestibular assessment in children is challenging, and therefore not yet fully established in clinical practice. The aim of this presentation is to discuss the feasibility of extensive vestibular assessment in young children, and to present practical tips on how to maximize this feasibility.

**Material & methods,** Fifty-eight healthy children (5mo-6yr) were subjected to an extensive vestibular test protocol. Children younger than three were examined with the video head impulse test (vHIT), rotatory test, and cervical vestibular evoked myogenic potentials (cVEMP). From the age of three, the protocol was extended with the caloric test and ocular vestibular evoked myogenic potentials (oVEMP).

**Results:** In the younger subjects (<3yr), the highest success rate was achieved for the cVEMP (94.1%), whereas the rotatory test appeared to be the most difficult to conduct reliably (73.5%). In contrast, the rotatory test was successful in all cases (100%) in the older group (>3yr), as were the cVEMP and oVEMP. In the extensive protocol, the caloric test remained the most challenging (82.6%).

**Conclusion:** The vestibular evoked myogenic potentials are the most feasible vestibular tests in young children. However, our results show that other vestibular examinations (vHIT, rotatory and caloric test) should also be considered as they prove to be quite feasible as well, provided that some adjustments are made.

**Conflicts of interest (if any):** There are no conflicts of interest to disclose for all authors.

ID: 03788

### Psychometric Properties of Dual-task Studies with the Aim of Developing a Test Protocol for Vestibular-Impaired Patients: a Systematic Review

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Keywords: Vestibular impairment, cognition, test protocol, posture, systematic review

**Background:** Patients with vestibular disorders often suffer from cognitive impairment. On the one hand, this can be attributed to extensive vestibular projections throughout the cortex and subcortex. On the other hand, increased cognitive-motor interference (CMI) might present in persons with vestibular disorders. CMI can be assessed by

performing dual-tasks, however, literature on this topic is scarce in the vestibular population. Therefore, before implementing a dual-task protocol in these patients, a systematic review on the psychometric properties of dual-tasks in a variety of populations was conducted.

**Material and Methods:** The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. An extensive literature search was run on MEDLINE, Embase, and Cochrane Databases. Their eligibility was assessed by two independent researchers, and their methodological quality was evaluated using the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN).

**Results:** Thirty-three studies were included in the current review. The cognitive and motor tasks varied in terms of test-retest reliability, and some were valid in persons with Parkinson's Disease, multiple sclerosis, dementia, stroke, or elderly.

**Discussion:** In order to maximally evoke CMI in the vestibular population, both static and dynamic motor tasks should be performed while challenging the vestibular cognitive domains (visuospatial abilities, memory, attention, executive function, and processing speed). Out of the large amount of cognitive tasks employed in dual-task studies, multiple tests can be suggested for executive function and processing speed. For the cognitive domain memory, only the Backward Digit Span Test can be recommended. As attention is required in every dual-task protocol, this component cannot be challenged separately. Finally, visuospatial cognition was not assessed in a reliable or valid way in the included dual-task paradigms.

**Conclusion:** The use of dual-tasks will give a more accurate and daily life representation of cognitive and motor deficiencies and their interaction in the vestibular-impaired population.

ID: 03809

## The evaluation of postural stability with Wii-Fit Plus in children with specific learning disabilities

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Ankara Yildirim Beyazit University

**Key words:** Wii-Fit Plus, postural control, specific learning disabilities, single leg.

**Background:** Specific learning disability (SLD) is a heterogeneous neurobehavioral condition associated with impaired reading (dyslexia), impaired writing (dysgraphia) or mathematics learning disorder (dyscalculia). It is known that in children with SLD may have problems in visual, auditory, tactile, kinesthetic and vestibular perception of stimuli during postural control process. Besides, there may be delays in the processing of motor functions and problems with cognitive skills in children with SLD. Nintendo Wii Fit ("Wii Fit") is a software package that evaluates

postural stability and is a new platform monitoring of balance systems that changes in the pressure center during the individual movements. The aim of this study was to evaluate postural control during single leg stance with the Wii-Fit Plus in children with SLD.

**Material and Methods:** Seventy children who did not have orthopedic, neurological, hearing and vision problems were included in this study. The study group consisted of 35 children (14 girls, 21 boys; mean age  $13.34 \pm 2.81$ ; range 9-18 years) who were diagnosed with learning disabilities. As controls, 35 healthy children (17 girls, 18 boys; mean age  $13.02 \pm 2.40$ ; range 8-18 years) also participated in this study. Postural control during single leg stance were evaluated in study and control group using the Wii-Fit Plus system. The scores of stability percentage were recorded in both groups and compared.

**Results:** A statistically significant difference was found in the scores of stability percentage between study and control groups ( $p < 0.05$ ). The single leg postural stability scores of the children in the study group were significantly lower than control group ( $p < 0.05$ ).

**Conclusion:** The single leg postural stability was negatively affected in children with learning disabilities. We think that postural control assessment is important in children with special learning disabilities. Easy to use, inexpensive and portable Wii-Fit Plus balance platform can be used to assess postural control in these children.

ID: 03829

## Combined program of aerobic and strength exercise training effects on postural control in elderly

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**Keywords:** Physical activity, Health, Combined exercise training, Supine, Senescence.

**Background:** Postural control in humans consists on the ability to maintain orthostatic position in everyday tasks<sup>1,2</sup>. Age-related declines physiological systems that participate in postural control mechanisms that lead to increased incidence of falls in elderly<sup>3</sup>. Postural equilibrium is evaluated while minimize sway of body performing balance test<sup>2,4</sup>. Falls prevention programs often multi-factorial, exercise being essential component, focusing balance improvement<sup>5</sup>. The main aim of this study the effects combined exercise program on postural stability of older people.

**Material and Methods** This longitudinal study screened 121 candidates and returned 65 active elderlies (3 drop-outs) randomly placed in experimental group (EG) and control group (CG) who performed nine months of combined exercise (CE) training (one hour sessions, aerobic exercise twice/week and strength exercise once/week), evaluated with the Postural Control test with a force platform.

A *mixed repeated measures ANOVA* showed the effects of CE program on Overall Stability Index (OSI).

**Results.** ( $M \pm SD$ ): in 62 participants (62.9% female) aged  $69.02 \pm 4.27$ , ANOVA showed that OSI in EG decreased  $M = 3.101$ ,  $SD = .79$ ,  $n = 62$ ) to  $M = 3.054$ ,  $SD = .927$ ,  $n = 62$ ); while in CG increased  $M = 2.957$ ,  $SD = .77$ ,  $n = 62$ ) to  $M = 3.786$ ,  $SD = 3.903$ ,  $n = 62$ ). The effect of CE training on values of OSI PC depends on group (EG vs. CG) as demonstrated by the significant interaction ( $F(2,120) = .552$ ;  $p = .577$ ;  $\eta^2 = .009$ ; Statistical Power ( $p$ ) = .140).

**Conclusions:** Study showed that postural control results can be significantly improved by combined exercise programs, promoting a better health condition on elderly people.

**Conflicts of interest:** none

**ID: 03830**

### Combined program of aerobic and strength exercise training effects on modified clinical test sensory interaction on balance in elderly

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**Keywords:** Physical activity, Exercise training, Supine, Afferent nervous information's, Senescence.

**Background:** Sensory interaction on balance translates, as ability people have to maintain postural balance, processing afferent nervous information from vestibular, visual and proprioceptive systems<sup>1</sup>. This ability declines with ageing due to slower central processing, along with peripheral dysfunction<sup>2</sup>. Time and attention resources need to be allocated to postural task when less sensory information is available as when performing (*mCTSIB*)<sup>3</sup>. Exercise is essential focusing towards balance improvement. The main aim was to study the effects of combined exercise program on postural stability of older people.

**Material and Methods:** This longitudinal study screened 121 candidates and returned 65 active elderlies (3 drop-outs) who performed nine months of combined exercise (CE) training (one hour sessions, aerobic exercise twice/week and strength exercise once/week), evaluated with *mCTSIB* with a force platform. A *mixed repeated measures ANOVA* showed the effects of CE program on the most balance-specific test condition (closed eyes foam surface-*CEFoS*).

**Results:** ( $M \pm SD$ ): 62 participants (62.9% female) aged  $69.02 \pm 4.27$ , ANOVA showed that *CEFoS* in EG decreased from  $M = 3.101$ ,  $SD = .79$ ,  $n = 62$ ) to  $M = 3.054$ ,  $SD = .927$ ,  $n = 62$ ); while in CG increased from  $M = 2.957$ ,  $SD = .77$ ,  $n = 62$ ) to  $M = 3.786$ ,  $SD = 3.903$ ,  $n = 62$ ). The mean value of *CEFoSSIB* in the participants of the EG ( $M = 2.978$ ,  $SD = .875$ ,  $n = 37$ ) was not significantly

different from the value of the variable in participants in the CG ( $M = 2.962$ ,  $SD = .705$ ,  $n = 25$ ) with high dimension ( $F(1,60) = .436$ ,  $p = .511$ ; Statistical power = .100). The size of the effect is ( $\eta^2_p = .007$ ) being the confidence interval 95% for the difference of means of the value of *CEFoSSIB* of the two groups [.386; .767]. Finally, the effect of CE training on changing the values of *CEFoSSIB* depends on the group of participants (EG vs. CG) as demonstrated by the significant interaction ( $F(2,60) = 1.861$ ;  $p = .178$ ;  $\eta^2 = .030$ ; Statistical Power ( $p$ ) = .269).

**Conclusions:** Study showed CE nullifies the natural age-induced decline maintaining participants' performance throughout nine months.

**Conflicts of interest:** none.

**ID: 03833**

### Vestibular function in children with congenital cytomegalovirus infection: Results of 2.5 years of follow-up

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**Keywords:** Congenital cytomegalovirus infection, vestibular, children.

**Background:** Congenital cytomegalovirus infection (cCMV) is a major cause of sensorineural hearing loss (SNHL) in children. cCMV can induce a viral labyrinthitis which can affect not only the auditory, but also the vestibular function. This in turn can have an impact on the motor development. Since June 2016, all cCMV-patients in our hospital are followed longitudinally with an extensive vestibular and motor test protocol from 6 months until 6 years of age.

**Material and methods:** Since June 2016, 75 patients have been enrolled for follow-up. At regular intervals, they underwent extensive vestibular testing consisting of the video Head Impulse Test, rotatory test and cervical Vestibular Evoked Myogenic Potential test. The results of 2.5 years of follow-up are presented.

**Results:** Of all cCMV-patients included in this study, 42 were asymptomatic and 33 symptomatic. Within the latter group, 12 had congenital SNHL (8 bilateral, 4 unilateral). Delayed onset SNHL occurred in 2 asymptomatic (both bilateral) and 2 symptomatic (1 bilateral, 1 unilateral) patients. Severe vestibular dysfunction was determined in 8 symptomatic and 2 asymptomatic children, resulting in an overall occurrence of 13.3%. Vestibular dysfunction occurred predominantly in patients with bilateral SNHL, but strikingly also in 1 patient with unilateral SNHL and 1 with normal hearing. The vestibular dysfunction was delayed in onset in 3 and progressive in 1 of these patients.

**Conclusion:** Symptomatic cCMV-infected children with bilateral hearing loss are most at risk for vestibular deficits. Vestibular loss in asymptomatic or normal-hearing patients is rather rare but not excluded. As the vestibular dysfunction can be delayed in onset and/or progressive, longitudinal follow-up is recommended.

**Conflicts of interest:** None.

**ID: 03893**

## The effect of the changes in the visual system on balance in strabismus patients

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**KEY WORDS,** Balance, Strabismus, Visual System, Vestibular System, Proprioceptive System

**Background,** Strabismus is defined as the absence of the plane of the visual axis where the physiological condition is required. In the literature, it is seen that the prevalence of strabismus is below 5%. Strabismus is known to cause postural control impairment due to the provision of false visual input. The aim of the study is to evaluate the effect of strabismus on the patient's postural control by comparing pre-operative body sway with the post-operative period.

**Material and method:** 15 female and 11 male subjects aged between 8-14 (avg. 9,64) with normal hearing thresholds were included in the study. All patients were diagnosed with strabismus and their surgeries were planned. Sensory organization test, adaptation test and rhythmic weight shift tests were applied to the participants pre-operatively, 1 and 3 months post-operatively.

**Results:** The pre-operative strabismus levels were statistically higher than one-month post-operative and three-month post-operative strabismus levels ( $p < 0,001$ ). Pre-operative visual field rate was found statistically lower than one-month post-operative rate ( $p < 0,05$ ). The pre-operative toes down value was statistically higher than three-month post-operative toes down value ( $p < 0,001$ ). When compared, one-month post-operative toes down value was significantly higher than three-month post-operative toes down value ( $p < 0,05$ )

**Conclusion** It is seen that a malfunction in the visual system will cause the visual information input to be misinterpreted because it will change the optical axis. In patients with defective optical axis, it is thought that the idiopathic falls will occur, as keeping the balance will get difficult particularly on difficult conditions. Strabismus surgery has been shown to reduce the risk of falls in patients as a result of optical axillary correction and it is useful to evaluate these patients also in terms of postural control before

and after surgery. Due to the fact that the strabismus surgery treats the optical axis, it is concluded that the risk of the idiopathic falls decreases and it is also useful to evaluate these patients in terms of postural control in pre-operative and post-operative period.

**ID: 03903**

## Balance assessment in children with vertigo

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**Key words:** vertigo, balance disturbances, Biodex Balance System SD, ENG

**Background:** Balance status was assessed in children with vertigo on Biodex Balance System SD (BBS). The platform offering a possibility of performing a panel of tests enables to check postural stability. The test on an unstable platform requiring closed eyes (Ps4) is usually difficult for patients with vestibular pathology. The aim of the study was to check whether the result of the latter test corresponds with vestibular impairment confirmed by electronystaggraphy (ENG).

**Material and methods:** 19 patients with vertigo: 16 girls and 3 boys aged from 6 to 17 years (medium 12.5) were recruited into the study group. They were diagnosed and treated in the Department of Audiology and Phoniatics CMHI from September to November 2018. Neurological, cardiological and ophthalmological causes of vertigo were excluded. Clinical examination, a panel of routine hearing and vestibular tests (ENG, VEMP and dynamic posturography on BBS) were performed.

**Results:** We diagnosed recurrent vestibulopathy in 7 children, vestibular migraine in 3, vestibular neuronitis in 2, benign paroxysmal vertigo of childhood in 1, superior semicircular canal dehiscence syndrome in 1, psychosomatic vertigo in 1, central vertigo in 4. The duration of vertigo in our probands ranged from 2 to 72 months (average 18). ENG test revealed reduced unilateral caloric response in 5 children (26% in our group). Nine patients reported problems with balance. Significant balance problems (open eyes and stable platform) were seen in 3 patients (16%), while problems with balance on an unstable platform requiring closed eyes (the Ps4 test) were revealed in 5 children (26%). None of the patients with peripheral vestibular weakness encountered problem with the Ps4 test. Balance problems (Ps4) were not limited to specific clinical diagnosis nor the duration of vertigo. Pure tone audiometry showed proper hearing in all patients but two: one with unilateral conductive impairment and the second with unilateral mixed loss.

**Conclusions:** Vestibular pathology is more frequently seen in teenager girls. Balance problems are not typical for

patients with unilateral vestibular weakness. Compensatory mechanisms of unilateral peripheral vestibular weakness in children are fast and effective. Balance disorders are not limited to particular clinical diagnosis.

**Acknowledgement:** The study was done within research grant Virtual Balance Clinic VB-Clinic founded by NCBR Poland (STRATEGMED3/306011/1/NCBR/2017)

## Free Papers 20 – Genetics

ID: 03960

### Axenfeld–Rieger syndrome: a rare cause of hearing loss.

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Ana Fernandes, Vanessa Machado,  
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**Keywords,** Axenfeld–Rieger syndrome, genetic; pedigree, audiometry, hearing loss

**Background:** Axenfeld–Rieger syndrome (ARS) is a rare disorder, with a prevalence estimated at 1 in 50,000 to 100,000 newborns, transmitted in an autosomal dominant manner. Its main clinical characteristics include ocular malformations particularly in the iris, cornea and the chamber angle. Patients also commonly present systemic features, namely craniofacial malformations, hypospadias, pituitary gland abnormalities, arachnoid cysts, growth retardation, heart defects and rarely sensorineural hearing loss. Current advances in molecular genetics have identified two major ARS genes, PITX2 (4q25) and FOXC1 (6p25), revealing a wide spectrum of mutations, and variable expressivity of clinical phenotypes.

**Material and methods:** We describe the clinical, radiological and audiometric characterization of a child with Axenfeld–Rieger syndrome, genetically confirmed. Additionally the three-generation pedigree with audiometric evaluation is presented.

**Results:** The child presented malformations of the anterior segment of the eye, mitral valve prolapse, and mild craniofacial dysmorphism and had the genetic confirmation of a 6p25 deletion at the age of 7. Several years later he was referred for otorhinolaryngologic evaluation due to hearing loss. Audiometry confirmed severe bilateral mixed hearing loss. Computed tomography of the temporal bones revealed bilateral cochlear malformation along with ossicular chain abnormalities. He was adapted to behind the ear hearing aids with adequate aided thresholds and speech recognition scores. The three-generation pedigree with audiometric evaluation confirmed the presence of sensorineural hearing loss in several members from the paternal side, a symptom rarely reported in this syndrome.

**Conclusions:** Sensorineural hearing loss is a rare occurrence in patients with Axenfeld–Rieger syndrome, which

might explain the delay in sending the patient to our consultation. Our case emphasises the importance of careful clinical and audiometric examination of patients with suspected Axenfeld–Rieger syndrome in order to prevent the late diagnosis of hearing loss and its consequences on cognitive, emotional and social development.

**Conflicts of interest,** None

ID: 04044

### Hearing loss and connective tissue disorders in Stickler syndrome

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**Key words,** Stickler syndrome, hereditary hearing loss, collagen.

**Background:** Stickler syndrome is a group of hereditary conditions in the collagen connective tissue that can include a distinctive facial appearance, hearing loss, eye abnormalities, and joint problems. A characteristic feature of Stickler syndrome is a somewhat flattened facial appearance. The hearing loss is both conductive and sensorineural and varies in degree and may become more severe as age increases. Stickler syndrome affects an estimated 1 in 7,500 to 9,000 newborns. The diagnosis of Stickler syndrome is clinically based, but understanding the genetic basis of this syndrome is important because numerous independent genes have been identified. Stickler syndrome can be inherited in an autosomal dominant manner or in an autosomal recessive manner depending on the gene that has a change (mutation or pathogenic variant). When Stickler syndrome is caused by pathogenic variants in *COL2A1*, *COL11A1*, or *COL11A2* genes, it is inherited in an autosomal dominant manner. Pathogenic variants in *COL9A1*, *COL9A2*, or *COL9A3* genes cause Stickler syndrome inherited in autosomal recessive manner. Between 80–90% of all cases are classified as type I and are caused by mutations in the *COL2A1* gene. Another 10–20% of cases are classified as type II and result from mutations in the *COL11A1* gene.

**Material and methods:** Using molecular genetic techniques, the identification of genes associated with hearing impairment in Stickler syndrome will allow screening and possible therapy for the hearing impaired. An early diagnosis can be made and early intervention can be pursued to establish, preserve, or restore functional hearing to maximize speech-language development in the setting of verbal communication, and allows genetic counseling for the families.

**Results:** The typical structure of collagen, a triple helix of three procollagen fibrils allows it to perform the cell adhesion function, strengthening the structures where it is present. If one of the fibrils is missing, the protein complex cannot fulfil its function in the living cell, and the cell probably have an abnormal function and the symptoms of Usher's syndrome appear.

**Conclusions:** Describe the presentation and genetics of the Stickler syndrome, one of the most frequently occurring syndromes involving hearing loss and help the correct diagnosis and treatment.

**Conflicts of interest:** None.

**ID: 04059**

### Investigations on the genetic background of nonsyndromic hereditary hearing loss in cochlear implant patients in Hungary

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**Keywords:** hearing loss, genetic disorders, GJB2, GJB3, GJB6

**Background:** Nonsyndromic hearing loss (NSHL) is one of the most abundant and also genetically heterogeneous disorder with several mutations in the already identified more than 100 causative genes.

**Material and methods:** We aimed in this study to identify the most possible genetic abnormalities in our group of Hungarian NSHL patients. We included patients who have either a family background of hearing loss or are enrolled in the cochlear implant program at the department. 153 patients were included. Mutation screening was performed by direct sequencing of the coding regions and the flanking introns of GJB2, GJB3, and GJB6 genes.

**Results:** During the investigation of GJB2, GJB3, and GJB6 genes, we have identified pathogenic mutations in 36% (n=55) of the examined individuals (n=153). Most patients (n=52) carried GJB2 mutation: in 29 cases homozygous, in 10 cases compound heterozygous GJB2 mutations have been identified and in 13 cases only one heterozygous mutation was detected. Regarding the GJB3 and GJB6 genes, in 3 individuals, a heterozygous missense mutation was identified.

**Conclusion:** Our results correlate well with the international data since mutations of the GJB2 gene are the most common causes of hearing losses in many populations. We plan to extend the screening panel to include other genes because the current method was only able to find mutations in 36% of our cohort of patients. The work was supported by the grant EFOP-3.6.2-16-2017-00009.

**ID: 04066**

### Nonsyndromic high frequency progressive hearing loss: a family case report

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**Key words:** Nonsyndromic, Hearing, High Frequency

**History:** *Case-1 (Father)*, a 56-year-old man who had bilateral severe-hearing loss. There were no information about his hearing when he was born. He reported that his hearing function better but problem when he was twenty. MRI and BT results were normal. *Case-2 (Mother)*, a 47-year-old woman who doesn't complain about hearing loss. There are not patient with hearing loss in her own family except for presbycusis of her parents. *Case-3,4,5 (Siblings)*, the cases are 10,16 and 20 years old respectively. The common feature of the these cases was normal (pass) in newborn hearing screening and didn't consanguineous marriage and no pre-, peri- and post-natal complications in their history. Whereas for the first time Case-3,4 was consulted to an audiology clinic, Case-5 was previously diagnosed with hearing loss but could not accept this situation.

**Audiologic Testing:** Pure tone audiometry, speech audiometry, immittance measurements and vestibular testing were performed to all cases. Normal findings were obtained from all tests of the mother (Case-2) but others had hearing loss in different degrees. In 2018, he had bilateral profound sensorineural hearing loss increasing with high frequency (PTA, more than 115 dB on left and right), very poor speech discrimination (%0 on left and right), normal tympanometric results but no acoustic reflex on bilateral in 500-4000Hz was observed in our assessment. Siblings (Case-3,4,5) showed similarity with the hearing loss configuration, but hearing loss degree of them was different, though they have normal tympanometric results, bilateral absent TEOAE, DPOAE, normal MRI and CT results and similar acoustic reflex results at presenting 500Hz and 1000Hz and absenting 2000Hz and 4000Hz. According to the hearing results of Case-3,4,5, they had bilateral mild, moderate and severe sensorineural hearing loss increasing with high frequency, respectively.

**Discussion:** Although there is no inner ear malformation or pre-, peri- and post-natal complication in the cases in this family, there was a progressive hearing loss that starts at high frequencies with increasing age in children in the family. In addition to the types of hearing loss of the cases, a common point in their stories is that they had passed through neonatal hearing screening. Taking history carefully, genetic consultation and school age hearing screening be important in the early diagnosis and treatment of such cases.

## Free Papers 21 - Other topics related to audiology I

ID: 03887

**Otoprotective function of statins****Pattarawadee Prayuenyong**<sup>1,2,3</sup>,  
**Anand V Kasbekar**<sup>1,2</sup>, **David M Baguley**<sup>1,2</sup><sup>1</sup> *Hearing Sciences, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham UK*<sup>2</sup> *NIHR Nottingham Biomedical Research Centre, Nottingham UK 3 Department of Otorhinolaryngology Head and Neck Surgery, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand***Keywords:** Statins, Otoprotection, Hearing, Tinnitus

**Background:** Statin drugs are commonly used as cholesterol-lowering agents. Various benefits of statins including anti-oxidative and anti-inflammatory properties could be potentially useful for otoprotective effect, at multiple levels involving vascular and non-vascular mechanisms. This systematic review examined the current literature on the efficacy of statins with respect to their ability to improve audiological outcomes.

**Methods:** A systematic literature search was conducted. Studies focusing on audiological outcomes of statin treatment in people with auditory disorders were included for data analysis.

**Results:** A total of 1,142 studies were screened. Four eligible studies (1 RCT and 3 quasi-experimental studies) were retrieved. One RCT revealed a trend toward a relief of tinnitus score in people with presbycusis. There was significantly lowered tinnitus intensity in people with noise-induced hearing loss. Following statin treatment, substantial number of people in cholesterol responsive group (70.5%) had improvement in tinnitus score compared to patients in cholesterol unresponsive group (4.2%). Significant improvement of hearing threshold at high frequencies was observed in people with noise-induced hearing loss, and at low frequencies in those suffered from chronic-phase sudden deafness. However, there was no significant effect on audiometric results in elderly people with presbycusis.

**Conclusions:** There was a tentative evidence to support tinnitus improvement after statin use although hearing outcomes after statin administration demonstrated mixed results. This systematic review highlights the potential benefits of statin drugs to protect audiological functions especially in people with concomitant hyperlipidemia.

ID: 03939

**Examination of wideband tympanometry (WBT) parameters in individuals with healthy middle ear****Murat Şahin**, **Songül Aksoy***Hacettepe University***Keywords:** Wideband Tympanometry, Middle ear, Immittance, Tympanogram, Absorbance.

Immittance is based on the saving pure tone sound which is reflected from eardrum after given at outer ear canal and gives objective information about the condition of the middle ear. The middle ear admittance is considered by changing pressure of outer ear. Usually 226 and 1000 Hz Tympanometry is used in clinics. Wideband Tympanometry (WBT) is done a click stimulus that incloses a wide frequency range (226–8000 Hz). The sound, that is reflected back from the middle ear is called Reflectance, that is absorbed by the middle ear is called Absorbance. It is aimed (1) collection of WBT data on the healthy middle ear, (2) comparison of these data with Immittance results and (3) to evaluate age-related changes in Immittance and WBT results. The study included 60 individuals who are on 20–49 years of age with normal hearing. Three age groups, with 20 individuals in each decade, were formed. WBT, 226 and 1000 Hz Immittance and is done in all groups. It is found no differences Immittance and WBT values between groups ( $p > .05$ ). There is no age-related changes Immittance and WBT values between 20–49 years. In all groups, Equivalent Ear Canal Volume (Vea), Static Admittance (Ytm) and Tympanogram Width (TW) values measured with 226 Hz Immittance is different from values measured with WBT ( $p < .05$ ). More study is needed to determine the causes of this difference.

ID: 03965

**Experiences of initiating ear and hearing care services in a remote region of the Nepalese Himalayas****Sandra Eisner**<sup>1</sup>, **Dorchi Nuppa Bhoté**<sup>2</sup><sup>1</sup> *Hilfe die ankommt (Hda, Austria)*<sup>2</sup> *Nepal Lhomi Society (NELHOS, Nepal)***Keywords:** Nepal, Ear and Hearing Health, Public Health, Start-up

**Background:** Ear disease (ED) and hearing loss (HL) are a major public health issue worldwide. 80% of those with a disabling HL live in low- and middle-income countries. Nepal is such a country but there is no existing national programme, specialized facilities are scarce, and professionals are employed in urban areas.

**Material and methods:** This is a retrospective analysis of starting ear and hearing care services in 2018 in a remote and resource-constrained community of East Nepal. The

services were implemented in the Upper Arun Valley in a joint collaboration with the Jhyambe Mengang Clinic and the Nepal Lhomi Society. A health needs assessment was conducted, medical records analyzed, a community profile developed and health education programs in 7 schools were conducted.

**Results:** The people living in the Upper Arun Valley, a Tibetan ethnic people group, believe that diseases are caused by evil gods. If sick, a person consults with a shaman. Only few patients with ED and HL visit the clinic. Reasons are a lack of awareness, health beliefs/practices based on their religious belief and insufficient prioritization against other needs. Several small health posts are located in the area and the government is increasingly implementing new facilities, but the next hospital is 2-4 days away and doesn't have an ENT Department. These are barriers for patients to seek further treatment. Additionally, health workers are lacking in-depth knowledge and proper equipment. Thus, the 4 main areas of need are: raising awareness; training; providing equipment; implementing specialized ear and hearing services. The first stage of the project included health education programs regarding ED and HL in 7 schools including ear syringing if needed. Out of 358 students, 33% were identified with ear pathology. The majority had impacted wax which was removed by a local health worker.

**Conclusion:** Starting new services needs thorough investigation about what is possible and achievable. It requires engaging with local communities, health facilities and health care workers and using already existing infrastructure. Health beliefs of the local community need to be taken into account as they are shaping health-related behaviour and will have great influence on up-take and sustainability of any project. Only if appropriate beliefs are held, cues to action (social influence/health education) can trigger health behaviour.

ID: 03985

## Ear disease and hearing loss in patients attending ear surgery outreach camps in western Nepal

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**Keywords:** Nepal–Ear Surgery Outreach Camps–retrospective study–Ear Aid Nepal

**Background:** In Nepal, ED and HL are treated in primary, secondary or tertiary government facilities, private clinics or through various NGOs and INGOs. Nevertheless, the provision of services is unsatisfactory with most of the facilities concentrated in urban areas. Out of 75 districts, only 11 offer specialized services. Thus, reaching out to these underserved communities should be an essential part of any hospital. Among others, the International Nepal Fellowship and Ear Aid Nepal have been conducting Ear Surgery Outreach Camps (ESOC) since 1992.

**Material and methods:** This study is a retrospective analysis of 51 ESOCs conducted between 1992 and 2015 in western Nepal. All data for this study were collected at time of presentation. All records were entered into an electronic database by team members after each ESOC. The records were then anonymized and exported to a personal computer for analysis.

**Results:** The ESOC teams saw a total of 43,147 patients and performed 4,646 surgeries. Patient inflow increased over time with most of them being <20 years of age. 70% of the attendees presented with definite ear pathology. After CSOM, the most diagnosed disease was SNHL (12%), 83% were bilateral, 17% unilateral. Profound hearing loss was affecting 12%, moderate hearing loss was predominant (36%) followed by severe (31%) and mild (21%). Profound hearing loss is high amongst children below 10 years compared to high numbers of moderate and severe hearing loss amongst people between 50 and 60 years. 42% of patients with SNHL were fitted with a hearing aid, 98% in one ear.

**Conclusion:** ED and HL are a huge burden of disease in Nepal and at the moment not managed without medical camps. A changing pattern of disease and visitors was found with rising numbers of women seeking treatment, SNHL increasingly being diagnosed and decreasing numbers of CSOM. But the numbers and results discussed might even only represent a small proportion of the actual problem as many areas are still not covered by medical camps.

ID: 03996

## Are we sure we are protecting our ears safely? Evaluation-study of personal hearing protection and verification procedures

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**Key Words:** Personal Hearing Protection, Safe Listening, Verification Procedures.

**Background** As audiologists, we are professionally involved in advising and providing solutions for safe listening. In this study we evaluated 7 different types of personal hearing protection, and 4 different verification procedures for hearing protection.

**Material and methods** Subjects: 40 young, normal hearing subjects (mean age 23 years, 20 male/20 female) participated in this study.

**Material:** For each subject the following types of personal hearing protection were provided and evaluated:

1 set Custom Made Hearing Protection, with 20 dB flat response music filter.

- 3 sets umbrella type instant reusable hearing protection systems with a music filter
- 1 set umbrella type instant reusable closed hearing protection system
- 1 set foam tip instant reusable closed hearing protection system
- 1 set disposable foam hearing protection system

#### Verification Procedures:

Audiometric evaluation under headphone at 6 octave frequencies (250 to 8000 Hz)  
 Free Field Adaptive Speech-audiometry in Noise at 70dB-SPL noise level (BLU list)  
 Insertion Gain (REM) evaluation with 65dB SPL and 80dB-SPL pink noise

#### Leak-test procedure

Subjective evaluation of Wearing Comfort, Occlusion, Sense of effective protection, Intelligibility of Speech in Quiet, Intelligibility of Speech in Noise, Music Sound Quality, Intelligibility of the lyrics in a song.

**Preliminary Results:** The Audiometric Evaluation replicated the specifications provided by the manufactures. A flat response leads to better perceived intelligibility and sound quality. Hearing Protection does not have a negative impact on Speech-audiometry in Noise. Insertion Gain (REM) should not be recommended to evaluate Personal Hearing Protection. Disposable Foam Hearing Protection has highly variable results

**Conclusions:** The overall conclusion is that custom made hearing protection with a flat response filter, provides the highest level of user satisfaction, the best intelligibility in noise and the lowest variability in effective protection. Audiometric Verification is recommended over Real Ear Measurements.

**ID: 04039**

### How professionals assess outcome in clinical hearing rehabilitation

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*Department of Electronic Systems, Aalborg University*

**Keywords:** hearing rehabilitation; tacit knowledge; outcome measures; clinical practice methods

**Background:** Denmark has currently no formal requirements for testing and documenting the aided listening performance and outcome obtained with hearing aids rehabilitation. Yet most professionals both validate and assess the aided listening experience in various ways as part of the fitting procedure and in follow-up assessments. The goal of the present study was to observe standard clinical practice and identify methods and actions currently used, and examine their potential for formalization and inclusion in guidelines, or replacement by existing formalized procedures.

**Material and methods:** The relevant professionals receive a major part of their training through supervised internships, and it is anticipated that much of their knowledge is tacit and informal. The general methods for the study therefore comprise a combination of interviews with and observations of professionals during hearing-aid fitting and at two-month follow-up. Observations and contextual inquiries of the clinical practice were made in three public hearing clinics in Denmark including 17 professionals, which were either medical audiologists (ENT doctors), audiology assistants or professionals in audiolopedics. These are the main categories of professionals involved in hearing-aid fitting in public clinics in Denmark. Each professional participated between two and ten hours in the present study.

**Results:** The results show that professionals assess outcome using methods, which are often individually and tacitly anchored covering 1) validation of basic hearing aid functionality, 2) patient awareness on gain with hearing aids, 3) access to knowledge on patient experiences through sound descriptions, 4) assessment of aided performance in real life and 5) non-auditory assessments.

**Conclusion:** Some of the informal methods observed may be formalized as a part of a more patient-centered communication strategy - other need further examination or may be replaced by existing, already validated formal frameworks, or by test batteries under development.

**ID: 04289**

### Cholesterol metabolism pathway involved in the recovery of NIHL in miniature pig

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*Chinese PLA general hospital*

**Key words** Acoustic trauma in Miniature Pig cochlear, Proteomic analysis (iTRAQ), Oxidative stress, ROS, Inflammation, NF-κB

Abstract Noise pollution is a threat to human health in auditory system and its pathophysiological mechanism is still not clear. Here we revealed the landscape of protein change in the inner ear of miniature pig induced by noise exposure based on isobaric tags for relative and absolute quantification (iTRAQ). GO and KEGG analyses were used to explore the gene pathway involved in noise induced hearing loss and recovery stage. Auditory brainstem response (ABR) showed a 30-40 dB hearing loss one day after noise exposure (120 dB 3 hrs/day for 2 days). At 7 days after noise exposure, the hearing loss partly recovered to 10-20 dB threshold. Total 2158 proteins were identified in the inner ear. Expression change of 227 proteins were detected 1 day after noise exposure (NE1 vs Ctrl). GO and KEGG annotation showed the key biological process and molecular pathway were related to immunity and metabolism during the acute noise induced hearing loss (Noise-1 day v.s. control group). The western blot and immunofluorescence results showed that the accumulation of ROS and up-regulation and the nuclear trans-location of

NF- $\kappa$ B (p65) transcription factor were found in noise exposure pig hair cells, which may related to initiate the downstream inflammatory factors overexpression. In summary, this study is the first to validate the molecular mechanism of both acute noise impair and recovery stage of NIHL in a large animal model using proteomic. Our data suggested that the activation of metabolism and innate immune signaling pathway may be involved in noise induced hearing loss and cholesterol metabolism pathway may play an important role in hearing loss recovery

## Free PaperS 22 - Hearing Screening

ID: 03759

### Hearing loss in infants with evidence of congenital Zika Virus infection

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<sup>2</sup> Centro Hospitalar Do Tâmega E Sousa, E. P. E., Portugal

**Keywords:** Zika virus, Hearing Loss, Congenital infection

**Background:** Zika virus it's spread by mosquito *Aedes aegypti*, that cause also Dengue and Chikungunya. First case reported in 1947 in monkeys of florest Ziika, Uganda<sup>1,2</sup>. Humans were contaminated in 1952 in Nigeria and Tanzania. From 60's to 80's spread in Africa and Asia. In 2007 reached Micronesia and in 2013 French Polynesia and during 2014-15 were reported at 17 cases of Central Nervous System(CNS) malformations on newborns of those islands. Brazil was affected since 2015 raising numbers of microcephaly<sup>3</sup>. Research show dysfunctions in newborns like pigmentary changes, hypertonia, spasticity, convulsions, cognitive deficit, hearing loss and microcephaly<sup>4</sup>. Zika virus stroked Cabo Verde in 2015. 64 suspected cases 17 positive for Zika, scattered in Santiago, Fogo, Maio, Boavista and Brava islands<sup>1</sup>.

**Material and methods:** This longitudinal study followed 35 newborns in Dr. Agostinho Neto Central Hospital, Praia, Cabo Verde, since July 2016 to present vertically exposed to Zika virus with microcephaly, CNS malformations, with or without any sintomatology<sup>5</sup>. Newborns were evaluated in medical consultation of ENT or pediatric specialties, with risk factors questionnaire administration, otoscopy, tympanometry with stapedial reflex research, and transitory evoked otoacoustic emissions (TEOAE) and in 2017 were added distortion product otoacoustic emissions (DPOAE) and automated Brainstem responses for infant screening (ABRIS) to the battery<sup>6-7</sup>.

**Results:** According study protocol, 35 newborns were evaluated returning 26 normal, 9 with hearing loss (6 sensorineural, and 3 conductive). Conductive hearing loss was not considered related to Zika virus<sup>7</sup>, so only 6 newborns presented hearing loss related to Zika virus.

**Conclusion:** The research returned 6 in 35 newborns (17%) with hearing loss, and eligible for hearing aids. This value was like others found in the range of congenital

infections (6%-65%)<sup>6</sup>. Even in the absence of severe microcephaly, all cases reported or suspected of Zika virus exposure should be evaluated. Sensorineural hearing loss is part of the clinical findings found in Zika virus infections, so should be included as risk factor for hearing.

**Conflicts of interest:** none

ID: 03771

### Irish childhood hearing and vision screening outcomes and cohort comparison with preschool specialist referrals

Theresa Pitt-Byrne, Pauline Roche

Wexford Community Audiology and Nursing Services

**Objectives of Study** 1. To analyse referral cohorts from School Entry Hearing (=SHS) and Vision (=SVS) screening and the impact of staff and protocol changes. 2. To assess SHS or Community Audiology Service impacts following the introduction of Universal Newborn Hearing Screening (=UNHS). 3. To summarise referrals to preschool Community Allied Health and Medical Specialists, relative to hearing and vision status.

**Design:** Randomised anonymised cohort audit analysis of the Child Health and Audiology Records of 882 mainstream schoolchildren, including some in specialist units. which was completed jointly by Audiology and Public Health (Schools) Nursing in County Wexford.

**Results,** 1. Significant age and referral rate differences existed for Hearing and Vision screening throughout. SHS referrals (not SVS), were impacted by staff changes, but SHS protocol changes produced non-significant falls in already low SHS referral rates <2%. 2. Preschool Audiology referrals far outnumbered SHS referrals; there was no overlap between 2% UNHS referrals and <1.5% SHS referrals for a final cohort of 200 children, none of whom had sensori-neural hearing loss. 3. 25% of all children studied were referred for various preschool additional assessments, mainly Speech and Language therapy or developmental assessment. Their SHS and SVS outcomes were similar to those not so referred. This preschool group will be analysed further in a separate study.

**Conclusions,** SHS referral rates fell, but SVS referral rates remained unchanged throughout. Low SHS referral rates and yield have less impact upon Community Audiology services than UNHS referrals, but SHS referrals are already well screened should also have a high priority on Audiology waiting lists. Preschool referral for various assessments for 25% of all children made no significant difference to their SHS outcomes compared to those not referred. More interaction between services, with better access to screening results through the Nursing and Child Health Records, could also be cost-effective for Community services in reducing unnecessary cross-referrals. Reference: Pitt-Byrne, T. (2018). School Entry Screening referral trends and cohort comparison with preschool specialist referrals.

ID: 03794

**Risk factors for hearing loss in children****M.F. Janett<sup>1</sup>, P. Paulo Cardoso Do Carmo<sup>2</sup>**<sup>1</sup> Hospital Dr. Agostinho Neto, Praia, Cabo Verde<sup>2</sup> Centro Hospitalar Do Tâmega E Sousa, E. P. E., Portugal**Keywords:** Risk factors; Hearing Loss; Children; Incidence

**Background:** The United Nations Children's Fund (UNICEF) estimates that approximately 126,000-500,000 children are born each year with hearing loss and about 90% of them live in developing countries<sup>1</sup>. Children are the most affected compromising their neuropsychomotor development<sup>2</sup>.

**Objective:** Study risk factors and incidence of hearing loss (HL) in children reported to Hospital Dr. Agostinho Neto, Praia City, from December 2013, to July 2018.

**Material and methods:** This longitudinal study evaluated the hearing of a convenience sample of 381 children, fulfilling a risk factor questionnaire, otoscopy, middle ear impedance, transient, and distortion products automatic oto-emissions acoustic, and automatic brainstem research for infant screening, and/or tonal and vocal audiometry. Degree, type of hearing loss classification and audiometric configuration according to WHO<sup>3</sup> and Silman and Silverman<sup>4</sup>. Pathologies were named as used in ICD95.

**Results:** 381 children mean age of 4.8 year, 180 females. HL was reported in 55% of the sample, with 78% of bilateral prevalence and 22% unilateral. Risk factors more incident were otitis media, followed by hyperbilirubinemia and family history of HL.

**Conclusion:** Otitis media is the risk factor with bigger incidence for HL. The age of diagnosis of hearing loss is very late. Thus, treatment should be initiated earlier to avoid damage to speech development and communication. This study may be continued toward all the pediatric Population of Cabo Verde.

**Conflicts of interest:** none

ID: 03876

**Universal neonatal hearing screening: are we following the right path? How to improve it****António Lima, Filipa Moreira, Acácia Silva, Ana Menezes, Isabel Costa, Luís Dias***Hospital de Braga*

**Keywords:** hearing loss; Universal Newborn Hearing Screening; Acoustic Otoemissions; Auditory Evoked Potentials.

**Background:** Early diagnosis and intervention offer a significant improvement on prognosis of congenital

deafness. *Hospital de Braga* implemented in 2013 the Universal Newborn Hearing Screening (UNHS) based on Portuguese government recommendations and international guidelines. The protocol divides newborns (NB) in 2 groups: the group with no known risk for hearing loss, and the group with risk factors. The former goes through otoacoustic emissions (OAE) and, if they pass, then the screening is over; if they "refer", besides the OAE, they also go through automated auditory evoked potentials (aAEP). The third phase consists on brainstem auditory evoked potentials (BEAP). The latter implies OEA and aAEP regularly during the first three years of life, and, if they do not pass in any of the evaluations, they are referred to BEAP. The purposes of this study are evaluating our protocol and comparing it with another national and international protocols.

**Material and Methods:** Retrospective and observational study of the NB in *Hospital de Braga* in 2014. Several variables were evaluated.

**Results:** 2616 children were born in this hospital in 2014, 97,8% of which were screened by UNHS. 95,8% had no risk factors for hearing loss; within this group more than 98% passed the first phase and 1,2% "refer". On the second phase (OAE and aAEP), 83,3% passed, and 10,0% went to the third phase ("refer"). None of the NB without risk factors had hearing loss according to the BEAP performed. Regarding the group with risk factors, 2,8% did not pass, and went through BEAP. In this population there were no diagnosis of sensorineural hearing loss.

**Discussion and conclusion:** To be accepted, a screening method has to be sensitive and specific, while being easily performed and not expensive. Our protocol seems to fulfil all of these requests. While referral rates are low and similar to other national and international protocols using different methods, UNHS implementation is still one of the main questions. In HB in 2014 it was successful and covered more than 95% of the NB. Nevertheless, there are some organizational measures which can improve this coverage, such as in-hospital screening tests, testing earlier in life (before 5<sup>th</sup> day) and sensitization campaigns. Besides, some countries have improved their coverage rates by creating online national databases.

ID: 03976

**Metrics reported from neonatal hearing screening programmes across Europe****Allison Mackey<sup>1</sup>, Andrea Bussé<sup>2</sup>, Inger Uhlén<sup>1</sup>, Hans Hoeve<sup>2</sup>, André Goedegebure<sup>2</sup>, Herbert Simonsz<sup>3</sup>, EUSCREEN Foundation<sup>4</sup>**<sup>1</sup> CLINTEC, Division of ENT Diseases, Karolinska Institutet, Stockholm, Sweden<sup>2</sup> Dep. of ORL and Head and Neck Surgery, Erasmus Medical Centre, Rotterdam, the Netherlands<sup>3</sup> Dep. of Ophthalmology, Erasmus Medical Centre, Rotterdam, the Netherlands <sup>4</sup> The EUSCREEN foundation consists of the Country Representatives of the 41 countries in Europe**Keywords:** hearing screening, neonate, quality assurance

**Background,** Many countries within Europe have implemented universal neonatal hearing screening (UNHS) programmes, but variability exists in both organization and protocol (Sloot et al., 2015). International recommendations describe metrics for measuring the performance of UNHS. The aim of this study is to describe outcome metrics across UNHS programmes and compare metrics to protocol variables.

**Method,** The EUSCREEN Paediatric Screening Questionnaire was delivered to experts in childhood hearing screening across participating countries. Details of data collection are described by Bussé et al. (2019) in this conference proceeding. Each answer received was categorized and qualified. High-quality answers are currently being validated, cross-verified with source material when referenced, and clarified in instances of a discrepancy. Metrics examined included coverage rate, pass rate per test, final referral rate to diagnostic assessment, and attendance rate to diagnostic assessment.

**Results,** Protocol variable results are described by Bussé et al. (2019). A mean coverage rate of 93% was calculated from the rates reported from 28 UNHS programmes. Sixty-one percent of programmes reported coverage rates over 95%. Referral rate was reported from 22 UNHS programmes for well infants and/or all infants, with average rates of both infant groups being less than 3%. Referral rates for NICU infants were not available from most UNHS programmes. Finally, a mean of 83% was calculated for attendance rate to a diagnostic assessment from 10 UNHS programmes. The final referral rate for well infants was correlated with the number of steps in the screening protocol and with inclusion of aABR as a screening tool. A correlation was also found between the number of tests performed prior to hospital discharge and the pass rate at discharge.

**Conclusion,** The EUSCREEN project has succeeded in aggregating data on protocols and outcomes of UNHS programmes across European countries and abroad. Results showed that data are not available for outcome metrics for some UNHS programmes. While many UNHS programmes reported coverage rate figures over 95% and referral rate figures under 4%, few programmes reported attendance rates to diagnostic assessment over 90%. Some variables of UNHS protocols correlate to the reported outcome metrics, and these data will be useful for the future development of cost-effectiveness models.

ID: 03977

## Inventory of hearing screening programmes across Europe

**Andrea Bussé<sup>1</sup>, Allison Mackey<sup>2</sup>, Hans Hoeve<sup>1</sup>, André Goedegebure<sup>1</sup>, Herbert Simonsz<sup>3</sup>, EUSCREEN Foundation<sup>4</sup>**

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**Keywords,** Hearing screening, Europe, Neonate

**Background:** The EUSCREEN study compares the cost-effectiveness of paediatric hearing screening programmes. The data needed to create this model are gathered from countries in Europe and beyond with an extensive questionnaire covering nine domains.

**Methods:** Experts in hearing screening were recruited from 41 European countries. They were found through professional networks and internet searches. A tender procedure was followed to ensure that respondents had sufficient knowledge about their local hearing screening programme. When regional differences within one country were large, multiple experts were approached. Detailed local data were preferred over sparse country data. After each questionnaire was submitted it was checked for completeness. When hearing experts provided inconsistent data, clarification was requested.

**Results:** Data were submitted by experts from 43 European countries or regions. Six countries outside Europe (Russia, Malawi, Rwanda, South-Africa, India and China) participated and supplied data that were unavailable in Europe due to the absence of very large or low-income countries and scarcity of middle-income countries in Europe. It was challenging to identify representatives with adequate knowledge and time to fill out the questionnaire. When unable to fill out the entire questionnaire, additional professionals were searched through networks, national societies or authors with published literature on the subject. Hearing experts were otolaryngologists, audiologists and other professionals involved in hearing screening. Experts involved in clinical work had less time to fill out the questionnaire. It was often difficult to assess the reliability of the data supplied. In Europe, 39 countries or regions reported to have an organised NHS programme, out of which 36 are organised universally. For well infants, most programmes use a two or three stage protocol, but aABR is used in only 50% of the programmes. The first stage is mostly performed in the maternity hospital by trained nurses. For NICU infants, not all programmes use a separate protocol and 34% use OAE for the first screening. Seventeen countries have an organised (pre)school screening programme.

**Conclusion:** It was challenging to identify appropriate professionals that were able to supply high-quality data on

hearing screening in Europe and beyond. Substantial differences were found in paediatric hearing screening programmes throughout Europe.

**ID: 04054**

### Ten year experience of audiological screening in people with an intellectual disability: European data

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**Keywords:** hearing screening, hearing loss, intellectual disability, Europe, Special Olympics

**Background:** Compared to the general population, people with an intellectual disability (ID) are more prone for ear and hearing problems, both negatively influencing their quality of life. Many of the ear and hearing disorders remain undetected unless screened for. This study documents the prevalence of the hearing health state of European athletes with ID.

**Methods:** By means of a multicenter retrospective descriptive study, the outcome of ten years of ear and hearing screening in athletes with ID originating from seven European countries is described. The screening was conducted by a trained team of professional volunteers, following an international and strictly standardised protocol.

**Results:** Of 15,363 screened athletes with ID, with a mean age of 27.47 years (range 8 to 89 years old), more than half (58.7%) needed referral for ear and/or hearing problems. The most commonly detected conditions were excessive or impacted ear wax (40.3%), middle ear problems (30.1%) and hearing loss (27.0%). There were significant differences for these conditions between the age groups as well as between the countries.

**Conclusion:** This multicenter study demonstrates an increased risk for ear and hearing problems in people with ID compared to the general population. Considering most athletes and their environment were/are not aware of these problems, it is highly recommended to organise regular screening, and provide follow-up for diagnostic elaboration, therapeutic management and long-term guidance.

**Conflicts of interest:** One of the authors, Bjoern Koehler, is employed by Special Olympics.

**ID: 04112**

### Risk indicators for pediatric hearing loss: what we found in 10 years of universal hearing screening program

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*Hospital Lusíadas Lisboa*

**Keywords:** Hearing loss, risk indicator; newborn; Universal Newborn Hearing Screening; Otoacoustic emissions; auditory brainstem response.

**Background:** It is estimated that 50% of children with hearing loss have risk indicators that must be identified at birth. Newborn hearing screening programs usually recommend that those children should be followed until, at least, 2 years of age or until language is fully developed, even if they pass screening stages, because some of the risk factors can produce delayed hearing loss.

**Objectives:** The aim of this study is to characterize the population of newborns identified with, at least, one risk indicator for hearing loss between July 2008 and July 2018 in our hospital and also to evaluate the efficacy of the tracking system of high risk babies at our institution.

**Material and methods:** Retrospective study based on the hearing screening database. Following Joint Committee on Infant Hearing recommendations (2007) and national standards (DGS, 2015) all newborns with any risk factor identified by the neonatology team were screened using automated distortion product otoacoustic emissions (DPOAE) and automated auditory brainstem response. All high risk children were referred to ENT consultation and were submitted to diagnostic audiological tests (Tympanogram; DPOEA and Diagnostic ABR) before 6 months, and repeated evaluation every six months until 36 months of age.

**Results:** In the 10 year period, of the 15050 children born at our maternity, 121 newborns (0,8%) had, at least, one risk indicator for hearing loss. The main identified risk indicators in our high risk group were: 48 newborns (39,7%) with ototoxic medication; 25 newborns (20,7%) with family history of hearing loss; 13 newborns (10,7%) with history of Citomegalovirus infection identified during pregnancy. All 121 newborns were referred to ENT consultation and diagnostic evaluation, even those who passed the screening phase, but we had a lost to follow up of 38 newborns (31,4%); 12 newborns (9% prevalence in the high risk population) were identified with significant hearing loss, four of whom and major external and middle malformations.

**Conclusion:** The organization of the hearing screening programs for children with risk indicators for hearing loss must be different from those used to screen the normal newborn population. An extra effort needs to be addressed to ensure better follow up rates in our institution considering the high incidence of hearing loss found in that special group.

**Conflicts of interest:** The authors declare no conflict of interest.

ID: 04123

## New tracking software and explanation of underlying functionality in Newborn Hearing Screening

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**Keywords:** Tracking-Software, Newborn Hearing Screening, Enhanced Screening

**Background:** To establish a high coverage rate with a low “loss to follow up” it is recommended to use a data tracking system within a Newborn Hearing Screening program. Tracking software can assist the daily routine of the tracking staff by providing a number of automated functions which in turn provides quality control and influence to the outcome of the program. A tracking system generates evidence-based data as a prerequisite of a cost-efficient and effective structure for early detection of congenital hearing loss.

**Material and methods:** By implementing a bi-directional data exchange, various institutions such as obstetric and neonatology departments, ENT and audiology, ambulances and mobile home visitors can contribute to the program. Furthermore, all kinds of screening or diagnostic devices can communicate with the tracking software via defined interfaces. Data will be processed automatically in the tracking software. An automated status for each individual case will be generated. When a patient does not pass their screening, their re-screening or follow-up, periodic reminder functions will indicate the need for intervention and the software will manage appropriate documentation/reminder letters to be sent to the parents. Follow up sites can additionally communicate via a web frontend. The system provides the patients records from screening or previous appointments and enables an ongoing documentation of results and diagnosis. A huge range of statistical data is rolled out for calculations and quality control. Online-benchmarking provides statistical information related to the hospital's outcome. Important target values of the screening program can be compared among the hospitals. Individual values of a hospital can be evaluated online and by simple mouse click.

**Results:** The tracking system can be used worldwide and is universally adaptable. It has been implemented in countries with more than three million births per year. It's also used in small communities with less than 10 sites. The tracking system demonstrates its advantages especially in areas where there are long distances to Medical Experts due to send data bi-directionality and the use of enhanced screening strategies.

**Conclusion:** The presentation gives an overview about advanced functions of tracking software and a preview of potential hearing screening strategies in the upcoming decade, based on data management and technology.

**Conflicts of interest,** Peter Böttcher, Orieta Palacios and Peter Matulat declare that they have no conflict of interest.

ID: 04128

## Universal Neonatal Hearing Screening: A tool of social (in)justice?

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**Keywords:** Universal Neonatal Hearing Screening, hearing loss, health gap, disability

**Background:** Social determinants of health are a serious concern worldwide. Considering people with hearing loss versus people without hearing loss, there are considerable worse health outcomes in the first group (especially in cases of congenital hearing loss), which arises a crescent interest about the reduction of this health gap. Any disability is a well-known factor for health inequities such as hearing loss which causes a health gap with several negative social consequences, besides the personal negative impact in the quality of life. The neonatal hearing screening (NHS) aims to detect congenital hearing loss (present or acquired soon after birth) and allow early diagnosis and intervention. So, the introduction of “universality” on Neonatal hearing screening serves as a tool of social justice through the reduction of this health gap.

**Material and methods:** A cross-sectional study reporting neonatal hearing screening coverage rate in Lisbon, including both public and private hospitals. A literature review on the universality of neonatal hearing screening and health gaps.

**Results:** The authors report the following variables on neonatal hearing screening (both public and private hospitals): type of physiological test used on hearing screening (otoacoustic emissions/Brainstem auditory evoked potentials), Pass and Refer results stratified in high-risk and no-risk categories (high-risk definition according to Portuguese GRISI recommendations), false positive rate and ENT appointment refer rate.

**Conclusion:** In order to reduce the negative impact of hearing loss in children suffering from this disability, neonatal hearing screening should be offered to every child after birth. The universality of this screening has to be warranted in order to maintain social justice and to reduce as much possible, the negative burden of hearing loss at individual and familial level, as well as to society.

**Conflicts of interest:** There are no conflicts of interest.

## Free Papers 23 - Otoacoustic emissions and Screening

ID: 03842

### Development of new screening taste test

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**Background:** Taste is the main sense determining the quality of consumed food. It is not necessary for basic life activities but the correct feeling of taste decides about the well-being and health of the body, which affects the quality of life. The sense of taste makes it possible to distinguish between foods, thus it is possible to avoid the consumption of spoiled products and toxic substances. In addition, it contributes to the formation of taste preferences and is one of the factors regulating food intake, thus affecting the energy balance of the body. Since now there is no self administered screening test for measurement the gustatory function. The aim of the study is to present new taste test for Capsule of Sense Examination.

**Material and methods:** The review of the literature shown that there is no golden standard for concentrations of substances used for taste testing. We proposed 4 concentrations for each one of 4 substances: citric acid, sodium chloride, quinine, glucose. After laboratory studies we chose concentrations for test.

**Results:** Taste test for the Capsule of Sense Examination consist of 5 paper strips impregnated with 40% glucose, 1% quinine, 15% citric acid, 25% sodium chloride and the paper „0” with no taste. During testing gustatory in the Capsule patient try to identify the taste of the paper. Starting with paper „0” every 30 seconds he is ordered to taste next paper.

**Conclusion:** Taste test for the Capsule of Sense Examination is the first self administered screening test for measurement of gustatory function. We hope that it will disseminate the access for taste testing in Poland

ID: 03843

### Development of new screening smell test

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**Keywords:** smell, screening, olfaction

**Background:** Olfaction is important for our daily living. Impairment of the sense of smell has important consequences for our safety and quality of life. Olfactory impairments are claimed to be one of the first non-motoric symptoms of Parkinson's disease and other neurodegenerative conditions such as dementia. Recently olfactory impairments have also been associated with an elevated risk of mortality. The aim of the study is to present new smell test for Capsule of Sense Examination.

**Material and methods:** The authors reviewed the existing literature on the cultural adaptations of existing smell test from all over the world. The search identified 30 articles. We chose the best and the worst recognizable smells.

**Results:** After literature review we identify 6 best recognized smell: banana, smoke, leather, cinnamon, chocolate, gasoline. A 30 healthy volunteers were included in the pilot study. Each one chose best matching smell through few various versions of the same flavor (eg. as a „chocolate” we had: dark chocolate, milk chocolate, hot chocolate)

**Conclusion:** Smell test for the Capsule of Sense Examination is the new one self administered screening test for measurement of olfactory function. We hope that it will disseminate the access for olfactory testing in Poland

ID: 03886

### Otoacoustic emissions and cochlear microphonic = a non-invasive measurement of intracranial or intralabyrinthine pressure changes

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**Keywords:** otoacoustic emissions, cochlear microphonic potential; intralabyrinthine pressure, intracranial pressure

**Background:** In clinical practice, intracranial pressure (ICP) represents a key parameter for diagnosing and treating several conditions. The gold standard for monitoring ICP is provided by the surgical placement of a ventricular or intraparenchymal transducer. Furthermore, if endolymphatic hydrops (hallmark of Menière's disease) could be visualized

by magnetic resonance imaging techniques, actually there is not functional recording of inner ear pressure. So, it seems crucial to have a non-invasive tool to assess both intracranial and intralabyrinthine pressure changes.

**Material and methods:** Body tilt from upright to head-down position induces an increase in the ICP of the cerebrospinal fluid due to gravity. The ICP and intralabyrinthine pressure (ILP) always remain correlated because they are equalized through various channels including the cochlear aqueduct. So, the posture-dependent changes of ICP induce variations of ILP. Finally, the ILP influences the stiffness of the middle ear and modifies its transfer function. Outer hair cell activities (microphonic potential or otoacoustic emissions) are expected to be very sensitive to variations of the impedance of middle-ear system. ICP and ILP variations rotate the phase of cochlear responses. Our protocol afford a precise time courses (every 10 sec) recording of the dynamic changes of cochlear response concomitant with de IPL variation.

**Conclusion:** Noninvasive cochlear responses based monitoring of ICP might be beneficial to early management of brain-injured patients. Furthermore, our method would be suitable for ICP monitoring with subjects such that invasive measurements are excluded. In terms of hydrops diagnostic performance, it seems to be it seems more relevant to combined diagnostic use of the otoacoustic emissions postural phase shift and the classical test of electrocochleography.

**ID: 03920**

### Influence of auditory selective attention on cochlear responses in humans

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**Key-words:** Auditory efferents, Medial olivo-cochlear neurons, Transiently evoked otoacoustic emissions.

**Background:** The auditory efferent system forms multiple cortical and subcortical loops, the most peripheral of which is represented by the median olivo-cochlear neurons within the brainstem, that can directly modulate cochlear responses. This brainstem loop is the only one accessible for non-invasive exploration in humans and represents the necessary pathway by which higher centers can modulate cochlear responses. Auditory selective attention is one of the major mechanisms allowing us to sort out relevant from irrelevant stimuli, i.e. to ignore noise. The aim of this study was to show the potential influence of auditory selective attention on the cochlea, using a constant monitoring of transiently evoked otoacoustic emissions (TEOAEs) in normally hearing humans.

**Material and methods:** The auditory attentional task was a two-alternative forced-choice reaction task, where the

subjects were asked whether two auditory stimuli (termed S1 and S2) were different or the same. S1 and S2 were composed of identical trains of tone-bursts slightly different in frequency. Two levels of difficulty of the task were tested. Those stimuli were embedded in a continuous train of clicks, which allowed continuous monitoring of TEOAEs. The S1/S2 stimuli were randomly positioned within the train of clicks, between 0.9 and 1.6 s after the onset of the clicks train, that lasted 4.5 s for a single trial. Trials were separated by 2s of silence, and 160 trials were averaged. A control condition used the same trials, without any S1/S2 stimuli.

**Results:** After clicks onset, a significant decrease of TEOAE amplitude, between 0.2 and 1.2 dB occurring within the first 200 ms, was obtained for the task of greatest difficulty, and lasted until the end of the click train. A further decrease of TEOAE amplitude was obtained and moved with the position of the S1/S2 auditory stimuli. A smaller decrease of TEOAE amplitude was obtained after click onset in the control condition as well, showing the existence of an ipsilateral adaptation of TEOAE amplitude, reflecting the ipsilateral efferent feedback brainstem loop.

**Conclusion:** We showed here the existence of an ipsilateral adaptation of TEOAE amplitude, suggesting the possibility to record ipsilateral efferent feedback loop efficiency in humans using TEOAEs, and the influence of an auditory selective attention task on cochlear responses.

**ID: 04001**

### New approach in a validation of endolymphatic hydrops

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**Keywords:** Otoacoustic emissions, endolymphatic hydrops, outer hair cells, postural test.

**Background.** This study considers that the use of non-invasive methods for the early diagnosis of diseases is valuable. Therefore, it is very important to underline all the technological development of equipment in health in the last few years.

**Study objective.** To show the value of the DPOEA in the evaluation of diagnosed patients with endolymphatic hydrops (Menière's disease), through the change in the intracranial pressure provoked by the postural alteration.

**Material and Methods.** This study is a literature review based on three existing studies "Abnormal fast fluctuations of electrocochleography and otoacoustic emissions in Menière's disease" [a], "Unstable distortion-product otoacoustic emission phase in Menière's disease" [b], "Mesures non invasives de l'activité électrophysiologique des cellules sensorielles et des neurones auditifs. Applications au diagnostic de pathologies de l'oreille interne" [c]. In these studies, diagnosed patients with Menière's disease were observed and registered, using DPOEA technique, performed simply and easily tolerated by patients even after a crisis. The monitoring of the DPOEA is done when the

patient is standing up, and after this registration, the patient is slowly laid down and put in a supine position facing up. After this, the patient returns to the initial position.

**Results:** Results show that there is a fluctuating cochlear response in the execution of the DPOEA, provoked by the postural change and consequent intracranial pressure in patients that show symptoms. On healthy subjects, as for subjects with endolymphatic hydrops, a postural test causes an increase of intra-cochlear pressure, and that is more evident and exaggerated in patients with Menière's disease.

## Free Papers 24 – Screening

ID: 03769

### Vestibular Infant Screening-Flanders (VIS-Flanders): Part 2: Preliminary results of a standard vestibular screening protocol for hearing-impaired children in Flanders

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**Keywords:** Vestibular infant screening, vestibular function, hearing-impaired children, neonatal hearing loss, vestibular evoked myogenic potential (VEMP)

**Background:** Hearing-impaired children are at risk for a vestibular impairment, as the auditory and vestibular end-organs are closely related. Although this can compromise a child's development on many levels, vestibular testing is not routinely performed in this vulnerable group. Consequently, vestibular deficits often go unnoticed, giving rise to associated disorders such as a delayed motor development. This project aims to give each congenitally hearing-impaired child in Flanders (Belgium) access to a basic vestibular screening at a young age and set an example for other regions worldwide by increasing awareness of vestibular deficits in hearing-impaired children.

**Material and methods:** From June until October 2018, 52 infants between 5 and 11 months old (mean age: 7 months) with a confirmed hearing loss were referred for a vestibular screening. The cervical vestibular evoked myogenic potential test (cVEMP) was applied as vestibular screening test in one of the 25 participating reference centres responsible for the neonatal hearing screening program in Flanders.

**Results:** During the first five screening months, a 'refer' on the vestibular screening was measured in 12% (n = 6) of the subjects. Most of these subjects (n = 5) had unilateral or bilateral severe to profound hearing loss with different etiologies (e.g. congenital cytomegalovirus infection and CHARGE syndrome). At the EFAS congress, it

is intended to present the preliminary results of about 120 subjects after one year of screening.

**Conclusion:** So far, a vestibular screening abnormality rate of 12% is shown in Flemish infants with predominantly severe to profound congenital hearing loss. The VIS-Flanders project continues data collection to confirm the first screening results and increase awareness of pediatric vestibular deficits in hearing-impaired children.

**Conflicts of interest:** There are no conflicts of interest to disclose for all authors.

ID: 03770

### Vestibular Infant Screening-Flanders (VIS-Flanders): Part 1: Implementation and rationale of a standard vestibular screening protocol for hearing-impaired children in Flanders.

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**Keywords:** Vestibular infant screening, vestibular function, hearing-impaired children, neonatal hearing loss, vestibular evoked myogenic potential (VEMP)

**Background:** Hearing-impaired children are at risk for a vestibular impairment, as the auditory and vestibular end-organs are closely related. Although this can compromise a child's development on many levels, vestibular testing is not routinely performed in this vulnerable group. Consequently, vestibular deficits often go unnoticed, giving rise to associated disorders such as a delayed motor development. This project aims to give each congenitally hearing-impaired child in Flanders (Belgium) access to a basic vestibular screening at a young age and set an example for other regions worldwide.

**Material and methods:** VIS-Flanders is financially supported by the Research Foundation-Flanders, with participation of all 25 reference centres responsible for the neonatal hearing screening program in Flanders. Since June 2018, each child with a confirmed hearing loss is referred for a vestibular screening at the age of 6 months with the cervical vestibular evoked myogenic potential test (cVEMP).

**Results:** More information about the set-up and rationale for the screening age of 6 months and the cVEMP as vestibular screening test will be presented.

**Conclusion:** A standard vestibular screening for all hearing-impaired children should increase the awareness and lead to early identification of vestibular deficits and subsequent referral for motor assessment and rehabilitation, in order to limit the impact of a vestibular dysfunction in developing children and improve their quality of life.

**Conflicts of interest (if any):** There are no conflicts of interest to disclose for all authors.

ID: 03844

**First Polish screening questionnaire of vestibular symptoms**

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**Keywords:** dizziness, vertigo, screening.

**Background:** Disturbances in the functioning of the vestibular system are a relatively frequent problem. According to a study by Neuhauser et al, conducted in Germany in a group of 4869 people, 7.8% of respondents reported dizziness and postural symptoms. In Scotland [Hannaford et al.] problem was experienced by 13% to 29% of the respondents. In Poland, in a large research among 4,799 people, 16.4% of respondents reported the presence of dizziness and postural symptoms [Wojtczak et al.]. The aim of the study is to present the first Polish screening questionnaire to assess dizziness and balance disorders created for the Capsule of Sense Examinations.

**Material and methods:** The theoretical basis for the design of the questionnaire was the classification of vestibular disorders proposed by the Bárány Society. 30 patients from the Otoneurology Clinic at the Institute of Physiology and Pathology of Hearing were included in the pilot study. A total of 131 patients (81 patients and 56 in the control group) were included in the study.

**Results:** The questionnaire design process was multi-stage and was completed with the creation of a short tool, consisting of 12 items relating to the occurrence of dizziness and balance disorders. The questionnaire is characterized by high accuracy and allows for reliable measurement.

**Conclusions:** The presented questionnaire for the assessment of dizziness and disturbances of balance can be used in screening tests and by general practitioners to identify people who are at increased risk of disturbances in the vestibular system.

ID: 03845

**Capsule of sense examination – new device for screening test of sensory organs**

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**Keywords:** screening, senses, public health.

**Background:** Screening programs are an important element of public health. Early detection of disorders and treatment significantly reduces the cost of health care. The increasingly aging society forces the creation and development of new methods and devices to carry out screening tests. In response to the demand, an innovative Capsule of Sense Examination has been created.

**Material and methods:** Currently, there is no such system of devices in the world, which allows to perform an examination of the most important sensory and speech organs in one place and in a short time. To diagnose subsequent organs, patients must visit several centers - this means many visits and often long months of expectations for consultations. For many, diagnostics are so burdensome that they give up research and treatment.

**Results:** The Capsule of Sense Examination is the first in the world device for the examination of the human senses. It contains infrastructure, equipment and standardized tests for conducting screening and diagnostic tests. The capsule allows you to test hearing, sight, smell, taste, balance, speech and its processing functions. Her main task are: early detection of disorders of the sense organs, early capture of prognostic factors predicting the development of neurodegenerative diseases, early implementation of mental and movement training, dissemination and improvement of access to preventive examinations of people with multiple sense organs disorders as well as their rehabilitation.

**Conclusion:** The Capsule of Sense Examination is the device that could reduce costs of the diagnostics and treatment of impairment of various sense systems

ID: 03858

## The essence of implementing screening programs - 20 years of experience

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Early detection of hearing disorders gives the opportunity to implement quick treatment. It reduces the costs of medical care and brings better results of the applied therapy. One of the priority activities of the Institute of Physiology and Pathology of Hearing are programs of hearing screening for people of all ages. The Institute's team, in cooperation with numerous national and foreign centers, laid the foundations for screening programs - developed methods, procedures and devices used to carry them out. The idea of hearing screening tests is promoted by the team of the World Hearing Center not only in Europe but also in other regions of the world. This particularly applies to developing countries characterized by a lower level of development of medicine and prevention. The International Consortium for Hearing Screening, which includes two institutes from Poland, currently includes medical units from such countries as: Armenia, Kyrgyzstan, Moldova, Romania, Senegal, Tadjikistan, Côte d'Ivoire, Congo is a continuation of many years of activities in the field of promoting - first in Poland, and then other European countries and parts of the world - programs for early detection and treatment of hearing disorders. During the numerous actions and programs in Poland and abroad, over 1 000 000 children and adults were examined. Specialists from the World Hearing Center organized and performed research, among others: Côte d'Ivoire, Senegal, Ghana, Rwanda, Tanzania, Russia (Western Siberia), Tajikistan, Turkmenistan, Uzbekistan, Kyrgyzstan, Azerbaijan, Armenia, Moldova, Ukraine South, Romania, Colombia.

During the conference, 20 years of experience in the organization and implementation of hearing screening will be presented. The research programs initiated by IFPS in Poland in Europe but also in the world will be presented. The results of screening tests carried out in various areas will be discussed, with particular commentary on African countries. In addition, the organization, essence and importance of performing hearing screening tests in areas with limited access to specialists will be discussed.

ID: 03865

## 16 years of the Polish Universal Neonatal Hearing Screening Program

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**Keywords:** newborn hearing screening, hearing loss, risk factors

**Background:** Polish Universal Neonatal Hearing Screening Program (PUNHSP) has been running in Poland since 2003. The aim of the program is to perform hearing screening in 2-3 day of newborns life with the analysis of the risk factors that predispose to hearing loss. The program involved 499 centers based on three references levels: early detection of hearing loss, audiological diagnosis and intervention.

**Material and methods:** From 1 January 2003 to 21 November 2018 there were 5 931 466 children registered in the Central Database of Polish Universal Neonatal Hearing Screening Program. It represents 96.5% of the newborn population born at that time in Poland. In this period various degrees of hearing loss were recorded in 15 118 children.

**Results:** 8.8% (522 500) children who has been screened on first level, were sent for further diagnosis. The median age of the diagnosis during the analyzed period was 81.9 days. According to the Central Database of the Program and telephone survey, 83.6 % of children who had been targeted for further diagnosis were recorded and diagnosed in laryngological and audiological centers. Bilateral sensorineural hearing loss was diagnosed in 63.4% children, conductive in 23.5% children and mixed in 13.1% children. In contrast, single-side sensorineural hearing loss was diagnosed in 48.5% children; conductive in 38.5% children; and mixed in 13.1% children. All children, that are diagnosed with hearing loss are referred to the third level centers in order to apply the appropriate treatment, including hearing aids - 59.3% of children, rehabilitation - 31.6%, surgical treatment - 9.1%.

**Conclusion:** PUNHSP is the biggest preventive health Program in Poland which has been successfully conducted for more than 16 years. It was created as a citizen's initiative together with The Great Orchestra of Christmas Charity Foundation with cooperation of neonatologists, otolaryngologists and audiologists. It is estimated that any hearing loss greater than 20 dB occurs in about 2-3 per 1000 children born in Poland.

**Conflicts of interest:** There is no conflict of interest.

ID: 03866

## Automated auditory brainstem response - pilot screening program in selected NICU units in Poland

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**Keywords:** AABR, newborn hearing screening, hearing loss, NICU

**Background:** Recent recommendations suggest implementation of AABR to newborn hearing screening, to identify the group of newborns at higher risk of hearing impairment. The aim of the study was to analyze the effectiveness of OAE and AABR used as screening tools for hearing impairment among infants.

**Material and methods:** The group of 878 infants (678 – with risk factors of hearing deficit; 200 – control group) was examined by means of both OAE and AABR before discharge from the hospital after birth. The risk factors of hearing deficit were recorded. Infants who failed the screening test and/or had risk factors were referred for further audiological evaluation.

**Results:** Out of 878 children 771 pass OAE test, 60 did not pass OAE test (38 bilaterally and 22 unilaterally) and 47 had no OAE test due to anatomical defects or respiratory support. The results of AABR were: PASS in 812 newborns, REFER 28 bilaterally and 38 unilaterally respectively. Eleven children were diagnosed with hearing loss, 318 with normal hearing, 103 without final diagnosis and 246 lost to follow up. Among 11 children with hearing loss: 5 had PASS result in both OAE and AABR and were diagnosed with mild deficit <40 dB; 2 had REFER in OAE and PASS in AABR and were diagnosed with moderate hearing loss 41 dB – 70 dB; 2 infants passed neither OAE nor AABR and were diagnosed with profound hearing loss > 90 dB; one child with no OAE test and PASS/REFER result of AABR was diagnosed with moderate hearing loss between 41 dB and 71 dB and one child who did not pass OAE test and had PASS/REFER result of AABR was diagnosed with hearing loss < 40 dB. All newborns of the study group had at least one risk factor of hearing deficit – the most frequent were treatment in the intensive care unit (90%), mechanical ventilation (83.3%), and ototoxic treatment (75.1%). AABR exam was assessed by the staff as more difficult and time consuming to perform (mean time of the exam 6.9 min; SD 6.64) when compared to OAE.

**Conclusions:** The AABR method, recommended as gold standard for hearing screening in premature babies, is

very useful in early diagnosis of hearing impairment. It allows for early identification of infants with hearing deficit as it examines the entire auditory pathway. However, it seems to be more difficult to perform when compared to OAE.

**Conflicts of interest:** There is no conflict of interest.

ID: 03937

## Hearing screening with the Digits-in-Noise: Stages of change and effect of decision support on uptake of intervention

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**Keywords:** Digits-in-Noise, Stages of Change.

**Background:** The Digits-in-Noise (DIN) test is becoming increasingly popular as a consumer-based hearing screening test, measuring the speech reception threshold (SRT in dB signal-to-noise ratio). The test initially developed for landline telephone, has also been released as a smartphone app in South Africa, called *hearZA*, allowing widespread uptake and accessibility. However, implementation of screening programs are no guarantee for higher rehabilitation rates. This study retrospectively analyzed persons who failed the screening according to the transtheoretical stage of change model. Furthermore, in a prospective study, this study aims to determine whether additional support functions, such as the Ida Institutes *Why improve my hearing* tool, can influence uptake of intervention following a failed test outcome.

**Materials and Method:** In a retrospective study, 2801 listeners who failed the *hearZA* screening were analyzed according to age, gender and stage of change. Regression analyses were conducted to determine predictors of SRT. The prospective study aims to compare uptake of rehabilitation after a failed screening, between a control group who received only general information on hearing loss, and an intervention group who completed a decision support tool. Preliminary prospective data will be shared.

**Results:** The majority of listeners were in the pre-contemplation stage (74.8%), while the remaining were in the contemplation stage (9.8%), preparation stage (8.6%), and action stage (6.8%). The SRT values deteriorated, and age increased across successive stages of change. Prospective survey results will be reported.

**Conclusions:** A large proportion of listeners in three pre-contemplation stage may be attributed to the lower average age of persons who failed the test. A minority of listeners were in the action stage, suggesting hearing screening unaccompanied by additional motivators are not sufficient to promote persons with hearing loss to take action for their hearing difficulties. Further investigation is required to focus on how to transition individuals into action stages to ensure best outcomes.

**Conflicts of interest:** This research is funded by the National Institute of Deafness and Communication Disorders of the National Institutes of Health, and the Ida Institute. The 3rd and 4th author's relationship with hearX and hearZA includes equity, consulting and potential royalties.

ID: 03978

### Intelligent games in audiological rehabilitation: the Pirates game

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KU Leuven

**Keywords:** hearing screening, children, game

**Background:** Hearing screening using the digit triplet test (DTT) has proven to be an efficient, reliable and fast screening method (Jansen, 2013) with considerable advantages over pure-tone thresholds audiometry. However, testing in young children has been difficult due to their limited attention span. Simply reducing the number of trials will involve loss of precision. Instead, presenting the DTT as a serious game, which taps into the child's fantasy, will be more engaging. Children will be more motivated, have a higher attention span, and therefore a more reliable score can be obtained.

**Material & Method:** We have developed the Pirates DTT Game where children are encouraged to open treasure chests by entering a three-digit code. Currently, the Pirates DTT Game is validated in normal-hearing young children (first grade – 6y). Therefore, we compare outcomes on the standard DTT procedure with performance on the game-based Pirates DTT. Speech reception thresholds, test stability and test reliability are compared for the two screening methods.

**Results:** results show that the standard and game-based screening provide similar results in adults, thereby validating the game-based procedure. In children, the game-based screening enhances their sustained attention and motivation, thereby providing more reliable outcomes.

**Conclusion:** Our study shows that intelligent games are promising tools when adapting validated SPIN tests to the interest and attention span of young children.

### Free Papers 25 - Speech understanding

ID: 03782

### Validation of the Polish Sentence Matrix test: sensitivity, specificity, and discrimination accuracy in different masking conditions

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**Keywords:** speech in noise, speech audiometry, matrix test, hearing impairment

**Background:** Speech recognition in listeners with hearing loss is affected mainly in noisy conditions and can be only partially explained by the elevated pure tone threshold. The goal of this study is to validate the Polish matrix sentence test (PMST) for reliable assessment of speech recognition in different acoustic conditions for listeners with and without hearing impairment.

**Material and Methods:** 35 normal-hearing listeners (NH, young N=18 yNH; older N=17 oNH) and 58 hearing-impaired (HI) listeners with mild to severe hearing loss participated in the experiment. Pure tone average (PTA) of HI listeners varied from 26.3 to 87.5 dB HL. Speech reception threshold (SRT, 50% correct responses) was measured adaptively with the PMST in quiet, test-specific stationary noise (TSN), modulated noise ICRA5-250 and IFFM, and in realistic noise of cafeteria ambience.

**Results:** SRT in quiet was highly correlated with the PTA ( $R^2=0.84$ ) and showed high sensitivity (97%). Weaker correlation with PTA ( $R^2=0.6$ ) but high test sensitivity (95%) and specificity (94%) was observed in the TSN condition indicating that speech recognition in this condition cannot be well described by the pure tone threshold. SRTs in modulated noises and cafeteria noise were well correlated with the PTA but also with the stationary noise. No differences in SRT were found between two modulated noises. Significant SRT differences between HI groups (mild, moderate and severe) were found in all considered conditions reflecting high discriminative power of the test. Older NH performed comparable to mild HI group in quiet, TSN and cafeteria noise and to young NH in quiet and TSN. In the modulated noises, they differed significantly from all listener groups.

**Conclusions:** The PMST with its high sensitivity, specificity, and discriminative power is an accurate and reliable tool for auditory diagnostics as well as for research purposes.

ID: 03795

**Detecting supra-threshold deficits with easy-to-use speech-in-noise tests****Jaap Blok, Cas Smits, Theo Goverts***Amsterdam UMC, Vrije Universiteit Amsterdam, Department of Otolaryngology/Head and Neck Surgery, Ear and Hearing, de Boelelaan 1117, Amsterdam, The Netherlands***Keywords:** supra-threshold processing, distortion sensitivity, metabolic hearing loss.**Background:** Reduced speech recognition performance of listeners with impaired hearing can be due to loss of audibility or problems in supra-threshold processing. The specific supra-threshold processing deficits are likely to vary between individuals, depending on the specific origin of the hearing loss (e.g., neural, strial/metabolic, sensory). These differences are likely important to take into account in clinical care and research. We aim to compose a set of speech-in-noise tests to discriminate between groups on their use of specific supra-threshold cues in speech recognition. The tests should be easy-to-use for clinical purposes.**Material and methods:** The test battery is based on the Digits-in-Noise (DIN) test. A distortion sensitivity approach is used, in which the digit triplets and noise stimuli are distorted in time (to detect temporal supra-threshold deficits) or frequency (to detect spectral supra-threshold deficits) using a wavelet decomposition and reconstruction scheme. Stimuli were low pass filtered and corrected for individual hearing thresholds to ensure audibility. Normal hearing subjects (N=13) and a specific group of hearing impaired subjects were tested using their better ear. The hearing impaired have a pure-tone audiogram with mild loss in low frequencies to moderate loss in high frequencies which is assumed to be representative for metabolic hearing losses.**Results:** The results for the normal hearing listeners are as expected: greater distortion of spectral cues as well as temporal cues leads to reduced speech recognition. The supra-threshold distortion sensitivity is in line with earlier research taking into account differences in stimuli and filtering. Additionally, we will present the data, currently being collected, of the hearing impaired (“metabolic like”) study group. The duration of a test is roughly 6 minutes per distortion, supporting feasibility for clinical use.**Conclusion:** We developed a test battery of digits-in-noise tests to measure the use of specific signal cues in speech recognition. The results are promising. Results from listeners with normal hearing are as expected. Data from listeners with a specific type of hearing impairment are currently collected. The tests seem to be feasible for clinical use and easy application to other groups of listeners with impaired hearing.**Conflicts of interest (if any),** none.

ID: 03881

**Open-set word lists development, using acoustic, psycholinguistics, and psychometric factors****Annie Moulin<sup>1</sup>, Nicolas Fourcaud-Trocmé<sup>2</sup>**<sup>1</sup> *Lyon Neuroscience Research Center, DYCOG/PAM team, CNRS UMR5292, INSERM U1028, Lyon, F-69000, France*<sup>2</sup> *Lyon Neuroscience Research Center, CMO team, CNRS UMR5292, INSERM U1028, Lyon, F-69000, France***Keywords:** Speech perception, contextual influence, psychometric curves, psycholinguistics.**Background:** Word lists currently used in speech audiometry were often designed well before the availability of large computerized lexical databases and therefore are not taking into account several influential factors brought to light by psycholinguistic research, such as spoken word occurrence frequencies, phonological similarities and various indices of contextual influences, factors that can contribute to substantial variability in speech recognition scores. We propose here a new procedure for building word lists of similar difficulty, by taking simultaneously into account acoustic, psycholinguistic and psychometric factors. Although we applied this procedure to word lists in French, it could be equally useful in a wide range of different languages.**Materials and methods:** A corpus of 324 disyllabic words was selected based on linguistic criteria, thanks to the Lexique<sup>o</sup> 3.8 database, taking into account the spoken occurrence frequency of each word, their phonological neighborhood, their phonemic composition, meaning and grammatical classes. Psychometric curves of each word were then obtained on 12 normally-hearing subjects, using randomized intensities ranging from 0 to 40 dB SPL. The scores were calculated in whole words and phonemes, allowing the calculation of different contextual influence indexes. Correlational analysis allowed the selection of the most relevant parameters to take into account to balance word lists in terms of item difficulty.**Results:** The slopes of the psychometric curves were of 11.8% / dB on average (DS = 4.5) (words) and 9% / dB (DS = 2.8) (phonemes), with a 3.4 dB greater threshold of intelligibility of for words versus phoneme scores. The differences between word scores and phoneme scores allowed the definition of a contextual influence index for each word. Words showing too low or too high slopes were eliminated. Finally, word lists were built by minimizing the distance between each word list for each factor, with the final aim that all word list would show similar ranges on several factors, including linguistic factors, indexes of contextual influence, acoustical factors and psychometric curves.**Conclusion:** The homogenization of word lists according to several acoustic, linguistic and psychometric factors is feasible and could help to reduce the unwanted variability of speech perception scores, as shown in a companion communication.

ID: 03888

## Comparison of three calibration procedures for free field reference speech audiometry

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**Keywords:** calibration, speech audiometry, free field reference

**Background:** In the Dutch audiological practice a discrepancy is observed between speech audiometry results of monosyllables (CVC words) measured with earphones and a loudspeaker (free field). This can be explained by difference in calibration; earphones are calibrated on an ear simulator and a loudspeaker is calibrated without an ear simulator. In different international standards (IEC 60645-1:2017 & ANSI S3.6-2010) the free field equivalent earphone output level method is recommended for speech audiometry with earphones. In literature three potential implementation procedures are suggested for this method. In this study these procedures are investigated and compared. A suggestion is given for the procedure to be used as common reference.

**Material and Methods:** Three calibration implementation procedures are investigated for Dutch monosyllable speech audiometry (phoneme score), conducted with a group of twenty normal hearing subjects: 1. The performance-intensity (PI) reference curve is determined for TDH-39 earphones and loudspeaker. The difference in intensity between the 50% performance points (SRT) of the reference curves, will be the calibration correction factor between the earphones and the free field. 2. A digital frequency dependent filter is constructed, based on the free-field equivalent sensitivity level (ANSI S3.6-2010). The speech material is filtered and the PI reference curve is determined for earphones (free field equivalent output level). 3. The difference in intensity (at SRT) between the PI reference curves of the earphones and loudspeaker is theoretically determined by correcting the speech spectrum with the free-field equivalent sensitivity level (ANSI S3.6-2010) in combination with the band importance functions.

**Results:** The PI reference curves for TDH-39 earphones, TDH-39 earphones (free field equivalent output level) and loudspeaker were estimated by a Gaussian curves fitted through the measured phoneme scores. All three calibration implementation procedures approximate the same calibration correction factor of around 7 dB.

**Conclusion:** All three calibration implementation procedures seem to be reliable. From a practical point of view procedures two and three are the best solutions because they are independent of empirical research per transducer and speech material.

ID: 03897

## Determination of the spectral resolution in patients after cochlear implantation

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**Keywords:** cochlear implantation, spectral resolution, band-limited rippled spectra

**Background:** to assess the correlation of speech intelligibility with spectral resolution of band-limited spectra in patients after cochlear implantation (CI)

**Material and methods:** 33 patients after CI with more than 1 year of CI experience at the age from 12 to 62 years old were included in the study. Speech intelligibility was evaluated with the free field speech audiometry with polysyllabic words in the open set presented in quiet and the spectral resolution with the ripple phase reversal test. The rippled spectra had 2-oct cosine envelope with ripples equally spaced on the logarithmic scale. The central frequencies of the rippled spectra were 1, 2, or 4 kHz. Ripple resolution was measured with a three-alternative forced-choice procedure using a paradigm of discrimination of a test signal with ripple phase reversals from a reference signals with a constant-phase ripples.

**Results:** According to the results of the free field speech audiometry with polysyllabic words presented in quiet, the mean value of the speech intelligibility was 70%. The average ripple discrimination thresholds were 1.94 ripples/octave (RPO) for 1 kHz, 2.3 RPO for 2 kHz and 2.2 RPO for 4 kHz. A significant correlation was found between the spectral resolution and speech intelligibility at a central frequency of 1 kHz  $R = 0.57$  ( $p < 0.005$ ) and 4 kHz  $R = 0.46$  ( $p < 0.005$ ).

**Conclusion:** Band-limited rippled-spectrum tests allow to reveal informative frequency bands for speech discrimination in cochlear implant users

ID: 03921

## Auditory profiling as a tool for characterizing individual hearing deficits: Data-driven analysis of the results of the BEAR test battery

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**Keywords:** Hearing aid fitting, individualisation, auditory profiling

**Background:** One aim of the Better hEARing Rehabilitation (BEAR) project is to define a new clinical profiling tool, a test-battery, for individualized hearing loss characterization. Whereas the loss of sensitivity can be efficiently assessed by pure-tone audiometry, it still remains a challenge to address supra-threshold hearing deficits using appropriate clinical diagnostic tools. In contrast to the classical attenuation-distortion model, the proposed BEAR approach is based on the hypothesis that any listener's hearing can be characterized along two dimensions reflecting largely independent types of perceptual distortions. Recently, a data-driven approach (Sanchez-Lopez et al., 2018) provided evidence consistent with the existence of two independent sources of distortion, and thus different auditory profiles.

**Method:** Eleven tests were selected for the clinical test battery, based on their feasibility, time efficiency and related evidence from literature. The proposed tests were divided into six categories: audibility, middle-ear analysis, speech perception, binaural-processing abilities, loudness perception, and spectro-temporal resolution. Seventy-five listeners with symmetric, mild-to-severe sensorineural hearing loss were selected from a clinical population of hearing-aid users. The participants completed all tests in a clinical environment and did not receive systematic training for any of the tasks.

**Results:** The analysis of the preliminary results will focus on the ability of each test to pinpoint individual differences among the participants, relationships among the different tests, and determining their potential use in clinical settings. Importantly, a parallel study will evaluate the extent to which the outcomes of these tests can be used for hearing-aid fitting.

**Conclusion:** Based on the results of a data-driven analysis for auditory profiling, the test battery will be refined and implemented as a clinical profiling tool in audiology clinics.

ID: 03953

## Noise reduction algorithm ForwardFocus-audiometric test results

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**Keywords:** Cochlear implant, noise reduction, speech comprehension.

**Background:** The novel noise reduction algorithm ForwardFocus was assessed with cochlear implant (CI) recipients using the CP1000 sound processor. This algorithm is designed to reduce background noise from behind the listener making it easier to understand speech from in front, through its microphone directionality processing. This study analyzes the effectiveness of this methods for noise reduction for improved speech comprehension. Matrix speech comprehension tests in noise were performed using the sound processor CP1000 in stationary (Oldenburger) speech shaped and in fluctuating (one talker ICRA) speech-like noise, for different noise source positions (S0N0; S0NCI; S0N90,180,270).

**Material and Methods:** Noise reduction methods BEAM and ForwardFocus were compared in CI users concerning speech intelligibility for sentences in noise utilizing the Oldenburger sentences. Normal hearing persons served as baseline condition for speech comprehension. Twenty CI users wearing a sound processor (Cochlear Limited) took part in the investigations. All patients showed postlingual onset of profound sensorineural hearing loss. Examination of differences in speech comprehension were measured for noise reduction algorithm ForwardFocus after 2-3 weeks adaptation in comparison to standard Beam algorithm.

**Results:** Significant improved speech comprehension is found for ForwardFocus compared to BEAM with S0N0 testing in stationary noise. There is significant better speech comprehension using ForwardFocus in all spatial conditions with fluctuating noise (S0N0; S0NCI; S0N90,180,270). Best speech comprehension was found for separated noise sources when using ForwardFocus in fluctuating noise.

**Conclusion:** ForwardFocus showed improved speech comprehension in a range of listening conditions. This shows potential to improve speech comprehension for specific listening situations by offering specific SmartSound options.

**Conflicts of interest:** Th. Hocke is an employees of Cochlear Limited. The other authors report no conflict of interest.

ID: 04023

## Validation of the Turkish Matrix Sentence Test in Noise

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**Background:** Matrix speech tests provide a means to assess speech intelligibility in noisy background and supra-threshold performance. They consist of fixed syntactical, but semantically unpredictable sentences (e.g., "Steven prefers three large windows"). Using an adaptive procedure, the test determines the patient's speech reception threshold (SRT), i.e., the signal-to-noise ratio (SNR) or signal level yielding 50% speech intelligibility. This contribution presents validation results for the Turkish matrix test (TUR-Matrix) in noise and quiet for patients with hearing impairment and normal hearing listeners.

**Material and methods:** In total, 80 native listeners of Turkish (aged between 18 and 80) participated in this study. 40 of them had normal hearing (pure-tone thresholds below 20 dB HL at octave frequencies between 0.25 and 8 kHz), 40 a hearing loss (pure tone average, PTA0.5, 1, 2, 4 kHz ≤60 dB HL; 10 dB maximum air-bone gap). SRTs in quiet and noise were obtained by presenting lists of 20 sentences each either 1) monaurally via headphones, or 2) in free field (S0, S0N0, S0N90 or S0N270). For SRT in noise, the test-specific noise was used, and for monaural headphone measurements also the fluctuating ICRA5\_250 noise. Noise level was fixed at either 65 dB SPL or, for listeners with PTA > 55 dB HL, at 80 dB SPL. Responses were counted in the open-set response format by word scoring. To observe test-retest reliability, all subjects completed two test sessions, app. 3-5 days apart. SRTs were correlated to the hearing abilities. For comparison purposes, similar data were collected for the Turkish monosyllabic and tri-syllabic test in the same listeners.

**Results & Conclusion:** Values found for normal hearing listeners and stationary noise (about -7 dB SPL) approved the reference values for the TURMatrix (Zokoll et al., 2015). Further, the TURMatrix was found to provide reliable results: For most of the conditions, mean pair-wise differences between test and retest were below 1 dB. For testing in quiet and in modulated noise, the test-retest-differences were about 1.7, and 1.5 dB, respectively. Correlations (Pearson) between test and retest were significantly for all conditions (R between 0.8 and 1.0). However, test and retest differed significantly, indicating a training effect. Sensitivity and specificity was found to be good (e.g., for SRT in stationary noise about 90%). It can be concluded that the TURMatrix is a good diagnostic tool.

ID: 04064

## Construction and validation process of a Hungarian speech recognition test

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**Keywords:** speech test, aural rehabilitation, speech recognition

**Introduction:** Speech tests have become the standard way of assessing development in aural rehabilitation. However, the currently available Hungarian speech tests don't seem to be sensitive enough to be used in advanced clinical studies. There is no efficient and validated Hungarian method and corresponding sound-recording which could measure speech understanding in controlled signal-noise ratio. This lack is well-known among the professionals working in this field. Therefore our team has been working on creating a sentence test which has not existed in the Hungarian language comparable to the ones used in other languages. Our aim was to effectively measure speech understanding in wide groups of patients, especially among children a cochlear implant users with regard to the particularities of the Hungarian language.

**Materials and methods:** Based on the literature we created a test including sentences. The sentences were selected by naturalness and were recorded in an acoustically controlled environment specified by the international standard. These sentences are simple enough to examine younger patient groups and hearing implant users as well. Sentence presentation is controlled by software, which adjusts the signal-to-noise-ratio (SNR) of each presented sentence according to an adaptive algorithm.

**Results:** With such procedure, SNR threshold can be determined with relatively few sentences, where under certain circumstances the patient can still understand a given percentage of the speech. The masking speech noise is created by superposing multiple times all sentence recordings with an individual random offset. Preliminary data suggests, that measurements with the unbalanced sentence material are comparable to other validated speech tests in the literature.

**Conclusion:** We present in our lecture the design process of the Hungarian sentence test, the design of the sentence material and the validation process.

ID: 04102

## Speech Discrimination in Noise: Auditory Implants Evaluation Protocol

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**Keywords:** Speech Discrimination, Discrimination Protocols; Auditory Implants; Hearing Rehabilitation; Discrimination in Noise.

**Background.** One of the greatest challenges of a patient with hearing impairment is to discriminate speech in noisy environments, even while using an auditory implant. The aim was to evaluate the daily clinical practice of speech discrimination tests in noisy environments.

**Material and Methods.** In order to evaluate the integration of binaural information of patients who are candidates for auditory implantation, a protocol to assess speech discrimination in noise was proposed by the authors. Four loud-speakers were used, arranged in azimuth 0°, 90°, 180° and 270°. An overall of 16 parameters were evaluated, according to the four stimuli/noise source conditions and considering the combinations of words/sentences and speech/cafeeteria noises.

**Results:** The result is the percentage of words and sentences repeated correctly. Pre- and postoperative comparison was performed.

**Conclusion:** It is considered that, beyond the study of spatial location of sound, this evaluation will allow a better understanding of the integration of hearing information in patients with auditory implants as well as their real binaural integration.

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ID: 03932

## The infra-red utilization in therapy of Meniere disease

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**Keywords.** Ménière Disease, Vertigo, Therapy, Infra-red rays

**Background.** The therapy of the Ménière Disease is one of the main problems of the Otoneurologist. Prevention of vertigo crisis, unpleasant and debilitating for the patient, is an outstanding issue in clinical practice, also considering the variability and unpredictability of the vertigo crisis. Up to now no significant news have been produced in

therapy, pharmacological and also from surgical point of view except for vestibular neurectomy, that is a very invasive surgical act, not well accepted by the patient. Starting from the above mentioned problems, considering that the hypertension of endolymph may be related to an alterate equilibrium with hematic circulation (excess of filtration or not-correct re-absorption), we assumed that the pathogenesis of the hydrops may be related to a non-correct hematic vessel mechanism. And so we tried to improve the hematic circulation, by using infra-red ray applied on the vertebral column. The main goal of this study is to verify the possibility of reducing number and intensity of vertigo crises, by using infra-red rays.

**Materials and methods.** 46 patients suffering from Ménière Disease have been submitted to this study. The crises frequency ranged between 1 per 2-3 months and 2-3 per week. All patients showed the typical symptomatological triad (vertigo, with severe neurovegetative symptoms, hypoacusia and tinnitus). The treatment consisted in exposing the vertebral column to a IR rays source. Time exposure varied between 30 and 45 minutes. The treatment was performed once a week for a full period of 12-15 weeks.

**Results.** In every case in a first step all patients reported a significative decrease of the vertigo intensity and successively, just a dizziness sensation remained, that was progressively disappearing with the treatment prosecution. Until the end of the treatment equilibrium was restored in about 90% of the patients.

**Conclusions.** We can reasonably conclude that the IR-treatment is able to restore endolymph pressure just improving the hematic circulation

ID: 03993

## Vestibular rehabilitation and table tennis exercises might improve balance function even in normal population

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**Keywords,** Balance, Vestibular Rehabilitation, Computerized Dynamic Posturography, Table Tennis

**Background:** Balance control is maintained with the coordinated muscle responses obtained from somatosensory, vestibular and visual inputs. Obtaining stable posture in stationary and moving positions is a result of the coordination of these receptor systems. The aim of our study is to create modified rehabilitation exercises which can be performed easily at home for these of patients after classical vestibular rehabilitation(VR) exercises but who still suffer from dizziness.

**Material and Methods:** 12 women and 9 men, aged between 19-21 years old, with no history of imbalance, neurological or physical complaints were recruited for this study. A 6-week program was developed for these people, which

combines table tennis with classical VR exercises. Sensory Organization Test (SOT), the Adaptation Test (AT) and Unilateral Stance Test (UST) were applied to these subjects before and after the exercise period. For subjective evaluation of balance function, a questionnaire was utilized based on the movements that we think they use their vestibular systems effectively in their daily life.

**Results:** According to the statistical analysis, a significant difference was observed between the SOT results for Vestibular System, Composite, Strategy 5 and Strategy 6 before and after the exercise program ( $p < 0.05$ ). For the UST results, there was a statistically significant difference between the results of standing on one leg, eyes closed (EC) before and after the exercise program ( $p < 0.05$ ). According to AT results, a statistically significant difference was observed between pre- and post-exercise periods in which the toes were moved up and down ( $p < 0.05$ ). For the results of the questionnaire, excluding first and seventh questions, responses for all questions were significantly different before and after the exercises.

**Conclusion:** In this study, improvement of the vestibular system and the subjects' balance performance after utilizing VR and table tennis exercises have been observed objectively as well as subjectively. EC UST improved significantly which is compatible with better SOT vestibular score. Of these exercises used in this study, table tennis exercises integrate and combine inputs from VOR and VSR. Table tennis exercises necessities more complicated tasks for normal subjects and therefore might improve balance function for patients with vestibular pathologies.

ID: 04037

### Dynamic posturography rehabilitation results of a patient with bilateral vestibular loss: a case report

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**Objective:** To determine an effective vestibular rehabilitation therapy via Computerised Dynamic Posturography and assess the effectiveness of the programme against bilateral peripheral vestibular loss

**Case Description:** A 47 year-old woman presented with a history of fall during gait, chronic, recurrent vertigo, sensorineural hearing loss in the right ear. She is suffered from unsteadiness, movement of the visual environment especially with the head movement, left ear fullness and tinnitus in both ear. She was diagnosed with right side unilateral Meniere's disease in 2014. She is reported that increased of unsteadiness after last vertigo episodes 5 months before the evaluation. VNG test battery (especially bithermal caloric test (30 and 44 °C) was performed according to the technique described by Fitzgerald and Hallpike), VEMP with 500 Hz tone burst stimulus, Computerised Dynamic Posturography (CDP) -Sensor Organisation Test (SOT), Fukuda, Babinski Weil, Head Thrust, tandem walk test were performed. To determine subjective complaints, Dizziness Handicap Inventory (DHI) and Visual Analog Scale (VAS) were used.

**Results:** According to the VNG, Oculomotor and Post Head Shake tests were found normal, Caloric test; total right ear response was 8°, total left ear response was 6°. No response according to iced water caloric. The patient lateralized left side after tandem walk and Babinski Weil tests, Both sides displacement were found in Fukuda test. SOT composite scores were found to be: 57 (under normal range). According to VEMP results revealed bilateral elevated P1-N1 threshold response (95 dBnHL) according to 500 Hz toneburst stimuli. DHI:76/100, VAS:8/10. Overall results indicated that the patient had bilateral vestibular loss due to the bilateral Meniere disease. CDP rehabilitation protocol were performed by the patient 3 times a week for a total of 20-30 minutes for each session. Exercises started with fixed support, sitting on a firm seat, progress with sitting on a foam seat, swiss ball through standing position. There were significant improvement before and after CDP rehabilitation programme in terms of subjective (DHI, VAS) and objective (SOT) tests results.

**Conclusion:** Our results indicate that, although the patient with BVL improve following CDP exercises continue to demonstrate mild physical impairments, gait exercises with head rotation and pursuit were prescribed as a home exercises.

ID: 04084

### Vestibular rehabilitation in patients after vestibular schwannoma treatment

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**Background:** A vestibular schwannoma is a benign, often slow-growing intracranial tumor of the VIIIth cranial nerve. In most cases acoustic neuroma treatment results in complete loss of vestibular function on the affected side. Vestibular rehabilitation may be useful for recovery of this loss. The aim of this study was to evaluate the effect of a customized protocol of vestibular rehabilitation program in patients after vestibular schwannoma treatment.

**Material and methods:** Retrospective study of 6 patients with unilateral vestibular loss after acoustic neuroma treatment (radiation or surgical removal), that completed a customized vestibular rehabilitation program in Otoneurology Department of Hospital Lusíadas Lisboa. All patients were evaluated before and after customized vestibular rehabilitation program for disability (Dizziness Handicap Inventory [DHI]), and postural stability (dynamic posturography).

**Results:** We have found improvement of postural stability as well as for disability perception (DHI).

**Conclusion:** Customized vestibular rehabilitation program plays an important role in the recovery of equilibrium on patients following acoustic neuroma surgery.

**Conflicts of interest:** The authors declare no conflicts of interests.

ID: 04090

### Evaluation of masseteric vestibular evoked myogenic potential (Mvemp) result in peripheral vestibulopathy disease

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**Keywords:** mVEMP, recurrent vestibulopathy, vestibulo-masseteric reflex

**Background:** Vestibular evoked myogenic potential (VEMP) tests are used to diagnose peripheral vestibular disorders. It is known that VEMP responses can be taken not only Sternocleidomastoid (SCM) and ocular muscles but also other cranial muscles. Masseter Evoked Vestibular Myogenic Potential (mVEMP) test pathways include the connection between the motoneurons of the trigeminal nerve and vestibular nuclei while the recording is taken from the masseter muscle. Thus, mVEMP helps us evaluate the pathway of vestibulomasseteric reflex. The aim of study is to add mVEMP to vestibular evaluation test battery after evaluating the mVEMP findings in recurrent vestibulopathy patients.

**Material and methods:** The control group consisted of 20 healthy participants (13 female, 7 male) aged 18-40 years with no vestibular and systemic disease, the study group consisted of 20 participants (16 female, 4 male) aged between 18-40 years who were diagnosed with peripheral vestibulopathy. In the study group, cVEMP and oVEMP tests were performed in patients who had at least two 20 min and longer vestibular attacks and no auditory symptoms. Patients with an asymmetry ratio of %40 or more in at least one of the tests were accepted as study patients. Recordings were taken with superficial electrodes placed on the masseter muscles of the patients. Latency and asymmetry ratios of the obtained waves are used in statistical analysis.

**Results:** There was no significant difference between the normal group and the study group in terms of latency values, but a significant difference was observed in asymmetry ratios.

**Conclusion:** The mVEMP under study allowed the assessment of integrity of the vestibular system. Correlation with cVEMP- oVEMP and use together may be valuable in the diagnosis of vestibular diseases.

ID: 04091

### Evaluation of the effectiveness of vestibulospinal tests in unilateral vestibulopathy: a preliminary study

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**Background Information:** It is believed that vestibulospinal integrity can be tested while stepping in place or walking with eyes closed. It is based on the principle that

vestibulospinal outputs exert ipsilateral tonic influence on antigravity muscles and that a unilateral vestibular lesion would reduce this tonic influence on the affected side. For this purpose several vestibulospinal tests were used. However which of these test is the most effective to determine unilateral vestibulopathy is unclear.

**Objective:** To assess which vestibulospinal reflex tests are the most reliable to determine unilateral vestibulopathy

**Materials And Methods:** Twelve subjects (8 Female-4 Male, Mean Age: 62 SD:8,3) with unilateral vestibulopathy were included in this preliminary study. To determine subjective complaints, dizziness handicap inventory were performed. VNG test battery including bithermal caloric test (30 and 44 °C) was performed according to the technique described by Fitzgerald and Hallpike as gold standart. Fukuda, Tandem Walk, Babinski-Weil were applied and rotation displacement were noted as left side, right side and both side. Also lateral and longitudinal displacement were noted.

**Results:** Seven patients were found to left side and six patients were found right side unilateral vestibulopathy. Mean dizziness handicap inventory score was 61.50, SD: 16.36 (Min: 46, Max: 84). There weren't statistically significant lateral and longitudinal displacement differences between Babinski-Weil and Fukuda Stepping test. To compare with caloric test results Babinski-Weil were found to be most reliable among tandem walk and Fukuda stepping tests.

**Conclusion:** According to our results Babinski-Weil test was suggested to include vestibular assessment protocol

ID: 04095

### Evaluation of hearing and balance system in childhood with chronic renal failure

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**Keywords:** Chronic Renal Failure, Hearing Loss, VHIT

**Objective:** This study was designed to assess the relationship between chronic renal failure and hearing loss and balance disorders.

**Method:** The hearing and balance system of 18 patients with chronic renal failure was evaluated. Patients who used ototoxic drugs, those under 18 years and over 50 years, those with acoustic trauma and metabolic disease and those with permanent hearing loss, external auditory pathway and middle ear pathology were not included. Audiologic evaluation, tympanometry, DPOAE, and VHIT tests were performed.

**Results:** While 39% of the patients had normal hearing, 61% of them had hearing loss. No statistically significant results between the normal and patient groups were found on gain values and asymmetry rates of VHIT.

ID: 04100

## Assessment of VHIT and VNG Findings in whirling dervishes

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**Background:** Vestibular system contributes to the continuity of important vital functions such as posture control, balance of the body, and coordination of the head and eye movement movements and visual fixation. Whirling dervishes (WH) bend their heads about 25 degrees to the right during whirling, lifting their arms on both sides, their right hand fingers upwards and their left hand fingers turned downwards. The axis of rotation of the body's axis, rather than the midline, reduces the swing to the minimum while rotating the vertical axis of the left leg and heart, minimizing the stimulation of the center of the equilibrium center. In this study; the relationship between this movement and the mechanism of the vestibular system was investigated and how to be affected of vestibular system of WH were evaluated with VHIT and VNG devices.

**Method:** This descriptive, sectional study consists of 20 WH with 1 year experience and 20 WH with 5 years of experience group in the age range of 18-40 between the WH in Konya /Turkey. The vestibular system functions of the two groups were monitored bilaterally with Video Head Impuls Test (VHIT) and eye movements with Video Nystagmography (VNG). In addition, 20 healthy subjects were evaluated for normative data on vertical and lateral VOR evaluation. Mean, Standard Deviation, Minimum, Maximum values are given for continuous data in descriptive statistics. One way variance analysis (ANOVA) was used to compare the measured variables (results of VNG, VHIT parameters) in group comparisons.  $P < 0.05$  was accepted as statistically significant.

**Results:** In five-year experienced group, the loss of vestibular function in the left posterior and anterior was greater than in the one-year experienced whirling dervishes. When the normative values of healthy individuals were considered, the left posterior vestibular functions of one year experienced WH were similar. There was no difference in the lateral VOR gains among the groups according to the experience of the WH. The results of five years of experienced whirling dervishes with vestibular function losses in the left anterior and left posterior channels were obtained. According to VNG evaluations, nystagmus, spontaneous nystagmus were not detected in the cases. In terms of wave morphology, there was no abnormality in saccade and pursuit results.

**Conclusion:** This study has drawn attention to the importance of longer experiential WH in vestibular rehabilitation, with an important contribution to the limited number of scientific studies done with whirling dervishes.

Free Papers 27 - Other topics related  
to audiology II

ID: 03758

## Hearing loss in subjects after meningitis

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**Keywords:** Meningitis, Hearing Loss, Acquired Infection

**Background:** Meningitis is a disease characterized by inflammatory process of meninges and classical signs are fever, stiff neck and headache<sup>1</sup>. Survivors may present sequelae like hearing loss, mental deficit, hydrocephalus and convulsions. Children are the most affected compromising their neuropsychomotor development<sup>2</sup>. This pathology kills and incapacitates hundreds of thousands in sub-Saharan African belt. Regarding the etiology, meningitis can be bacterial, fungal and viral, being the last the most frequent in children over 2 years of age and usually causing sensorineural hearing loss; Bacterial and fungal causing unilateral or bilateral profound hearing loss<sup>3</sup>. In Cabo Verde, cases number ranging from 29 to 421 in the last six years and without specified infectious agent record.

**Material and methods:** This longitudinal study occurred in Dr. Agostinho Neto Central Hospital, Praia, Cabo Verde, since December 2013, screening 1789 patients for meningitis returned 98 positive cases. 43 adults and 55 children evaluated with anamnesis, tonal and vocal audiometry, or transitory evoked otoacoustic emissions (TEOAE) when lack of Audiometry. Degree, type of hearing loss classification and audiometric configuration according to WHO<sup>5</sup> and Silman and Silverman<sup>6</sup>.

**Results:** After study protocol, 98 patients affected by meningitis, reporting 16% normal, 9% with unilateral hearing loss and 69% with bilateral hearing loss. As to the type of hearing loss, regarding left and right ears: sensorineural:73%-68%, conductive:2%-4%, and normal:19%-22%. As to the degree of hearing loss, regarding left and right ears: normal:17%-26%, mild:2%-1%, moderate:9%-9%, severe:14%-6%, profound:32%-35% and cophosis:26%-23%. As to the configuration, descending was the most frequent and mainly symmetrical.

**Conclusion:** This study showed that meningitis cause profound bilateral sensorineural hearing loss with great social repercussion. Long period of time since infection to diagnosis may lead negatively

**Conflicts of interest:** none

ID: 03779

## Hyperbaric oxygen therapy as a salvage treatment of sudden sensorineural hearing loss

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**Keywords:** hyperbaric oxygen therapy, salvage therapy, sudden sensorineural hearing loss

**Background:** Idiopathic sudden sensorineural hearing loss (ISSNHL) is defined as a hearing loss of greater than 30 dB over 3 contiguous pure-tone frequencies occurring within 3 days period. Diverse pathologic processes have been suggested as a cause of ISSNHL and many different regimens have been used for therapy such as vasodilators, anticoagulants, plasma expanders, steroids, hyperbaric oxygen therapy (HBO) etc. Steroid therapy is mostly used. HBO therapy is used as a primary or as salvage therapy after steroids. However there is a lack of trials. The aim of this research is to measure the effect of HBO therapy after the failure of steroid therapy in the treatment of ISSNHL.

**Material and methods:** 110 patients with SSNHL were unsuccessfully treated with systemic steroid therapy. Following steroid therapy, 60 patients received additional HBO therapy while 50 did not. Hearing levels at 0.25, 0.5, 1, 2, 4, and 8 kHz before and after therapy were measured.

**Results:** Significant difference in hearing thresholds after hyperbaric oxygen therapy was found in all frequencies in patients with a hearing loss greater than 61 dB. The group of patients with a hearing threshold less than 60 dB had a significant improvement only at low frequencies (250 and 500 Hz).

**Conclusion:** HBO as salvage therapy for SSNHL is a safe therapy. Better results should be expected in patients with severe hearing loss, while in patients with mild-or-moderate hearing loss, recovery is limited to low frequencies.

**Conflict of interest:** none

ID: 03783

## A case report of deterioration of hearing after hyperbaric oxygen therapy for sudden deafness

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*General Hospital of Ikaría, Greece*

**Key words:** sudden deafness, idiopathic sudden sensorineural hearing loss, hyperbaric oxygen therapy.

**Background:** Indications of hyperbaric oxygen therapy (HBOT) in ENT field include inner ear's decompression trauma, sudden deafness – particularly idiopathic sudden sensorineural hearing loss, acoustic trauma, acute

noise-induced hearing impairment, osteoradionecrosis, otogenic infection of skull base and malignant external otitis. In idiopathic sudden sensorineural hearing loss HBOT is considered to be safe and effective as supplementary treatment. After such a therapy a temporary deterioration of tinnitus has already been described in 5% of patients. However, at least up to now and up to our knowledge, deterioration of hearing ability after HBOT has not been described. We aim at presenting a report of such a case.

**Material and methods:** A forty-seven years old otherwise healthy female suffering from idiopathic sudden sensorineural hearing loss, particularly of low frequencies, started HBOT after the failure of conventional steroid treatment.

**Results:** Two days after the beginning of HBOT she noticed a deterioration of her hearing ability. When visiting the ENT outpatient ward of our hospital pure-tone audiogram revealed a deterioration of thresholds of all frequencies (air and bone conduction), particularly the higher ones: 20dB in the frequency of 1kHz, 45dB in 2kHz, 40dB in 3kHz, 60dB in 4kHz, 20dB in 8kHz. Both ears' tympanograms were normal. Unfortunately the previous doctor had not estimated the thresholds at 6, 10, 12.5 and 16kHz, so that we could compare them too.

**Conclusion:** In all studies of HBOT of sudden deafness the overall hearing outcomes are usually divided in good, fair, no change. It seems that a new category, the one of deterioration has to be added, if not for anything less at least for medico legal reasons.

**Conflicts of interest:** none.

ID: 03787

## The ototoxic potential of cobalt from metal-on-metal (MoM) hip implants: Objective auditory and vestibular outcome.

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**Keywords:** metal-on-metal implant; cobalt; ototoxicity; vestibulotoxicity

**Background:** Local as well as systemic toxic side effects have been associated with excessive metal ion release from MoM implants, in which cobalt (Co) plays an important role. The rare condition of systemic cobaltism seems to manifest as a clinical syndrome with cardiac, endocrine, and neurological symptoms, including hearing loss, tinnitus, and imbalance. In most cases, revision surgery and the subsequent drop in blood Co level led to (partial) alleviation of the symptoms, suggesting a causal relationship with

Co exposure. Moreover, the ototoxic potential of Co has recently been demonstrated in animal experiments. Therefore, the current study aimed to objectively and extensively examine auditory and vestibular function in this population.

**Materials and methods:** 20 patients (aged between 33 and 65 years) implanted with a primary MoM hip implant were matched for age, gender, and noise exposure to 20 non-implanted control subjects. Each participant was subjected to an extensive auditory and vestibular test battery, supplemented with a blood sample collection to determine the plasma Co concentration.

**Results:** The plasma Co concentration was significantly higher in the MoM patient group versus the control group ( $p < 0.001$ ). Within the auditory test battery, a clear trend was observed towards higher audiometric thresholds (11.2–16 kHz), lower DPOAE (4 & 8 kHz) and total TEOAE (1–4 kHz) amplitudes, and a higher inter-aural latency difference for wave V of the ABR in the patient versus control group ( $0.0 \leq p < 0.05$ ). Within the vestibular test battery, considerably longer cVEMP P1 latencies, higher oVEMP amplitudes ( $0.01 \leq p < 0.05$ ) and lower asymmetry ratio of the vHIT gain ( $p < 0.01$ ) were found in the MoM patients. In the patient group, no suggestive association was observed between the plasma Co level and the auditory nor vestibular outcome.

**Conclusion:** The auditory results seem to reflect signs of Co-induced damage to the high-frequency hearing function, largely corresponding to previous findings on drug-induced ototoxicity and recent animal experiments with cobalt. The vestibular outcomes are currently inconclusive and require further elaboration, especially in animal studies. The dose-response relationship could not be accurately evaluated in this study, but recent findings in MoM hip implant patients have confirmed that this relationship can be complicated by many patient-specific factors.

**ID: 03853**

### Mastoid cavity obliteration with bioactive glass – a preliminary study

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Canal wall-down mastoidectomy is common surgical technique used in cholesteatomatous inflammation of the middle ear. After operation anatomy of the middle ear changes. Creation of an open space, called radical cavity, results in many disadvantages as chronic otorrhea, debris accumulation, demands periodic cleaning. Vast majority of these problems can be solved with mastoid cavity obliteration.

16 patients with chronic cholesteatomatous otitis media were analysed in prospective study. All subjects had radical cavity, after previous surgeries, then obliteration of this space with bioactive glass were performed. All patients

were operated in World Hearing Centre in Kajetany, Poland, and were observed for 6 months

There were no severe complications in all cases, but initially after removing path local inflammation has occurred in 40% of patients. There were also no hypersensitivity reaction. Bacteriological examination from external auditory meatus 1 month after surgery was clear. Hearing improvement were not observed, as hearing deterioration, because of another aim of the surgery. Patients were qualified for various bone conduction implants.

Mastoid cavity obliteration with bioactive glass is currently the best solution for patients with radical cavity remaining after previous surgeries. Due to preliminary group of patients, and small number of available publications, further studies are needed.

**ID: 03855**

### Audiometric results after stapedotomy with titanium prosthesis

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Otosclerosis is disease of the bones of the middle ear and inner ear. Vast majority of patients presents conductive or mixed hearing loss with or without tinnitus, sometimes with vertigo. Very often the first symptom is tinnitus. Purpose of our study was to assess hearing results and complications after stapedotomy performed using titanium prosthesis.

After over 25 years of successful experiences with platinum prosthesis surgeons from World Hearing Center of Institute of Physiology and Pathology of Hearing in Warsaw started performing stapedotomies with KURZ Pistons. From January 2014 to October 2015 we performed over 450 surgeries with new type of prosthesis. Data, as medical histories, surgery protocols and hearing examination outcomes were reviewed and audiological results are gradually collected.

All patients presented progressive, conductive or mixed, unilateral or bilateral hearing loss, ears had never been operated before. Comparing pre- and post-operative pure tone audiometry on frequencies: 0.5, 1.2, 4 kHz, results are quite satisfactory. After surgery the mean bone and air conduction decreased, and air bone gap also decreased. Period of observation, due to initiation time of titanium prosthesis in our Center was 12 months.

Stapedotomy with KURZ Piston is good treatment method. Satisfying hearing effect for patients and surgeons, frequent tinnitus reduction, and chance for normal social living is enough to risk this statement. To be sure of that, further studies are needed.

ID: 03868

**Effects of treatment of acoustic accidents with N-Acetyl-L-Cysteine (NAC)**Ulf Rosenhall, Per Muhr, Bjorn Skoog*University of Gothenburg*

**Key words:** Antioxidant (AO); Noise-induced hearing loss (NIHL); Permanent threshold shift (PTS); Temporary threshold shift (TTS); Relative risk (RR).

**Background:** Pharmacological treatment of persons who have been exposed to excessive noise has been proposed for almost half a century. A variety of pharmaceutical agents have been suggested to reduce the risk of NIHL. It has been shown that antioxidants (AOs) have these properties, and N-Acetyl-L-cysteine (NAC) is the AO-agent that has been most thoroughly studied. Moreover, AOs have a favorable profile regarding side effects. A comprehensive research on otoprotection with AOs has been performed using animal models. These studies have demonstrated that NAC, as well as other AOs, have the capacity to protect the cochlea against NIHL in rodents. However, data regarding AO protection in humans is limited. The aim of the present study is to find out whether or not NAC reduces the risk of hearing loss after acoustic accidents in humans.

**Material and methods:** The design is a retrospective, observational study. The study sample consists of personnel of the Swedish Armed Forces exposed to military acoustic accidents during a five year period, from 2010 to 2014. Included in the study were 221 cases (mean age: 22.9 years). A majority of the cases were men (87%). Most of the exposures, 84%, were caused by weapons. NAC (400 mg) was given directly after the accident in 146 cases; 75 had not received NAC. All cases were tested with automated audiometry before and shortly after the noise exposure, and a majority (64 %) about 6 months later as well.

**Results:** The NAC group had significantly better hearing a short time after the acoustic incident than the controls, indicating that the drug reduces a temporary threshold shift (TTS). The deterioration was temporary, since it was not discernable a long time after the accident. The difference was most pronounced in the right ear. The risk reduction to get a temporary hearing loss, affecting one or both ears was 39% (significant) in the NAC group.

**Conclusions:** The study has demonstrated a significant reduction of temporary hearing loss by the use of NAC. This effect was most pronounced in the right ear. Since cases of both permanent hearing loss (PTS) and noise-induced tinnitus are recruited from cases with temporary hearing loss, the demonstrated risk reduction by NAC indicates a positive effect of the drug.

ID: 03885

**Treatment options in otosclerosis**Thomas Rasse, Thomas Keintzel, Niederwanger Lisa, Müller Sophie*ENT departement Klinikum Wels-Grieskirchen, Austria*

**Keywords:** otosclerosis, stapedotomy, malleovestibulopexy, active middle ear implant, CI

**Background:** Otosclerosis is a disorder of bone metabolism in the otic capsule. If there is only a fixation of the footplate patients suffer from a conductive hearing loss. If the otosclerosis affects the inner ear a mixed hearing loss may occur up to a profound hearing loss or even deafness.

**Methods:** In our study we reviewed the audiological outcomes of our otosclerosis patients from 2017 and 2018. A number of 134 ear surgeries had been performed, in which an otosclerosis was confirmed intraoperatively. In cases of a conductive hearing loss we performed a stapedotomy or malleovestibulopexy. In patients with a mixed hearing loss stapedotomy was combined with an active middle ear implant, if a treatment with a conventional hearing aid was not possible. Patients with a severe to profound hearing loss were provided with a cochlear implant.

**Results:** Looking at the conventional stapedotomy, there is a clear improvement of the auditory thresholds over all frequencies. Already 2-3 weeks postoperatively patients show a good outcome. Most significant improvements are seen in the first 2-3 months after surgery. Thereafter only slight changes in hearing are detected. Preoperative existing Tinnitus is reduced in most cases. The audiological outcome showed no difference in patients with malleovestibulopexy or combined active middle ear implantation. Patients provided with a cochlear implant achieved excellent results in speech discrimination.

**Conclusion:** The conductive hearing loss caused by otosclerosis can be treated well with surgery. There is a low risk of severe complications such as deafness. In this case a cochlear implant can be the perfect solution.

## Free Papers 28 – Tinnitus

ID: 03773

**Transcanal sound recordings as a screening tool in the clinical management of patients with pulsatile tinnitus.****S.W.J. Ubbink<sup>1</sup>, R Hofman<sup>1</sup>, P van Dijk<sup>1,2</sup>, J.M.C. van Dijk<sup>3</sup>**<sup>1</sup> Department of Otorhinolaryngology/Head and Neck Surgery, University Medical Center Groningen, The Netherlands<sup>2</sup> Graduate School of Medical Sciences (Research School Behavioral Cognitive Neuroscience, University Medical Center Groningen, The Netherlands<sup>3</sup> Department of Neurosurgery, University Medical Center Groningen, The Netherlands**Keywords:** objective tinnitus; pulsatile tinnitus; cerebral angiography; dural arteriovenous fistulas; transcanal sound recordings.**Background:** In pulsatile tinnitus, the differential diagnosis includes neurovascular pathology, which can be occult on non-invasive imaging techniques. Therefore, if a clear diagnosis is lacking catheter angiography (digital subtraction angiography [DSA]) is indicated to rule out a potentially hazardous dural arteriovenous fistulas (dAVFs). However, the DSA carries a procedural risk of 1-2%. We studied whether transcanal sound recordings could narrow the indication for a DSA in patients with pulsatile tinnitus.**Material and methods,** Prospective analysis of 20 consecutive patients in a tertiary care setting with pulsatile tinnitus who were referred for DSA to rule out dAVFs. In all these patients, non-invasive imaging did not reveal a cause for the pulsatile tinnitus. We performed transcanal sound recordings with a sensitive microphone placed in the external ear canal. We investigated if the transcanal sound recordings could be used as a screening instrument to prevent patients of undergoing unnecessary the risk of a DSA.**Results:** A pulsatile sound was detected in ten patients. In seven of these patients, an arteriovenous fistula was found on catheter angiography. In the ten patients, no pulsatile sound was detected and in all these patients DSA did not identify any neurovascular pathology. In this patient cohort this resulted in a sensitivity of 100% (95% confidence interval: 54-100%) and the specificity 78% (95% confidence interval: 40-97%) for transcanal sound recordings as a screening test for identifying arteriovenous fistulas on DSA.**Conclusion:** Transcanal sound recordings as a screening instrument can prevent patients for the unnecessary risks of DSA in the diagnostic work-up of pulsatile tinnitus.

ID: 04040

**Cortical responses in subjective tinnitus patients****Duygu Hayir Zahra Polat, Ahmet Ataş**<sup>1</sup> Department of Audiology, Faculty of Health Sciences, Istanbul University-Cerrahpaşa, Istanbul, Turkey<sup>2</sup> Department of Otolaryngology, Cerrahpaşa Medical Faculty, Istanbul University-Cerrahpaşa, Istanbul, Turkey**Key Words:** Tinnitus, Quantitative EEG, Brain Mapping, Electroencephalography, Limbic System.**Background:** Tinnitus is defined as the sound perceived in ear or head without an environmental stimulus. The tinnitus complaint is one of the most common symptoms and the prevalence is 15% of the population. It is known that individuals with tinnitus may have effects at the cortical level. The purpose of our study; is to investigate the cranial influence of patients with tinnitus complaints.**Material and methods:** In our study, 25 patients with normal hearing and tinnitus complaints and 15 normal individuals were evaluated. Each individual assessed with audiometry, high frequency audiometry, tympanometry, acoustic reflex, speech audiometry, quantitative EEG (QEEG), Tinnitus Handicap Inventory (THI) and BECK Depression Scale. Alpha and Delta waves were evaluated in QEEG findings using different stimulus types and frequencies.**Results:** In the QEEG assessment, when the patient and control group were compared in the presence of stimulus; there was a significant increase in the delta waves of the frontal, parietal and temporal regions of the individuals with tinnitus complaints ( $p < 0,05$ ). In contrast to delta wave findings, there was a significant decrease in the alpha waves of the frontal, parietal and temporal regions ( $p < 0,05$ ). As the frequency increases, the significance values increases. The most significant increase was found at 4000 Hz and 6000 Hz tone stimuli ( $p < 0.001$ ). For this reason, it was thought that study group patients' tinnitus frequency range were mostly in these frequency bands.**Conclusion:** This change in the frontal region due to the presence of psychological problems at the same time in patients with tinnitus was thought to be the result of stimulation in the limbic system due to tinnitus. Due to the increase in delta waves in the temporal region, it is thought that patients with tinnitus complaints are caused by an increase in neural activity.

ID: 04052

## Investigation of mismatch negativity results using multi feature paradigm of individuals with subjective tinnitus

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**Background:** The mismatch negativity (MMN) test evaluates neural responses to unexpected sounds, is accepted as an objective tool for the evaluation of the neural plasticity in the auditory system. Previously, it was suggested that tinnitus may occur due to differences in neural plasticity in the hearing system. The aim of this study is to compare MMN responses of normal hearing individuals with and without tinnitus.

**Material and methods:** Tinnitus Handicap Inventory (THI) was used to evaluate tinnitus-derived annoyance. Sixteen subjects with chronic subjective idiopathic tinnitus and twenty matched healthy controls were included in the study. Multi-feature MMN paradigm was recorded from 22 surface scalp electrodes.

**Results:** The MMN responses of five different deviants, consisting of frequency, intensity, duration, location and silent gap, were compared between the two groups. On the other hand, the amplitudes of MMN responses were statistically different between the groups for all type of the deviants, there was no difference between the groups when MMN latencies were concerned.

**Conclusion:** According to our results, MMN test might indicate a possible impairment in pre-attentive and automatic central auditory processing for individuals with chronic tinnitus and can be used for the evaluation of the habituation in central auditory pathways in individuals with tinnitus.

ID: 04075

## Prevalence and severity of tinnitus in a representative sample of 70 year olds

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**Introduction:** Tinnitus is a common and potentially debilitating symptom affecting millions of people worldwide. There are several reports on the incidence and prevalence of tinnitus showing that the condition is particularly common among old persons. However, less is known about the severity of tinnitus in old age.

**Aim:** To investigate the prevalence and severity of tinnitus in an age-homogenous population-based sample of 70-year olds.

**Methods:** Data was collected within a large-scale geriatric population-based study in Gothenburg, Sweden, *the H70 Study*. A birth cohort consisting of 1202 70 year olds born in 1944 (55% women) answered a questionnaire about tinnitus and performed pure tone audiometry. Valid results were available for 1128.

**Results:** The overall prevalence of tinnitus was 30,4 %. More men than women reported tinnitus (33% vs. 28% in women), however this difference was not significant when adjusting for hearing status. Tinnitus was perceived bilaterally by 47%, unilaterally by 28% and centrally in the head by 25%. Of those with tinnitus, 46% were mildly bothered, 13% were moderately bothered and 7% were severely bothered. Rates of severity were similar among men and women. Hearing loss was significantly associated with both prevalence and severity of tinnitus.

**Conclusions:** Tinnitus affects nearly a third of the population at age 70. The prevalence of moderate to severe tinnitus, probably requiring intervention, is around 6 % in this age group. Hearing loss is an important risk factor.

ID: 04290

## Hidden hearing loss (HHL) is a neglected cause of tinnitus

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Tinnitus is the hearing of sound when no external sound is present and most of the suffering have variant degree of hearing loss, but some tinnitus patients have normal hearing. There are more and more evidences show that the hidden hearing loss may be the cause of tinnitus with a normal audiogram. In the present study, we recruited 119 tinnitus subjects with nearly normal audiogram. We used pure-tone threshold (125Hz-8kHz), extended high frequency hearing test (8-22 kHz), DPOAE, ABR, TEN test (Dead region) and speech-in-noise tests to detect the hidden hearing loss. Our results indicated that extended high frequency hearing threshold increased in 87% of single side tinnitus subjects, and Dead region existed in 75% of subjects affected both sides.

Free Papers 29 - The smartphone revolution  
in audiology

ID: 03812

Should we “swipe right” on app-based patient-provider communication?

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**Keywords:** Smartphone apps, hearing aids, teleaudiology.

**Background:** Hearing aid manufacturers have begun to leverage cloud-based technologies, such as smartphone apps that enable remote communication between patients and hearing health care providers, to increase the flexibility and reach of hearing services. However, the role of such apps in hearing health care and their effect on how patients communicate their needs to their provider are not yet well-understood. The aims of this study were therefore to: (1) compare patient-provider communication post-fitting via a smartphone app versus a face-to-face consultation; and (2) determine whether hearing aid fitting outcomes are influenced by the mode of patient-provider communication.

**Material and methods:** In a randomised controlled trial, 30 experienced hearing aid users were fitted with a pair of hearing aids and given a smartphone app that enabled them to adjust the gain and frequency response. The intervention group (n = 15) had access to an additional feature in the app with which they could remotely request fine-tuning and receive new settings to upload into their hearing aids. The control group (n = 15) attended an additional face-to-face follow-up appointment two weeks post-fitting. Hearing aid outcomes, experience with and perception of the app, and app handling skills were assessed six weeks post-fitting.

**Results:** Participants were able to communicate their needs equally well in both the app and face-to-face conditions. Intervention participants reported that while the diagnostic questions in the app were sufficiently detailed, they preferred to explain their specific problem in the app’s text box. Several participants suggested that the range of questions be broadened so they could report Bluetooth connection and audio streaming problems. There were no significant differences between the intervention and control groups on any of the hearing aid outcome measures.

**Conclusion:** Apps that facilitate patient-provider communication are a viable method of providing remote follow-up support post-fitting.

**Conflicts of interest:** Jennifer Groth is an employee of GN ReSound, who funded the study.

ID: 03955

A pilot study evaluating recipient experience and clinical impact with Cochlear’s™ Remote Check technology

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**Background** The number of cochlear implant (CI) recipients is growing rapidly across the globe and this results in an ever-increasing caseload for all CI clinics. In the UK, there are approximately 17,000 existing CI recipients and an additional 1500 adults and children received cochlear implants in 2018. Additionally, the proposed relaxation in candidacy criteria in the UK has been predicted to increase the number of CI recipients further. With NHS budgets constantly under pressure, new ways to manage new and existing recipients need to be considered. The majority of CI recipients attending their annual review do not require any changes to their programming settings and their outcome measures remain stable. With this in mind, Cochlear Ltd have developed a remote solution which will allow stable CI recipients to complete their review assessment from home.

Remote Check allows recipients to complete a series of checks which are then uploaded securely into the myProfessionals Portal for their clinician to review. Based on these results, the clinician can decide to schedule another Remote Check appointment or arrange a face to face clinic appointment.

A pilot study for Remote Check is currently underway at a number of UK sites including Manchester Royal Infirmary.

**Material and Methods:** A minimum of 30 cochlear implant recipients from both the adult and paediatric programmes were invited to enrol onto the Remote Check pilot. Recipients must:

1) use a Cochlear™Nucleus® 7 device; 2) have a compatible mobile Apple™ device; 3) have their implant for more than 9 months; 4) have stable hearing with their implant.

A baseline check was performed within 14 days of enrolment. A Remote Check appointment was then scheduled within 6 months’ time. Qualitative questionnaires were sent to recipients and clinicians to ask for their views on the technology. Modelling was also used to assess the potential impact of this technology in the CI clinic.

**Results** Recipients are currently in the process of being enrolled. Results from the questionnaires and clinical modelling will be presented. A discussion around the challenges to implement a remote care pathway will also be explored.

**Conclusion** In the context of growing caseloads and limited resources, we evaluate whether Remote Check can provide a solution to ease the clinical burden and provide a convenient user and clinician experience which can save travel time and inconvenience without compromising quality of care.

ID: 04060

**Investigation of changes in static balance parameters during using of smartphone****Emre Orhan<sup>1</sup>, Büşra Altın<sup>2</sup>, Songül Aksoy<sup>2</sup>**<sup>1</sup> Gazi University<sup>2</sup> Hacettepe University**Keywords:** Smartphone, Attention, Balance, Posturography, Vestibular**Background:** Visual, vestibular and proprioceptive systems must work together in harmony with sensor systems for the protection and maintenance of balance. The primary objective of telecommunications is that smartphones have many advantages such as gaming, internet, access to online communities and being portable. However, the continuity of visual fatigue that can be created by smartphone

use can have a negative effect on the somatosensory network, vestibular system and postural control system. The aim of this study was to investigate the possible physiological and cognitive effects of smartphone usage on biomechanical balance system.

**Materials and methods:** In this study, we included 25 voluntary healthy young adults (10 males, 15 females) aged between 18 and 25 years with no balance problems. In this study, Walk Across (WA) and Tandem Walking (TW) tests applied to the participants.**Results:** In this tests, was obtained statistically significant findings ( $p < 0.05$ ).**Conclusion:** It is considered important that determining more extensively the effects of using smartphone on postural control and balance in different conditions to prevent accidents and possible difficulties

## POSTER DISCUSSIONS

## Poster Discussion 01

ID: 03760 -P001

**Functional Head impulse test (f HIT test) with Acute vestibular syndrome (AVS)****Z. Pusara<sup>1</sup>, Z. Pejic, M. Cvijic***Hospital Gradiška ORL Department, Public health institution, Hospital of Gradiška, Republic of Srpska***Keywords:** acute damage of vestibular sense, Head impulse test.**Introduction:** Vestibular ocular reflex (VOR) detects head movements and produces compensatory eye movements with the goal of keeping still on the retina the image of the outside world as long as possible. The Functional Head impulse test is an objective method capable of measuring and recording eye movements during this test.**Goal:** The main goal of this research is to present the results of the Functional Head impulse test for patients with acute vestibular symptoms caused by the damage of peripheral vestibular parts.**Material and methods:** We present the result of the Functional Head impulse test done on a patient who came to the Hospital with acute vestibular symptoms and normal neurological test. We did the testing in the first 24 hours after the first symptoms appeared, then after 3 and 6 months.**Results:** The Functional Head impulse test done in the first 24 hours was positive. Neurological tests were normal. MR endocranium test normal. The patient was submitted to vasodilation, vestibular rehabilitation. There was

a subjective improvement after 3 months, but the Functional Head impulse test was still positive. After 6 months the Functional head impulse test was negative, a peripheral vestibular sense recovered.

**Conclusion:** The Functional Head impulse test is the most certain method to detect a one sided complete loss of the function of semi-circular canals. In the early stages of the acute vestibular syndrome HINTS testing (Head impulse test –Nystagmus-Test of skew) is more sensitive than MR for differencing peripheral from central vestibular lesion.

ID: 03819 - P002

**Relationships between postural stability in young people following late cochlear implantation (CI) and selected clinical and environmental factors****Anna Zwierzchowska, Aleksandra Żebrowska, Grzegorz Juras, Agata Krużyńska***The Jerzy Kukuczka Academy Physical Education***Keywords:** postural stability, following late cochlear implantation, compensation.**Objective:** Research results in the field of the effect of cochlear implantation on postural stability are ambiguous and even contradictory. The aim of the study was to identify correlations of selected clinical and environmental factors with postural stability of young people following late cochlear implantation (CI) under conditions of activation and deactivation of hearing aids and in different visual perception conditions.**Material and methods,** The study covered 27 students with CI in aged 14-20 years: girls ( $n=13$  aged  $17 \pm 1.9$ ) and boys

(n=14 aged 16.6±1.7). The selection for the study was purposeful, with all patients suffering from sensorineural hearing loss, after cochlear implantations (CI) and using conventional hearing aids in the other ear. The study examined young people with the time from implantation not shorter than 2 years (girls: x=8.9±3.9; boys: x=8.0±4.0). A research tool used in posturographic tests was the Accu Gait balance platform (AMTI) with NetForce computer software.

**Results:** The study revealed a significant difference in the velocity of the centre of pressure (vCOP), which depended on the visual perception conditions. The analysis of the vCOP measurements showed that CI were not statistically differentiating factors. No statistically significant differences were found in the area of the moving centre of pressure (Area) due to the visual control factor, both for activation and deactivation of CIs. Analyses of vCOP data showed statistical significance of age factor for this parameter (negative coefficient), whereas no correlation of vCOP were found with sex and such somatic variables and clinical factors, e.g., type of hearing loss, time from diagnosis of hearing loss, time from implantation. The analysis demonstrated a directly proportional relationship between the vCOP and the aetiology of hearing loss, which was statistically significant.

**Conclusions:** Lower vCOP values were found for the study group with active CI and eyes open. With age, the level of postural control increased in CI patients. A directly proportional relationship was found in the study group between the aetiology of hearing loss and vCOP results.

**ID: 03832 - P003**

### Life quality in patients with vertigo

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**Key words:** DHI, VADL, Vertigo, Videonystagmography

**Background:** Numerous authors have reported that the intensity, duration and frequency of vertigo accompanying vestibular disorder often affect everyday life, social and professional activities due to physical, economic and psychological disadvantages. Vestibular disorders can be associated with the loss of confidence, loss of self-esteem and depression which causes a lack of concentration and decrease in the quality of life. The objectives of the study were to evaluate the disabilities of the patients due to vertigo by using questionnaires, to record patient symptoms, the impact of vertigo on performing everyday activities, the impact of vertigo on the quality of life, and the impact of vertigo compared between patients with peripheral and central vestibular disorders.

**Materials and methods:** The study included 57 patients treated in the Department Otorhinolaryngology and Head and Neck Surgery, University Hospital Center Osijek.

Vestibular disorder and vertigo type was diagnosed by videonystagmography and all the patients completed two questionnaires: DHI (Dizziness Handicap Inventory) and VADL (Vestibular disorders activities of daily living).

**Results:** The DHI questionnaire showed that in majority of respondents a sudden head movement worsened the condition (67%), patients avoided heights (59,6%), bending over also worsened the condition of patients (52,6%), and patients experienced difficulty while lying down and getting up (52,6 %). In VADL questionnaire the answers of the patients mostly varied from being able to stand on his/her own to being forced to support oneself with an object while performing an activity. Patients were rarely dependent or unable to perform activities anymore. No statistically significant difference in outcome was found between patients with peripheral and central vertigo.

**Conclusion:** Vertigo affects the quality of life. In our study, we found that there is not statistically significant difference in the impact of the quality of life between patients with peripheral and central vertigo.

**ID: 03848 - P004**

### Translation and adaption of the scale The Pediatric Vestibular Symptom Questionnaire into European Portuguese

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**Background:** The “The Pediatric Vestibular Symptom Questionnaire” aims to quantify, identify and measure the intensity of vestibular symptoms in children. The present study aims to verify the facial validity of the *The Pediatric Vestibular Symptom Questionnaire – PVSQ*.

**Material and Methods:** In collaboration with the *Centro de Estudos e Investigação em Saúde da Universidade de Coimbra* two translations of the original scale were made into European Portuguese by two independent translators to obtain the first consensus version of the scale in European Portuguese. This version was translated into the original language in order to compare the retroversion obtained with the original scale and thus make the necessary changes to the 1<sup>st</sup> version of the scale in Portuguese, obtaining therefore the 2<sup>nd</sup> version of consensus – semantic equivalence. The 2<sup>nd</sup> consensus version was analyzed and commented by three specialists in the area of vertigo and/or pediatric vertigo. After being analyzed the amendment proposals by the specialists, the 3<sup>rd</sup> version of consensus was obtained – cultural equivalence. The 3<sup>rd</sup> version was applied to 12 children/ young people, aged between 8 and 17 years old and followed in the vertigo consultation in Dona Estefânia Hospital– equivalent of content.

**Results:** After the translation processes, retroversion and analysis of the semantic, cultural and content equivalence, it can be stated that the scale *The Pediatric Vestibular Symptom Questionnaire* translated into European

Portuguese and adapted to the Portuguese Population has facial validity.

**Conclusion:** The confirmation of the facial validity of the Pediatric Vestibular Symptom Questionnaire (P-PVSQ) is a great benefit from the clinical point of view. The questionnaire may be used by audiologists and/ ENT doctors because it helps to detect and better understand vertigo in children.

**ID: 03869 - P005**

### Vestibular dysfunctions: comparison between patients with head and neck tumors and a control group

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**Keywords,** Vestibular Dysfunctions, Head and Neck Tumors, DHI, Computerized Posturography.

**Background,** The use of ototoxic drugs is common in patients with head and neck tumors. Consequently, there may be vestibular dysfunctions that are not always detected, affecting the quality of life. Thus, it is important to evaluate the factors that may lead to vestibular system dysfunction. The objective of this study is to determine if vestibular dysfunction in individuals with head and neck tumors who underwent chemotherapy and/or radiotherapy also occurred in a control group.

**Material and Methods,** The sample consists of 54 individuals of both genders, aged between 20 and 91 years old and is divided into two groups: a group of 30 individuals without any kind of tumor and no medical history of chemotherapy and/or radiotherapy (control group) and a group of 24 individuals with head and neck tumors. The instruments used to collect the data were an Anamnesis, the *modified Clinical Test of Sensory Interaction and Balance* (mCTSIB), *Limits of Stability test* (LOS) and the *Dizziness Handicap Inventory* (DHI) scale.

**Results,** There are statistically significant differences between the two groups on the Physical, Functional and Emotional sub-scales of the DHI scale, on the DHI Total ( $p_{DHI\ Physical} < 0,0001$ ;  $p_{DHI\ Functional} < 0,0001$ ;  $p_{DHI\ Emotional} < 0,0001$ ;  $p_{DHI\ Total} < 0,0001$ ) and on the Reaction Time (RT) in LOS test in every position ( $p_{RT\ Front} = 0,020$ ,  $p_{RT\ Back} = 0,011$ ,  $p_{RT\ Right} = 0,036$ ,  $p_{RT\ Left} = 0,036$ ). There are marginally significant differences between the two groups in the postural oscillation velocity in Condition 4 of the mCTSIB ( $p_{Condition\ 4} = 0,065$ ).

**Conclusion,** The group of individuals with head and neck tumors had worse results on the DHI scale, in the RT in LOS test and in the Condition 4 of the mCTSIB, suggesting the existence of greater vestibular alterations in this group compared to the control group.

**ID: 03894 - P006**

### Epley maneuver versus Semont maneuver for the treatment of benign paroxysmal positional vertigo: how different are they really?

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**Keywords:** benign paroxysmal positional vertigo, posterior semicircular canal, canalith repositioning procedure, Epley, Semont

**Background:** Posterior semicircular canal benign paroxysmal positional vertigo (PC-BPPV) is one of the most common diseases of the peripheral vestibular system. Multiple canalith repositioning procedures (CRPs) have been introduced, with the Epley and Semont maneuvers being the most widely used. The objective of this review is to address the similar efficacy of both procedures based on the mechanics of the canalolithiasis theory of PC-BPPV.

**Materials and Methods:** We performed a narrative, non-systematic review in the English literature on PC-BPPV published in PubMed, and a step-by-step analysis and comparison of the trajectory of otoconia particles during the Epley and Semont CRPs.

**Results:** Even though a stepwise description of each CRP may be clinically different, the anatomical course that otoconia particles follow to reach the utricle is shown to be identical.

**Conclusions:** The comparable efficacy between the Epley and Semont maneuvers for treating PC-BPPV can be explained by the canalolithiasis theory, and the similar mechanics that apply to both approaches. Either CRP may be used alternatively, based on physician preference and patient stature, with similar expected treatment outcomes.

**ID: 03919 - P007**

### Profiling the dizzy patient in an Emergency Department

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**Keywords:** dizzy, dizziness, Emergency Department

**Background:** Dizziness is a common presenting symptom in the Emergency Department (ED). We assessed the prevalence of dizziness in patients who visit the ED, the most common accompanying symptoms, concomitant chronic diseases, the route of the patient through the various specialties and the hospitalization rate.

**Materials and Methods:** Retrospective data collection from hard-copy and electronic medical records of patients who arrived in our hospital over a 3-month period. Exclusion criteria were age < 16 years, non-ambulatory patients, not fluent usage of the Greek language and initial major complaint description “vertigo”. Statistical data analysis was conducted with SPSS v25.

**Results:** In total, 408 patients arrived in the hospital complaining of dizziness. Hospital admission rate was 15.44%. The most frequent accompanying symptoms were vertigo, headache, fatigue, nausea and imbalance. The most frequent co-morbidities were hypertension, coronary artery disease and diabetes. Triage referrals were mainly to Internal Medicine (65,2%) and ENT (18%) specialists, while 57,1% of the patients not admitted to the hospital had to visit multiple specialists.

**Conclusions:** While many studies focus on the proportion of cerebrovascular events in the dizzy patient, dizziness in the ED is generally benign in etiology. More research is necessary on the pattern of medical history acquisition and co-morbidity evaluation from the General Practitioners in order to minimize the delays in the ED and reduce the number of multiple referrals to specialists.

**Conflicts of Interest:** none to declare.

ID: 03970 - P008

## Vestibular rehabilitation after cochlear implantation

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**Keywords:** cochlear implant, vestibular therapy, vertigo, dizziness

**Background,** cochlear implantation (CI) is a well-known surgical procedure to rehabilitate patients with severe to profound hearing loss. Although CI has been accepted as a safe procedure, the insertion of an electrode into the cochlea may have an adverse effect on vestibular receptors, resulting in vertigo and dizziness. Vestibular rehabilitation (VR) is based on specific and repeated exercises aimed to activate the neural plasticity mechanisms of the central nervous system in an attempt to achieve and accelerate central and vestibular compensation. These exercises are used to improve vestibulo-ocular reflex and vestibulo-spinal reflex responsible for the stability of the

gaze during head movement and of the head/ body respectively. The present study aimed to investigate the impact that VR had on subjects who underwent CI surgery with vestibular symptoms two weeks after the surgical intervention.

**Material and methods,** in a sample of 28 patients, 28.6% had vestibular symptoms two weeks after CI surgery and started VR. The VR exercises considered the patients' symptoms and the results of DHI, postural stability evaluation and peripheral vestibular deficits. Each program was patient-specific and included compensation, adaptation and substitution exercises. Therapy sessions were held initially in the hospital. After that, the patients who were able to perform and tolerate the activities started the home-based training program. The reevaluation was conducted every two weeks, totalizing 6 weeks. After VR, the patients were evaluated through DHI and postural stability (modified clinical test for sensory interaction on balance – mCTSIB).

**Results,** the outcomes of the DHI demonstrate that the scores in the physical (from 22.00 to 10.71), functional (from 25.57 to 12.71) and emotional (from 19.29 to 8.14) components improved after VR. The same result was found in all conditions of mCTSIB: platform fixed/ eyes open (from 0.16 to 0.10), platform fixed/ eyes closed (from 0.23 to 0.16), platform unstable/ eyes open (from 0.79 to 0.51) and platform unstable eyes closed (from 2.86 to 1.99). VR significantly ( $p < 0.05$ ) improved self-perceptions of dizziness based on DHI and the postural stability.

**Conclusion:** VR was an appropriate and effective therapy for treating patients with vestibular symptoms after cochlear implant surgery.

ID: 03982 - P009

## Vestibular implants: solution for the increase of the vestibulo-ocular reflex?

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**Keywords:** Vestibular prostheses; Bilateral vestibular loss; Vestibular system, Balance

**Background,** Bilateral vestibular loss results from the reduction or absence of vestibular organ function, vestibular nerves, or a combination of the two. Subjects with this dysfunction are advised to perform vestibular rehabilitation, to train and learn strategies that help improve their symptoms, however, in most cases, they continue to present complaints. The modified cochlear implants, which consist of both auditory and vestibular stimulation, have been presented as a possible option for some individuals with bilateral vestibular deficit and candidates for cochlear implants. The purpose of this work is to verify, through a systematic review, if individuals with bilateral vestibular loss present an increase in the vestibulo-ocular reflex (VOR) gain after the placement of a modified cochlear implant.

**Material and methods:** For this systematic review, the research of original articles was carried out between February 2017 and January 2019, using databases such as B-on, PubMed, SciELO, Medline and ResearchGate with the following keywords: vestibular implants, vestibular prostheses, balance, vestibular system, vestibulo-ocular reflex, bilateral vestibular loss, modified cochlear implant.

**Results:** A total of 35 articles were found, but 27 were excluded due to the fact that 13 studies had as main focus the animal population (and not the human population), 10 were review articles, 3 studies did not have the intended objective and 1 article was excluded because it didn't have a sample. We included 8 original studies involving 15 participants with severe bilateral vestibulopathy with ages between 21 and 71 years (mean age = 57.53). These studies used different methods of evaluation of the VOR such as the rotating chair, the video Head Impulse Test (vHIT) and an electric treadmill.

**Conclusion:** After analysis of all selected studies which had different evaluation methods, it was observed that all of them presented an increase of the VOR gain after the placement of the modified cochlear implant. The studies demonstrated that individuals were able to adapt to the stimulus, making possible to electrically evoke the VOR. However, it has been verified that further studies will be required to prove/relate the modified cochlear implant and the improvement in quality of life in individuals with bilateral vestibular loss.

**Conflicts of interest:** None to declare.

ID: 03999 - P087

### Binaural speech processing: temporal resolution and reported hearing difficulties In genetically confirmed Friedreich's ataxia patients

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**Background:** Clinical presentation of patients with auditory neuropathy (AN) typically includes difficulty listening in noise due to temporal resolution deficits. AN may present in infancy, or at a later stage when associated with generalized neurodegenerative processes (Starr et al., 1996, 2000; Rapin and Gravel, 2003) such as Friedreich's Ataxia (FRDA). FRDA is the most frequent autosomal recessive inherited ataxia caused by mutations in the FXN gene. AN, as a result of axonopathy, is reported in a high proportion of FRDA individuals (Rance et al., 2008). Some evidence suggests that auditory spatial perception as well as temporal resolution ability are disrupted in FRDA individuals with AN (Rance et al., 2012). Despite

the existing preliminary research, auditory phenotyping in FRDA individuals remains unclear. Some studies have found a positive correlation between the number of GAA trinucleotide repeats on the shorter allele (GAA1) with the severity and the frequency of occurrence of some disease complications. Anecdotal observations suggest that there could be a correlation between variations in repeat length of GAA1 and severity of the auditory phenotype and perceived hearing difficulties in FRDA patients. The aim of this study was to assess the predictive value of the repeat length of GAA1 and GAA2 and also that of the severity and duration of the disease in regard to different audiological presentations.

**Methods:** Fifteen patients with genetically confirmed Friedreich ataxia underwent baseline audiological assessment and auditory processing evaluation including a temporal resolution test and a binaural speech perception test.

**Results,** Spatial-processing ability, as measured by the spatial advantage measure of the LiSN-S test, and temporal resolution ability, as measured by the gaps-in-noise test, were associated with the repeat length of GAA1.

**Conclusion,** The findings of our study suggest more severe temporal resolution and more degraded neural sound conduction leading to more problems with speech perception and spatial processing in those patients with the GAA1 more than 500.

**Conflicts of interest:** None

ID: 04036 - P010

### Experience with the N7-system (CP1000 speech processor)

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**Keywords:** CP1000-upgrades, benefits, reasons for new implantees to opt for Cochlear N7

**Background:** since the launch of the N7-system we have done more than 220 SP-upgrades and have fitted more than 100 newly implanted patients with the N7-system (CP1000 SP). The aim of our investigation was to analyse how much benefit the CI users had when they switched from Freedom / CP810 or CP910 to the new N7-system. Regarding the newly implanted subjects, we asked them why they opted for the Cochlear system instead of others.

**Material and methods:** In the Upgrade-group we compared the percentage of speech understanding in different conditions: Freiburg Numbers at 45dB (or 55dB), Freiburg Monosyllabics at 65dB (or 55dB), Oldenburg Sentence Test (SVS SN) with noise coming from 180°. We asked the newly implanted CI-users (or their parents) why they had opted for the Cochlear system: They received a questionnaire of 4 possible answers with the option of choosing more than 1 answer: a) The implant (including the possibility of NRT-Measurement), b) the N7-speech processor (size, style, robustness), c) the (wireless) accessories,

iPhone compatibility (App instead of remote control) and Aqua+ and / or d) because of recommendation (other CI users / the first implant being a Cochlear system).

**Results.** Most of the N5 or N6 users had a significant improvement of speech understanding when they received the new N7 system, especially at 45/55dB. Parents of newly implanted children often chose the Cochlear system because of the implant system (NRT measurements) and because of the size and the robustness of the CP1000-SP. They reported that they wanted to check the system themselves, which is possible via Microphone Tester, signal check and App. Adolescents and adults mostly chose the system because of the small speech SP, the wireless accessories and the iPhone-compatibility. In addition to that, the system was frequently recommended in CI-self-help-groups.

**Conclusion:** The new CP1000-speech processor allows better speech understanding for the upgrade-subjects. Regarding CI-candidates, it depends on age and lifestyle regarding which parameters lead to the decision of the N7-system of Cochlear.

**ID: 04048 - P011**

### Role of long-term vestibular rehabilitation in a patient with posterior fossa tumor – a case report with a 2-year of follow-up

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**Keywords:** Posterior fossa tumor, vestibular rehabilitation, computerized dynamic Posturography

**Background:** Posterior fossa is the site of many types of tumors, as well as brain metastases of the most common adult malignancies. Posterior fossa tumors may disrupt the function of the ocular motor systems. These tumors may disrupt visual fixation and vestibular and/or gaze-stabilization mechanisms, which can lead to acquired nystagmus, skew deviation, and complex gaze palsies.

**Material and methods.** This study was conducted between October 2016 and December 2018 at the Department of Audiology, Istanbul Medipol University. A 36-year-old male patient, underwent excision of the cerebellar tumor in April 2016 as he was diagnosed with ganglioglioma. The patient complained of only bilateral tinnitus since the age of 14-15. Furthermore, he had mild dizziness, and headache in his younger ages. After the operation, he reported severe imbalance, nausea and vomiting for one month. The patient, who had difficulty in walking, had problems with the loss of sensation and control of the center of gravity when climbing the stairs. After his admission to the Department of Audiology when conducting the VNG test battery, in head shake test, we obtained 10° downbeat nystagmus. Furthermore, in the computerized dynamic posturography, Sensory Organization Test (SOT) composite score was 48. Regarding the SOT parameters, 'visual' and 'vestibular' inputs were severely impaired. Thus, we administered a 6-week

posturography-assisted vestibular rehabilitation protocol (extending an hour per week) combined with a home-based exercise program. At the end of the rehabilitation program, the composite score increased to 66. After two years when the patient admitted to the Department, the composite score was determined as 63. After 6-week vestibular rehabilitation, SOT composite score increased to 72, which is within the normal level.

**Results:** This is a rare type of case report which demonstrates that even a 36-year-old adult with partial excision of the right cerebellar lobe may benefit from long-term vestibular rehabilitation. Although cerebellum is an important part of the balance system and compensation mechanism, even patients who have undergone partial excision of the cerebellum may be candidates for the vestibular rehabilitation program.

**Conflicts of interest:** There are no conflicts of interest for any of the authors.

**ID: 04049 - P012**

### Validation of the Polish version of the Dizziness Handicap Inventory

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**Background.** Dizziness Handicap Inventory was developed to assess disabling effects of vertigo and dizziness on everyday life. Although this questionnaire was translated to several languages, validation of the Polish version of DHI is still missing.

**Objective.** The aim of this study was to translate and cross-culturally adapt the DHI for the use in Polish-speaking population.

**Methods.** Study included 343 patients of audiology clinic, who voluntarily agreed to participate in the study. All patients revealed vertigo and/or dizziness accompanied by vestibular lesions or not. The repeatability was assessed in a subgroup of 41 patients with vertigo or dizziness, excluding acute vertigo and benign paroxysmal positional vertigo (BPPV). Subjects filled the questionnaire twice, with 2.5 month interval between testing.

**Results.** The high Cronbach's alpha indicated high homogeneity. Satisfactory internal consistency was found ( $\alpha$  0.92). DHI demonstrated good ability to discriminate between patients with and without handicap (sensitivity and specificity 80%, the cutoff point 54). The repeatability of particular questions for questionnaire was 74.8% and weighted Cohen's Kappa coefficient was 0.752128. Correlation coefficients were high and were equal to 0.83 for physical (P) subscale, 0.92 for functional (F) subscale, 0.88 for emotional (E) subscale, and 0.93 for total DHI index.

**Conclusions.** Polish version of DHI is a repeatable and valid method for assessing the impact of dizziness on handicap reporting.

ID: 04050 - P013

## Clinical use of the Dizziness Handicap Inventory

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**Background:** Dizziness Handicap Inventory (DHI) is widely used in clinical practice for screening patients with balance diseases. However, its clinical value in differential diagnostics of such patients is still to be established.

**Objective:** The aim of the study was to assess clinical value of DHI (Polish version).

**Material and Methods:** The study included 343 patients selected from our database of 628 subjects with dizziness. The neurotological examination and laboratory tests were the base to extract 7 clinical groups with: non-compensated (NC) and compensated vestibular (C) paresis, benign paroxysmal positional vertigo (BPPV), migraine, central and psychogenic vertigo, and bilateral vestibular loss (BV). Factor structure (Principal Component analysis, PCA), internal consistency (Cronbach's alpha), and discrimination ability (ROC curve analysis) were examined.

**Results:** In PCA, the five factor solution was obtained. Factors were related to: F1 – restricted participation, F2 – activities aggravating vestibular symptoms, F3 – positional vertigo, F4 – handicap/anxiety, F5 – depression. C group revealed the lowest DHI scores, while the scores in remaining groups were similar. The cutting point between NC and C groups was set at 52, with sensitivity of 76%. The differences revealed the factors F2 and F4. As it could be predicted, F3 results showed the highest score for BPPV.

**Conclusion:** DHI (Polish version) may differentiate compensated and uncompensated vestibular patients. It possesses also some clinical value in screening positional vertigo.

ID: 04053 - P085

## Evaluation of hearing screening results in individuals exposed to occupational noise

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**Key Words:** Industrial Audiology, Noise, Noise-Induced Hearing Loss, Occupational Noise, Audiology

**Background:** Noise can be defined as a mixture of sounds at various frequencies that exceed a certain loudness as unwanted, meaningless, undesirable sound. In this industrialization age, the use of machinery in the working areas are increasing and accordingly, the number of individuals exposed to noise levels and noise increases. Effects of noise on hearing; the characteristics of the noise, the

duration of exposure, the individual's personal predisposition and genetic factors. The noise affects the high frequencies first, then the speech frequencies. Individuals initially do not have problems related to speech comprehension, as the hearing loss progresses it becomes the irreversible stage.

**Material and Method:** Hearing tests of the workers were performed regularly. Threshold shifts between work entrance and in 2018, were assessed for workers in 4 different units (age range: 20-40 years, 552 persons). Tested individuals were grouped according to the level of noise exposure (noise level ranging 85 dB-140 dB). Threshold shift at each frequency was found to be correlated with the noise level. The patients were examined for otoscopic examination, and Interacoustics AC 40 audiometer and TDH 39 headphones were used to perform a pure tone audiometry test in a quiet cabin.

**Results:** When the threshold shifts according to noise levels were examined, no significant relationship was found between the working years. However, regarding the threshold shifts over time, hearing deteriorations in 2, 4 and 8 kHz air conduction levels were found and this difference was statistically significant.

**Conclusion:** It should be kept in mind that employees are at risk for noise and hearing loss may occur in the future. For this reason, training should be provided to protect the employees who are exposed to high-intensity sounds from the noise and to raise their awareness. Earplugs should be used when working in noisy environments is mandatory. These earplugs reduce noise by 10-30 dB, more particularly at high frequencies.

**Conflicts of interest:** There are no conflicts of interest for any of the authors.

ID: 04071 - P086

## UK first experience with Cochlear's Smart Bimodal Solution: Nucleus 7 and Enzo 3D

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**Keywords:** bimodal, cochlear implants, N7, Enzo 3D

**Background:** Bimodal hearing – a cochlear implant (CI) in one ear and hearing aid in the other - provides proven benefits for people with severe to profound hearing loss, when compared to hearing aids or unilateral CI alone. These include: better sound quality, improved hearing in quiet and noise, better music perception, improved sound localisation, and prevention of auditory deprivation in the non-implanted ear. Cochlear implant users with a Cochlear™ Nucleus® 7 sound processor and compatible ReSound hearing aid benefit from a range of connectivity options, including direct streaming of calls, audio and music to both ears, and control of both devices, from compatible Apple products. Wolfe et al. (2016) demonstrated up to 25% improvement in speech understanding on the phone when bimodal CI users streamed calls wirelessly. Being connected

has become a necessity of modern life, so this UK pilot sought to evaluate CI user and clinician experience with Cochlear's Smart Bimodal solution; exploring the relative importance of direct streaming and its perceived benefits on hearing performance.

**Material and Methods** Ten CI users have been recruited from the Oxford Auditory Implant Programme and will be fitted with a ReSound Enzo 3D hearing aid in their non-implanted ear. Inclusion criteria were: 1) Aged 18 years or older; 2) Recipient of a Nucleus® 7 sound processor; 3) Aidable hearing in the non-implanted ear; 4) Received their implant no less than 6 months prior to hearing aid fitting appointment. CI users will complete an online questionnaire, prior to and 6-8 weeks post fitting of the Enzo 3D. The questionnaires focus on device use and experiences, and include a shortened version of the SSQ. The fitting audiologist/s will also complete online questionnaires following each fitting, and at the end of the pilot; providing feedback on the ease of fitting and counselling of patients.

**Results** The outcomes of the pilot will be presented, including patient and audiologist feedback regarding the bimodal fitting of Nucleus® 7 sound processors and ReSound Enzo 3D hearing aids.

**Conclusion** Bimodal hearing can provide numerous benefits for unilaterally implanted CI users. The introduction of direct streaming and user control from smartphones, as is available with Cochlear and ReSound technology, could further improve user experience and performance, particularly in more challenging listening environments.

**ID: 04094 - P014**

### **Paresis n. facialis as a result of otological complication - case report**

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Vladimir R. Pavicevic, Aleksandra Lakovic-Tatar**

*RH`Danilo I`*

**Key words:** Paralysis, n.facialis, otogenic complications

A 26-year-old patient comes from the facial nerve of the left side of the face of the last three days with the severe pain of the entire half of the head. Previously treated in another institution. The day before she was admitted to the ward, she had a lice of lean lips that leaked the liquid content from pustular changes.

Clinical ENT examination: The left half of the whole does not accumulate, the left eye does not close, and the left corner of the lips hangs. The right aurikula is hyperemic, edematous, warm to the touch, covered with crayfish and pustular changes from which the lymphatic content is poured. The external listening channel is hyperemic, edematous with a serous secret in it that is aspirated. Membrana tympani thickened, hyperemic, with smaller perforation on the lower quadrant joint, from which there are visible pulsations of the serous secretion. Laboratory parameters, apart from lymphocytic prevalence, are within the limits of the reflex values. Audiogram: Left

mixed hearing loss up to 35 db, right hearing neat. The performed Rtg of both mastoids by Schuller indicates a well-pneumatic mastoid. Left ear rush: Pseudomonas aeruginosa. The CT of the temporal bone shows a weaker pneumatic, left mastoid in relation to the right. In the cage, the chain of sweets is preserved with a smaller liquid collection in it.

The patient has initiated therapy with two antibiotics parenterally (cephalosporin III generation and aminoglycoside), local fat (hydrocortisone + oxytetracycline), then drops (Dexametason, neomycin) with parenteral vitamin therapy. After 3 days there is discrete improvement, and given the finding of ear and antibiotics, excluding aminoglycoside from therapy. Ordinary therapy was carried out for 7 days.

More than a month later, when the changes from the external hearing channel and lips were withdrawn, physical therapy was advised. After two months of the initial symptoms, the lower branch of the facial reaction still does not react, but the eye closes completely and collects the left half of the whole completely.

It is noticeable improvement on a daily basis. The ear canal control is neat, as is the audiogram. Timpanogram is the type of 'A', with preserved reflexes. It appears that the function of the animal's face will be fully restored.

**ID: 04130 - P016**

### **Auditory Processing Disorder in a patient with a large cerebellopontine angle (CPA) meningioma**

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**Key words:** Auditory processing disorder; cerebellopontine angle; meningioma; spatial processing disorder

**Background:** A 67-year old female musician was referred to our Neuro-otology clinic presented with a two-year history of non-intrusive tinnitus, hearing difficulty in the right ear, significant problem with the perception of music and understanding speech in the presence of background noise. She also explained that certain piano notes are distorted. Her MRI scan showed presence of a meningioma at the right cerebellopontine angle. She was referred for auditory processing assessment. This case is highly educational as it shows the presence of spatial processing disorder and dichotic listening deficits in a case with a large cerebellopontine angle meningioma.

**Methods:** The patient underwent a standard audiological evaluation including pure-tone audiometry (PTA), speech audiometry test, otoacoustic emissions and auditory-evoked brainstem responses (ABR). The APD test battery consisted of Listening in Spatialized Noise – Sentences Test (LISN-S) and dichotic digits test (DDT).

**Results:** Her PTA showed bilateral symmetrical mild high frequency sensorineural hearing loss. ABR showed an abnormal waveform with missing waves I-V on the right. Her speech audiogram showed a significant rollover in the right ear. Her auditory processing results showed deficits in LiSN-s demonstrating spatial processing disorder and abnormal DDT worse in the right ear. All tests exhibited deficits strictly limited to the right ear, which was consistent with her presenting complaint.

**Conclusions:** This case demonstrates the presence of spatial processing disorder and dichotic listening difficulties in the cerebellopontine angle lesions and the efficiency of the current diagnostic test battery in revealing the lesion-causes of central APD.

**Conflict of interest:** none

## Poster Discussion 02

ID: 03796 - P040

### 10-year results of the implementation of comprehensive program for medical and pedagogical rehabilitation of children with hearing impairment in Moscow

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**Keywords:** children, medical and pedagogical rehabilitation, hearing impairments.

**Background:** Analysis of implementation results of the program for medical and pedagogical rehabilitation of children with hearing impairment in Moscow.

**Material and methods:** 3697 children with hearing impairment at the age of 0-18 years were examined from 2007 till 2018. The comprehensive program included methods of assessment of auditory, speech, psychomotor development of the child, incidence, genetic tests, hearing aid, endoprosthetics, surdopedagogical exercises, corrective techniques (pedagogy for blind and visually impaired, treatment of co-morbidities, etc.).

**Results:** There is a trend towards an increase in the number of children with sensorineural disorders. The average age of children with congenital and early acquired pathology who consulted a surdologist for the first time changed significantly (2007 – 5 years, by 2018 – from 4 months to 1 year 4 months). Inherited genetic mutations and syndrome pathology are significant inherited factors in 36-59.4% of children. Pregnancy failure and birth defects – 15.3-19%, abnormal ear development – 2.7-10.1%, auditory neuropathy 0-0.8%. Acquired hearing impairments were caused by prior neuroinfection in 3.7-4.9% of patients, by craniocerebral injury in 0-2.4%, by cerebrovascular disturbance in 2-1.2%, by ototoxic drug administration in 0.7-0.8%, by viral infections in up to 1.2%, by autoimmune disease of inner ear in

up to 2%, by oncology in 0.7-2%, by chronic otitis media in 0.7-1.2%. 12.8-20.4% of patients had hearing impairment of unclear etiology. The most part of children with hearing impairment had confounding factors in their ante- and intra-natal history (nervous system pathology, vision impairment, hearing impairment). 60% had attention deficit disorder, as-thenoneurotic syndrome, 12% had signs of intracranial hypertension, 47% had reduced vision, 60% had general speech underdevelopment, 28% had speech retardation with learned phrase formation, 12% had kinetic speech.

**Conclusion:** Timely development of individual rehabilitation program aimed at the full restoration of patient's function led to the reduction in diagnosis age, timely provision of highly effective medical care. Genetic screening helps parents to find problems of their child more quickly and to follow doctors' advice. However, about 2% of parents, despite early diagnosis, start rehabilitation of their children at the age of 3-4 years when a delay in speech development progresses to the severe one.

ID: 03797 - P041

### Hearing potential in children with various forms of chronic suppurative otitis media

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**Keywords:** children, CSOM, hearing loss.

**Background:** Studying the nature of hearing impairments in children with various forms of chronic suppurative otitis media (CSOM).

**Material and methods:** Examination and treatment of 99 children (118 ears) with various forms of CSOM, at the age from 7 to 15 years: medical history, anamnesis morbi and complaints of the child (or his parents), otorhinolaryngologic examination, ear endoscopy, CT of temporal bones, hearing test (Weber and Federici audio tests, tonal threshold audiometry, ultrasound hearing sensitivity).

**Results:** Chronic suppurative otitis media of tubotympanic type (CSOM TT) – 73 children (87 ears), chronic suppurative otitis media on anterior epitympanic type (CSOM AET) – 26 children (31 ears). Bilateral process – in 19 children, unilateral – in 80 ones. Treatment duration was from 6 months up to 12 years, 78.5% of patients had disease onset at the age of 1-3 years. At CSOM TT, in 12 (13.9%) ears a tympanic membrane perforation happened, in the pars tensa, perforation size did not exceed 3 mm, in 75 (86.1%) ears a central perforation was found, in 71 cases it did not exceed 2 mm. In all cases of CSOM AET, defect in pars flaccida of tympanic membrane was marginal, in 12 cases it did not exceed 1.5 mm. At this form of CSOM, cholesteatoma with fetid odor was found in auditory passage. In children with CSOM TT, conductive hearing loss was diagnosed in 64 (87.6%) patients, mixed form of hearing

loss – in 9 (12.4%) ones. Mixed form of hearing loss at CSOM AET was diagnosed in all patients of this group. Several CT-signs of middle ear cholesteatoma: sclerotic changes of mastoid process, soft tissue substrate in the attic, destructive changes of auditory ossicles (especially in the long limb and body of incus), dilated aditus, localized carious changes of the walls of middle ear cavities – were diagnosed in all patients with CSOM AET, and in 9 patients with CSOM TT. All diagnoses of cholesteatoma were confirmed with intraoperative findings. The asymmetry of auditory analyzer lesion in 80 children was due to a chronic unilateral process of middle ear.

**Conclusion:** Sensorineural signs in children with chronic suppurative otitis media on anterior epitympanic type were registered in 100% of cases, in children with chronic suppurative otitis media on tubotympanic type – in 12.4%, it may indirectly indicate the presence of a cholesteatoma.

ID: 03798 - P042

### Assessment of hearing in newborns and infants with congenital cytomegalovirus disease

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**Keywords:** Newborns, infants, cytomegalovirus disease, hearing impairment

**Background:** Studying the role of congenital cytomegalovirus disease (CCD) in the etiology of sensorineural hearing loss in newborns and infants.

**Material and methods:** A total of 100 children with CCD were examined at the age of 28 days: medical history, examination, CBC and common urine analysis, biochemical blood test, immunofluorescence blood test for opportunistic infections, blood and salve PCR for herpesvirus infections. After CCD confirmation, a hearing test was conducted: otoacoustic emission of DP-type (OAE), impedancemetry, for medical reasons – short-latency auditory evoked potentials (SLAEP) registration, objective computer audiometry (ASSR-test). Hearing test was repeated at the age of 3 and 6 months.

**Results:** Patients were divided into three groups: group 1 (75 children) with positive OAE test, group 2 (15 children) with negative OAE test, group 3 (10 children) with equivocal test results. Hearing examination at the age of 3 months: all patients in group 1 had positive OAE test, showed impedancemetry results corresponding to “A” type and bilateral reflexes; 8 patients in group 2 had positive OAE test, 7 – negative one, impedancemetry results of “A” type – 10, of type “B” – 5; 7 children in group 3 had positive OAE test, tympanogram of “A” type, 3 children

had negative OAE test and tympanogram of type “B”. At the age of 6 months: children in group 1 showed no otorhinolaryngologic pathology. 3 patients in group 2 and 2 patients in group 3 had negative OAE test, tympanogram of type “B”, were diagnosed with bilateral exudative otitis media with characteristic otoscopic evidence; course of conservative treatment was recommended. After 1 month – age-dependent normalization of clinical and audiological parameters. 4 patients in group 2, and 1 patient in group 3 had negative OAE test and tympanogram of “A” type. Patients (5) were examined using SLAEP registration and ASSR-test: 3 children were diagnosed with bilateral sensorineural hearing loss of grade 1, 2 patients – with that of grade 2.

**Conclusion:** Newborns and infants with CCD are diagnosed with bilateral sensorineural hearing loss of grades 1-2 in 5% of cases. For all children with CCD a hearing test is indicated, with further follow-up by pediatrician and surdologist.

ID: 03805 - P066

### A first exploration of the treatment options for people with an acquired brain injury with complaints of hyperacusis

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**Keywords:** hyperacusis, acquired brain injury

**Background:** In literature there can be found a lot of interesting information about acquired brain injuries and hyperacusis. However, when combining both terms the search results are limited. Insights on acquired brain injury are growing each day. Hyperacusis, on the other hand, stays more under the surface. Libra Revalidation & Audiology observed a growing number of patients with an acquired brain injury that also developed a hypersensitivity of sound. Colleagues of the revalidation branch asked their fellow employees of audiology whether there is a specific treatment protocol for these patients?

**Materials and methods:** Due to the lack of evidence in literature, a case report was chosen as the method for this research. Two case reports of patients of Libra Revalidation & Audiology were studied retrospectively by looking into the case files and through discussion with the practitioners.

**Results:** A brief summary of the multidisciplinary treatment patients received at Libra Revalidation & Audiology, is given. This treatment based on cognitive behavioral therapy and desensitizing exercises, is considered ‘good practice’.

**Conclusion:** Some insights are given to work out a standard protocol to further optimize the treatment of this target group.

ID: 03817 - P043

**Congenital syndrome of Zika virus and auditory evaluation – case study****Milaine Sanfins***Instituto de Pesquisa Professor Joaquim Amorim Neto (IPESQ) – Campina Grande, Brazil  
Centro de Eletrofisiologia e Neuroaudiologia Avançada, São Paulo, Brazil***Keywords:** zika virus, electrophysiology, hearing, FFR, ABR.**Background:** The consequences of Congenital Syndrome of Zika Virus is associated with morphological changes of the central nervous system, intracranial calcifications, craniofacial dysmorphism, mild to moderate symptoms including exanthemas, ophthalmological, auditory and osteomalacia alterations, headaches, fever, arthralgia, myalgia, and an increasing number of neurologic disorders, speech and swallowing difficulties, sensorineural hearing loss, and behavioral disorders, characterizing symptoms of Congenital Disease of Zika Virus. However, few studies reported the auditory evaluation in children Congenital Syndrome of Zika Virus.**Case report:** A 23 months infant with positive serology for zika and rubella after birth. The baby was born at 32 weeks of age, weight of 1855 grams, cranial perimeter of 26 cm, apgar: 1<sup>\</sup>: 8 and 5<sup>\</sup>: 9. In addition, he remained in the intensive care unit for 5 days due neonatal seizures, required oxygen therapy, had early sepsis < 48 hours. Neuropsychomotor development showing absence of cervical control, delay of language development (no babbling). Currently, it presents convulsion, stiffness and spasms. Click ABR with presence of only the V wave with absolute latency values within the limits of normality in the intensity of 80dB in the right ear and absence of responses in the intensity of 80dB in the left ear.**Conclusion:** Congenital Syndrome of Zika Virus demonstrated that it was observed negative effects on functioning of the auditory pathways.**Conflicts of interest:** No exist

ID: 03839 - P044

**Hearing thresholds in small children with cleft palate****Birgitta Tengroth<sup>1,3</sup>, Anette Lohmander<sup>2</sup>, Christina Hederstierna<sup>1,3</sup>**<sup>1</sup> *Department of Audiology and Neurotology, Karolinska University Hospital, 171 76 Stockholm Sweden*<sup>2</sup> *Division of Speech and Language Pathology, Department of Clinical Science, Intervention and Technology Karolinska Institute, Stockholm, Sweden*<sup>3</sup> *Division of ENT, Department of Clinical Science, Intervention and Technology Karolinska Institute, Stockholm, Sweden***Keywords:** cleft palate, hearing impairment, otitis media with effusion**Background:** Hearing impairment may contribute to deviances in speech, language and learning abilities and other communicative disorders in children with oral clefts. Children with cleft palate (CP± L) frequently have otitis media with effusion (OME).

There is still a lack of knowledge of the nature of the hearing loss related to OME in children with and without CP± L. The overall aim of the project is to collect longitudinal information about hearing thresholds and complications due to OME in children with and without CP± L.

**Material and methods:** A prospective longitudinal study on how OME affects children with CP±L compared to children without cleft started in 2012 as the TUTH project (Early development of hearing, speech and language in infants born with cleft palate and infants with early problem with OME). Two groups of children were followed longitudinally from 1-3 months of age up to 3 years of age. Thirty-four children were enrolled in the study, sixteen with cleft palate and eighteen without. Assessments included otomicroscopy, tympanometry, OAE and hearing sensitivity and data were collected at nine different appointments. Each assessment was performed at each visit, unless there was non-compliance.**Results:** The hearing thresholds were analyzed and were classified as pass or fail according to ABR-thresholds or four frequencies pure tone average (PTA4). At 12 months of age we found that the children without cleft had poorer thresholds at 500 and 4000 Hz and a poorer PTA4.

The data presented includes information about which children had ventilation tubes in place in at least one ear. A strict longitudinal analysis was possible to evaluate in 25 children.

**Conclusion:** In this study the hearing thresholds are significantly better in the CP±L group at 12 months of age. This result probably implies a hearing benefit of ventilation tube placement at 6 months of age in this group. This benefit needs to be weighed against the risk for complications from the ventilation tube treatment.**Conflict of interest:** None.

ID: 03841 - P090

### Lithuanian speech audiometry test: the development of bisyllabic phonemically balanced word lists

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**Keywords,** speech, audiometry, bisyllabic word, Lithuanian.

**Background,** The word lists for speech audiometry tests in Lithuanian language were first developed several decades ago. Polysyllabic words from those lists were both used for SRT (speech recognition threshold) and for WRS (word recognition score), the lists consisted of an inadequate number of items (20 words per list) and the words didn't represent the phonetic balance of Lithuanian language. The aim of the study was to develop Lithuanian word lists for speech recognition, considering phonological structure of the standard Lithuanian language, word homogeneity and familiarity criteria.

**Material and methods,** The key criteria, chosen for constructing word lists, included the relation between vowel and consonant phonemes in the standard Lithuanian language, the frequency of specific vowel and consonant phonemes, the structure and frequency of syllable types, equal distribution of syllable stress, word frequency, word familiarity. The words, matching the criteria, were selected from the Frequency Dictionary of Modern Written Lithuanian. The chosen words were read out in a recording studio by a male professional speaker and were digitised at a sampling frequency of 44.1 kHz and 32-bit resolution. The assessment of Word Recognition Score for each 50 word list was performed at four hearing levels ranging from 15 dBHL to 45 dBHL in 10 dB increments to 68 individuals with normal hearing sensitivity. Data were statistically analysed with Excel and SPSS 22 (ANOVA)

**Results,** A total of 200 bisyllabic phonemically balanced words were selected and organised to 4 lists, with 50 words in each. The consonant (C) – vowel (V) ratio in a syllable was 55,66 % : 44,34 % and there were two dominant types of syllables: CV (60,3%) and CVC (23,87%) in developed set of words. The distribution of vowels, consonants and syllable type was similar among the lists. Monaural performance functions on 4 lists at 4 hearing levels showed no statistically significant difference in word recognition score among the lists.

**Conclusion,** The developed phonemically balanced word lists in standard Lithuanian language are equivalent, reliable and have been ascertained to be appropriate for speech recognition testing.

ID: 03850 - P045

### Translation and adaption of the scale The Parents' Evaluation of Aural/Oral Performance of Children (PEACH) into European Portuguese

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**Background:** The Parents' Evaluation of Aural / Oral Performance of Children (PEACH) scale is a tool used in re (h) auditory habilitation based on parents' observations that allows us to determine how the child is evolving with the use of auxiliary hearing aids. The present study aims to translate and adapt the PEACH scale for European Portuguese as well as to verify its internal consistency.

**Material and Methods:** In collaboration with the "Center for Studies and Research in Health of the University of Coimbra", a translation into European Portuguese and adaptation to the Portuguese population of PEACH was carried out. After this process, the translated and adapted scale (P-PEACH) was applied to 42 parents of children who used hearing aids. The internal consistency of P-PEACH was verified through Cronbach's Alpha.

**Results:** The P-PEACH scale has a very good internal consistency (Cronbach's alpha = 0.943).

**Conclusion,** P-PEACH has an internal consistency similar to that of the original scale (0.88). We can consider P-PEACH as a reliable instrument for monitoring the re(h)abilitation of children from the observation of their parents.

ID: 03851 - P091

### A comparison of ASSR and pure tone thresholds in infants with unilateral hearing loss

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**Keywords:** ASSR, audiometry, hearing thresholds, infants, unilateral hearing loss

**Background:** The gold standard in the neonatal hearing screening program consists of OAE and ABR. As a complement ASSR is often used to obtain information from a wider frequency range. The reliability in ASSR has been discussed in several studies and its clinical value has been debated. The aim with this study is to compare neonatal ASSR and pure tone thresholds when the child is old enough for behavioral testing.

**Material and methods:** The charts of all children with unilateral hearing loss tested via ASSR, in addition to routine ABR, in the neonatal hearing screening program,

were reviewed (2013-2017). Those who still showed unilateral hearing loss, without evidence of otitis media with effusion (OME), at 6-12 month of age when tested with pure tone audiometry were considered for this compilation of data. The ASSR thresholds were compared with the pure tone thresholds in each ear. The normal hearing ear served as a control for comparison with the ear with hearing loss in each individual child. The findings in 14 children are included in this presentation.

**Result:** Most of the normal hearing ear showed conformity between the results of ASSR and pure tone thresholds. In the ears with hearing loss a larger variation was seen. The findings will be presented in diagrams for each individual child.

**Conclusion:** ASSR adds important hearing information in the neonatal period, before it is possible to obtain reliable behavioral responses. The results must be evaluated with caution due to varying results, and further studies are needed to improve the accuracy of hearing threshold assessment in a wider frequency range.

**Conflicts of interest:** None

**ID: 03873 - P092**

### Clinical Ent and audiologic findings in neuroborreliosis

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**Keywords:** Lyme Neuroborreliosis; Facial Palsy; Reflex, acoustic; Recovery.

**Background:** Lyme borreliosis is a vector-borne infectious disease characterized by three disease stages. In the majority of cases, facial palsy is the only sign and symptom of neuroborreliosis as the second, disseminated stage of the disease. There are several predictors that suggest the potential etiology, therapy and prognosis of facial palsy. The aim of the study was to evaluate acoustic reflex and to investigate prodromes with prognostic significance in patients with Lyme borreliosis facial palsy.

**Materials and Methods:** The study included 176 patients with acute facial palsy divided into three groups based on serologic testing: borreliosis, Bell's palsy, and facial palsy caused by herpes simplex virus type 1 (HSV-1). Study patients underwent baseline audiometry with tympanometry and acoustic reflex. Subsequently, the same tests were obtained on three occasions, i.e. in week 3, 6 and 12 of presentation. At the same time, prodromes that preceded the facial palsy were examined, such as: loss of taste, ear pain on the affected side, headache, feeling of ear fullness on the affected side, increased tears, paresthesia and no prodromes.

**Results:** In each timepoint patients with diagnosis of Lyme disease had statistically significantly the biggest percentage

of suprapedial lesions, especially in the third week since hospitalization (mostly occurrence of paralysis as well) ( $p < 0,001$ ), as well as in measuring that occurred later, all the way to the end of study in the 12th week since paralytic occurrence ( $p = 0,001$ ). Only 47% of patients with borreliosis recovered in the 12th week comparing to Bell's paralysis and patients with HSV1. Patients with Lyme borreliosis presented with headaches more than the other two diagnoses. In third week headache had 31.4% with Lyme disease, 7.1% with Bell's palsy and 14.3% patients with HSV1 diagnosed. In the sixth week, the percentage of patients with headache decreased for all patients, but in borreliosis patients it was still 11.4% compared to 2.4% for Bell's palsy and 0% for HSV1. Other symptoms did not differ in patients with borreliosis compared to the other two diseases.

**Conclusion:** Acoustic reflex is a valuable predictor of Lyme neuroborreliosis facial nerve palsy. As well, dominant clinical feature patients with Lyme neuroborreliosis facial palsy is headache in comparison with HSV or Bell's palsy.

**ID: 03880 - P093**

### A unilateral speech perception deficit specific to cocktail party noise after a right temporal venous infarct. A case study

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**Key-words:** Voice Perception, Prosody, Pitch, Hearing in noise, Central Auditory Processing Disorders

**Background:** Speech perception deficits occurring almost exclusively in noise, in absence of peripheral hearing loss and in absence of deficits in speech perception measured in silence is relatively common in audiology. However, auditory perception in noise deficits, linked specifically to the type of noise used, are rare and allow to tap into the specific brain mechanisms subtending the different aspects of auditory perception. Here, we report the case of a normal-hearing 33-year-old woman, suffering from a right temporal venous infarct, who reported a very unusual impairment of emotional prosody perception: the voices of people talking to her were perceived as if people were sobbing.

**Material and methods:** On hospital admission, triggered by severe headaches, neurological examination revealed a left visual extinction. Brain MRI showed a right lateral sinus thrombosis associated with a right temporal hemorrhagic venous infarct involving the superior temporal

gyrus. A series of auditory perception tests were performed 5 (D5) and 17 days (D17) after hospital admission. The Speech Spatial and Qualities of hearing scale (SSQ) and a listening effort questionnaire were used. Speech perception in noise (-3 dB SNR) was tested using monosyllabic words in a four alternative forced choice paradigm, in cocktail party and speech noises. Emotional prosody perception was tested using sentences of neutral content, pronounced by actors expressing various emotional states.

**Results:** At D5, the SSQ score was at 7.5, with a clearly pathological speech subscale score (4.2 for a normal score above 8.4). At D17, the SSQ score rose at 9.4, with speech subscale scores at 8.6. Listening effort questionnaire showed a decrease in listening effort in noise from D5 to D17. Speech perception scores were normal for both ears in silence and speech-noise conditions. However, an obvious asymmetry was obtained in cocktail party noise, with only 45% correct responses for the left ear versus more than 85% for the right ear. At D17, this very specific unilateral speech perception in cocktail party deficit almost fully recovered. At D5, emotional prosody categorization was impaired, especially for joy, and recovered at D17.

**Conclusion:** This case confirms the role of specific cortical areas involved in voice perception processing within the superior temporal sulcus.

**ID: 03891 - P094**

### Prevalence of sensorineural hearing loss on screening in preschool children - a 10 year experience

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**Background:** Hearing impairment in children can compromise the development of language and communication skills, academic achievements, and the negative impact of even *minor alterations* is recognized. Since the implementation of Universal Newborn Hearing Screening, preschool hearing screening programmes would identify later onset or progressive hearing losses and conductive hearing loss. Early identification of hearing loss is very important to provide optimal hearing conditions in school children, minimizing the effects on the social, emotional and cognitive development of the individual, which are very important by the time the child starts primary school. Hearing loss can have a great impact on reading, writing, central auditory processing, and balance. According to Wake et al. (2006), the prevalence of slight sensorineural hearing loss is 1.5% when unilateral and 0.6% when bilateral. The present study aims to verify the prevalence of referring only on audiometry screening in pre-school screening (sensorineural hearing loss).

**Material and Methods:** This is an observational study utilising the results obtained in a ten year audiological and

otological screening of preschool children. Written Informed Consent was obtained from the parents prior to initiating the study. Otoscopy, Tympanometry and Audiometry (1, 2 and 4 KHz presented at 40 and 20 dB intensity) were performed at the first stage of the screening and the results were classified as “pass” or “refer”. Every non-normal result of any category would imply a second stage consisting of observation by an ENT specialist at the site and the establishing of a follow-up plan.

**Results:** 595 children aged 5 and 6 years were screened between 2007 and 2017, of whom 192 (32.3%) required referral to the second stage. 10 children had unilateral changes only on audiometry screening and 3 children had bilateral changes only on audiometry screening. The most frequent alteration was found in the tympanogram.

**Conclusion:** The prevalence of sensorineural hearing loss is 2.2%, with 1.7% unilateral and 0.5% bilateral. The prevalence of sensorineural hearing loss was similar to the reported in others studies. It's extremely important to perform a hearing screening in the age range of 5-6 years, with the main objective of identifying and referring for treatment/rehabilitation children who present alterations in order to reduce the consequences of the hearing impairment.

**ID: 03909 - P095**

### Contextual effects of auditory information on the localization of visual moving stimuli

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**Keywords:** representational momentum; audiovisual integration; Bayesian multisensory integration.

**Background:** Representational momentum (RM) is the name given to a forward localization error that occurs when observers indicate the last seen position of a suddenly vanished moving object. RM has also been documented with auditory objects. This work investigates how adding different types of synchronized auditory information to a moving visual object affects RM, and whether such effects can be accounted by a Bayesian framework of multisensory integration.

**Material and methods:** A light gray square (1 cm<sup>2</sup>) moving horizontally on a computer screen at a constant speed suddenly vanished. Observers (at a distance of ≈ 85 cm, head fixed) had to locate the square's last seen position using a wireless mouse. Two speeds and three vanishing points were considered (further vanishing points were included for ensuring position uncertainty). Synchronously with the square motion three types of sounds (pure, band-passed noise, and material sounds) were presented in different blocks via headphones at a constant intensity of 60 dB (A). Each type of sound was varied in two levels (respectively: two frequencies; two nonoverlapping bandwidths; low and high suggested friction). Across blocks, sounds

were either spatialized, so as to move congruently with the visual square, or nonspatialized. To provide for unimodal baselines of the localization error, trials with only a moving square or a moving sound were also presented.

**Results:** The difference between levels of each type of sound had virtually no effects on audiovisual (AV) presentations. However, adding sound strongly reduced the error of localization of the vanished square, more so in the spatialized material sounds condition. An RM reduction was also observed for isolated visual presentations interspersed in the AV block with spatialized material sounds, reflecting an improved calibration of the response induced by this particular AV context.

**Conclusion:** Bayesian optimal AV integration is incapable of predicting the observed patterns. The whole of the evidence found is suggested to be consistent with an attentional interpretation whereby: (1) the emergence of an AV object enhances attention to the vanishing point; (2) congruent spatialization of synchronous sounds and event-compatible material sounds ease up the emergence of a dynamic AV object.

**Conflicts of interest:** There are no conflicts of interest to report.

**ID: 03911 - P046**

### Effect of bilirubin level on auditory brainstem responses in newborns: a case study

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**Keywords:** Bilirubin level, Auditory Brainstem Responses, Newborn hearing

#### Background:

Hyperbilirubinemia is one of the most common clinical manifestations that usually requires medical care and attention in newborn infants with no other health problems and risk factors. The term Jaundice refers to the yellow appearance of the skin and sclera as a result of accumulation of bilirubin in the skin and mucous membranes; this causes the elevation of bilirubin in the body (Hyperbilirubinemia). Total bilirubin level is only 5 mg / dl when the jaundice is seen. It is known that at least two-thirds of the newborns are clinically yellowed during the first week of life. Although it is usually a benign, transient phenomenon, and most of the time the total bilirubin concentration remains at a level that is not a source of danger to the baby, it can reach levels that are potentially irreversible to serious brain damage in a small portion of newborns.

**Material and Methods:** 13 mg / dl bilirubin was found in the patient who was born in Gazi University Health Application and Research Center. In the TEOAE test, the right ear remained and the left ear passed. Then, diagnostic ABR, (click stimulus. 21.1 Rate rarefaction polarities) test was applied to patient. At different times, auditory brain

response thresholds was determined at different levels of bilirubin were measured. The ABR test and measurement of bilirubin level were carried out on the same day.

**Results:** When Bilirubin level was 13 mg / dl, bilateral V wave was not observed. When Bilirubin level was 9.12 mg / dl after 1 month, V. wave observed at 20 dBnHL at the left ear and 40 dBnHL at the right ear. After 1 month, when bilirubin level was 1.7 mg / dl, V. wave observed at the left ear 20 dBnHL and at the right ear 35 dB nHL.

**Conclusion:** In this case study, the effect of the change in the amount of bilirubin in the blood on the auditory brain responses was investigated by breastfeeding. A strong association between the risk of hyperbilirubinemia and the feeding of the baby by breast only milk is indicated. Therefore, the main primary prevention initiative is to ensure adequate and successful breastfeeding. The benefits of breast milk are well known and mothers should be encouraged to breastfeed their babies.

**ID: 03918 - P089**

### Influence of design principles of word lists on speech in noise discrimination scores in a population of hearing-aid wearers

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**Keywords:** Contextual influence; speech discrimination scores; word lists;

**Background:** The aim of this study was to compare standard word lists currently used in audiology in France, lists that were designed in the fifties (called old lists: OL), with a new linguistic material, built to minimize top-down influences on single word perception (called new lists: NL) and whose design principles are described in a companion paper.

**Material and methods:** Speech discrimination in cocktail party noise (SNR=0 dB) was tested in 71 hearing-impaired patients, aged 72 (SD=5.0), with an average hearing loss of 42 dB HL (SD=8.0) on their better ear, using 2 ten-word lists, for both the old (OL) and the new word lists (NL). The choice of the lists was randomized between patients and conditions. The scores have been obtained for whole words, syllables and phonemes and converted into raw scores and the j factor (defined by  $\log(\text{phonemic score})/\log(\text{whole word score})$ , representing an index of contextual influence, was calculated. The population was split in two groups differing by their hearing loss, to test the discrimination power of the word lists, using Cohen's d statistic.

**Results:** The NL scores (29.3 rau, SD= 16.4) were significantly lower than the OL (44.2, SD=21) and showed significantly less contextual influence ( $j=1.21$ ,  $SD=0.2$ ) than the OL ( $j=1.1$ ,  $SD=0.1$ ). Correlations between the average hearing loss on the better ear were  $-0.58$  with the NL phonemic scores and  $-0.49$  for the OL phonemic scores. Both NL and OL phonemic scores correlated significantly ( $r=0.62$ ). Cohen's  $d$  statistics were  $0.57$  for the OL and  $0.96$  for the NL.

**Conclusion:** The NL showed significantly lower scores than the OL, which was expected as they were designed to be reliant on the perception of all individual phonemes in a word. In agreement with their design, the NL showed as well a significantly lower contextual influence and a better discrimination power than the OL. Designing new word lists according to the principles that take into account psycholinguistics, acoustics and psychometric factors (described in the companion communication), might help to increase discrimination power of speech perception scores and decrease unwanted variability due to contextual influences.

**ID: 03949 - P047**

### Quality of life of schoolchildren who use hearing aids

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**Keywords:** quality of life, hearing loss, hearing aids

**Introduction:** Hearing loss can impact the subjects' quality of life. Understanding each person's perception of their goals, expectations and concerns becomes important as each disability involves varying levels of limitations and restrictions in social participation. Thus, the objective of this study was to analyze the perception of the quality of life of schoolchildren using hearing aids and to correlate with audiological and school characteristics.

**Material and method:** The study design was of cross-sectional, quantitative and descriptive type. The sample consisted of 25 schoolchildren, aged between eight and 18 years, diagnosed with mild to profound sensorineural bilateral hearing loss, users of hearing aids granted by the Unified Health System (UHS) and linked to a public school clinic in Brazil. The study was developed between March and December 2017 and the data collection was carried out in two ways: (i) interview with family members with questions related to the type of school, use of the Frequency Modulated (FM) system, daily use time of the hearing aids, being considered effective eight hours or more and (ii) application of the Pediatric Quality of Life Inventory (PedsQL) version 4.0, Portuguese - Brazil questionnaire. The results were submitted to statistical analysis using the Mann-Whitney U-Test and a comparison was made between the scores obtained from the PedsQL categories and the variables: progressive or non-progressive hearing loss; effectiveness of use

of hearing aids; use of the FM system and the type of school they attend (regular or special).

**Results:** The quality of life scores of subjects with non-progressive hearing loss were significantly higher when compared to progressive hearing loss for the psychosocial aspect ( $p = 0.0342$ ) and the total score ( $p = 0.0492$ ). The use of the FM system and the effective use of hearing aids, demonstrated a greater tendency in the influence of quality of life mainly in the social aspect, however, the results were not statistically proved. The type of school, from the statistical point of view, had no influence on the perception of quality of life.

**Conclusion:** The non-progressive hearing loss variable was positively correlated in the quality of life of the sample subjects. There was no direct relationship in the quality of life of schoolchildren regarding the profile of the use of hearing aids, the FM system and the type of school.

**ID: 04026 - P048**

### DANPE - Progressive sensorineural hearing loss in children: results from a project of international cooperation

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**Keywords:** Hearing Loss; Child; Mass Screening; International Cooperation

**Background:** Projects of research cooperation contribute to the advancement of science and technology and the implementation of actions ranging from hearing loss prevention to diagnosis and intervention, based on the experiences of different countries. Therefore, the collaboration between University Clermont-Auvergne, France and Federal University of Minas Gerais, Brazil, has developed studies on this issue. The main objective was to investigate the manifestation of progressive sensorineural hearing loss in children and to develop tools for hearing monitoring and diagnosis.

**Material and methods:** This project was developed from 2015 to 2018. Two prospective studies were implemented: a) follow-up of children with high risk for deafness from a hearing screening program in a hospital in Belo Horizonte, Brazil; b) hearing screening of children aged 12 to 48 months, enrolled in day care centers. Both projects followed the necessary research ethical criteria.

**Results:** a) the screened population was 194 high-risk infants. The most frequent risk indicator was prolonged (> 5 days) neonatal intensive care unit stay (87.6%) followed by prolonged mechanical ventilation (38.1%). Sensorineural hearing loss was disclosed in 3% of these infants. b) specific questionnaires were developed in Portuguese for the hearing screening of children from 12 to 48 months, validated by Delphi method. The questionnaires contain binary questions (yes/no) about hearing and language child development in the following ages: 12 to 18 months, 19 to 36 months and 37 to 48 months. To validate this instruments, 201 children, aged 12 to 48 months, enrolled in day care centers in Belo Horizonte, were evaluated by the questionnaires and by the gold standard tests (auditory brain response, immittance measures and otoacoustic emissions). The questionnaires presented sensitivity of 100.00% and specificity of 73.15% to screen bilateral sensorineural hearing loss.

**Conclusion:** The international collaboration allowed the articulation of teaching and research actions to expand hearing screening in Brazil. The most outstanding advances were in postnatal hearing health, which has call attention of the international hearing loss committees by the high level of undiagnosed cases

**ID: 04062 - P096**

### **Aging: cognitive decline and hearing loss**

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**Keywords:** Hearing Loss; Aging; Cognitive Decline, Dementia.

**Background:** In the aging process the physical and psychological capacities may be diminished, such as the cognitive and emotional skills. Aging of the peripheral and central auditory system interacts with changes in cognition, determining the deprivation of information and communication sources and maximizing the changes of organic decline. Cognition can be damaged by these changes in the auditory system as increased auditory processing tasks deplete the already limited set of cognitive resources. The purpose of this study was verifying the influence of hearing loss in cognition in older people.

**Material and Methods:** For the present research, 37 participants, aged 60 years and over, who attend a day care center were enrolled, divided into two groups according to the presence or not of hearing loss (the experimental group composed of 16 individuals with hearing loss and control group composed of 12 individuals without hearing loss). Data collection includes the application of the following instruments: sociodemographic questionnaire, Mini-Mental State Examination (MMSE) and Clock Test. Hearing was determined with pure-tone audiometry and classified by the Bureau Internationale d'Audiophonologie.

**Results:** Moderate hearing loss was the degree with major representation (50%) in the experimental group. The results showed the influence in cognition by hearing loss when we use the MMSE ( $p=0,035$ ), verifying that the control group have better cognition than the experimental group. Similar results were founded comparing the control group and the experimental group when used the Clock Test ( $p=0,001$ ).

**Conclusion:** The results indicated that hearing plays an important role in cognition, with hearing loss promoting cognitive decline. Changes in brain activity over prolonged periods may induce permanent changes in neuroplasticity, so it is considered that the recovery of sensory functions can trigger a significant improvement in their cognitive status, reducing the incidence of dementia. In the case of hearing, recovery increases the cognitive reserve for the recognition and understanding of the spoken word. Restoring sensory function in cognitively impaired adults might enable a significant improvement in their cognitive status, reducing the worldwide incidence and prevalence of dementia.

### **Poster Discussion 03**

**ID: 03808 - P017**

### **Electrode impedance values and postoperative performances in children with cochlear implants**

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**Key words.** electrode impedance, cochlear implant, children, postoperative performance

**Background.** The aim of the study was to analyze electrode impedance values in children with Med-El cochlear implants during the first 12 months post-activation, and to determine if patients with different implant types, with different age at the time of implantation and different postoperative performances have significantly different electrode impedance

**Material and methods.** The retrospective study was carried out collecting data of 43 implanted children (2-12 years old) in ENT Clinic Tuzla, Bosnia and Herzegovina, operated from January 1<sup>st</sup> 2001 to December 31<sup>st</sup> 2016. For each patient impedance values were measured at several time points (up to 12 month after activation). Their values were analyzed and compared with type of CI implant, age of implantation and postoperative performance of CI users. Postoperative performance of CI users (success of rehabilitation) was analyzed using EARS evaluation protocol developed by Med-El.

**Results.** Average impedance values were highest at 4 months after activation (7.96k $\Omega$ ), and after that slowly

decreased to 6.86k $\Omega$  (12 months after activation). The results presented showed that the absolute values of the basal impedance (7.60k $\Omega$ ) are higher than at the apical (7.36k $\Omega$ ) and middle segment (6.19k $\Omega$ ) of cochlea. Our segregated data over time showed a slight decrease, although not significant, in basal (8.04k $\Omega$ -7.13k $\Omega$ ) and middle impedance (6.99k $\Omega$ -5.92k $\Omega$ ) over time and a slight increase for the apical segment (6.95k $\Omega$ -7.53k $\Omega$ ). Rehabilitation of children with cochlear implant was successful in 27 children (60%), and unsuccessful in 18 children (40%). Statistically higher average impedance values was found in children with success in rehabilitation (6.22k $\Omega$ ) in comparison with children with unsuccessful in rehabilitation (7.82k $\Omega$ ) (Independent T-Test: p=0.0001). There was also a statistically significant difference in impedance values in different cochlear implant types (Combi 40+: 6.23k $\Omega$ , Pulsar: 7.11k $\Omega$ , Sonata: 7.54k $\Omega$ ) and values of impedance (One-Way Anova Test: p-value 0.00164). Age of implantation was not found to be a statistically significant connected to average impedance values (younger than 5 years: 7.58k $\Omega$  or older than 5 years: 7.15k $\Omega$ )- Independent T-Test: p-value: 0.88.

**Conclusion.** Electrode impedance values decrease fourth month post-activation of implant. There was a difference of impedance values between basal, middle and apical segments of cochlea. Success of postoperative rehabilitation was statistically connected with type of implant and with values of electrode impedance, but not with patient age at the implantation.

**ID: 03837 - P018**

### Treatment of deafness with the use of cochlear implants in children with severe heart defects after cardiac surgery

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**Keywords:** cochlear implants, cardiac surgery, severe heart defects

**Background:** Children with severe heart defect are often after multiple surgeries and are exposed to stays in ICU department - that is way their hearing loss is often a secondary issue. Cardiovascular defect occur in about 1% of the newborns and stands as the second most frequent cause of perinatal deaths. In the group of children with congenital deafness, 30 % of them have additional defects, such as craniofacial defects, neurological disorders, defects of cardiovascular system and renal system defects.

**Material and Methods:** In our database there are 8 children (age: 2,5-5,5) with congenital heart defect after cardiac surgery, including 2 cases of hypoplastic left heart syndrome (HLHS) with coarctation and hypoplasia of the aortic arch, 1 case of complete atrioventricular canal (AV canal) with a pacemaker, 2 cases of transposition of the great arteries (TGA) and 3 cases of ventricular septal

defect (VSD). All of them were implanted with Cochlear CI512. Late implantation was a result of a necessity to perform life-saving cardiac surgeries. The children are still under observation of audiologists and speech therapists.

**Results:** Assessment of the four-frequency average of indicative free field audiometry shows that there is an increase of hearing ability within a given time period: without sound processors (SP) the threshold of hearing had been 100 dB, with SP (one month after surgery) it was 68 dB, 3 months after first fitting it was brought down to 49 dB and 6 month after first fitting it was 35 dB. After the cochlear implantation, speech development of implanted children was faster.

**Conclusion:** Pre-operation planning reduces the risk during cochlear implantation. The most important factor is early and properly identification of cardiac problems of potential patients for cochlear implantation. Pre-op procedures, including cardiac, anaesthetic and surgical procedures with detailed diagnostic imaging (MRI, CT) are essential to avoid potential anatomic problems in this group of patient. The cochlear implantation is safe for children with heart defect, if they are early diagnosed and treated. Speech and language therapy of the children after cardiac surgery is the same as of normal heart children. Children with heart defects should not have a limited access to the world of sounds.

**ID: 03871 - P019**

### The absence of intraoperative neural response during cochlear implantation: doubtful cases

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**Keywords:** Cochlear implantation, Electrophysiological tests, Evoked compound action potential, Intraoperative monitoring

**Background:** Intraoperatively, evoked compound action potentials (ECAP) can assess the response of a patient's auditory system to electrical stimulation immediately after intracochlear insertion.

**Material and methods:** We present three cochlear implantation cases in which intraoperative ECAP was abnormal, followed by a discussion on the implications of the results of this test based on a current literature review.

**Results:** In cases 1 and 2, ECAPs were absent in electrodes 11-22 (basal) and 1-13 (apical), respectively. In case 3, ECAPs were absent in all electrodes. EI was normal in all cases. Plain radiographs (PR) confirmed the correct electrode positioning. In all cases, postoperative psychoacoustic tests showed behavioral responses to all electrodes. Images documenting EIs, ECAPs and PRs are presented.

**Conclusion:** Intraoperative monitoring using the ECAP has innumerable advantages, mainly regarding electrode positioning, overall device functionality, auditory nerve stimulation and hearing benefit. With respect to electrode position, measurable ECAP responses have been demonstrated in various case reports in which the CI electrode was extracochlear or had an intracochlear tip rollover. Additionally, a lack of measurable ECAP does not necessarily indicate a lack of auditory response to electrical stimulation or a dysfunctional device. Postoperatively, these intraoperative threshold ECAP values have not been shown to correlate with speech performance at one year. However, they have demonstrated significant value in postoperative programming, serving as a basis for initial mapping, due to a modest correlation between ECAP values and behaviorally obtained threshold (T-) and comfort (C-) levels. Currently, there are no guidelines regarding intraoperative monitoring during cochlear implantation. Cosetti *et al.* (2012) and Khater *et al.* (2015) state that only the results of an intraoperative modified Stenver's view plain radiography (PR) should impact surgical decision making, even when ECAPs are absent. Anne *et al.* (2017) suggest that intraoperative PRs are only useful if ECAPs are abnormal, asserting no additional benefit in a routinely use. Despite these inconsistencies, a normal ECAP and impedance measurements can be reassuring, while abnormal results are more difficult to interpret and may require PR.

**ID: 03904 - P020**

### Assessment of music perception abilities for pediatric cochlear implant users and normal hearing children

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**Keywords:** Cochlear implants, music perception, children.

**Object:** Our objectives were to evaluate music perception abilities in pediatric cochlear implant (CI) users and to compare performance of CI users with that of normal hearing (NH) control group.

**Methods:** We aimed to ascertain ability to discriminate different music components such as rhythm, timbre, pitch, melody, and harmony, and to assess differences with NH children. We estimated the relationship between music perception abilities and etiologic profile of deafness, speech recognition and language use skills. There were investigated 55 prelingually deafened children using unilateral or bilateral CI and NH control group of 60 children matched to the CI users regarding sex and age. The selection criteria for the CI group included more than 5 years old, at least 3 years of CI experience and absence of development disabilities or attention deficit disorders.

**Results:** Children using CI and NH participants performed significantly differently on (CI users' vs NH control): pitch

discrimination (60.2% vs 76.9%), timbre identification (65.1% vs 90.2%), rhythm perception (62.5% vs 95.5%), and melody change recognition (42.4% vs 80.5%). No significant difference in performance was seen comparing GJB2 carriers, congenital CMV and other perinatal factors. There was found positive relationship between perfect speech and language development, tested by speech audiometry and surdopedagogic tests, and excellent music perception performance in children after CI.

**Conclusions:** Comparing to NH participants all CI subjects vary widely in their ability to recognize timbre, and identify pitch and melody changes. Results suggest that pediatric CI users can make use of temporal and spectral cues to discriminate between musical stimuli, but not to the extent of their NH peers.

**ID: 03914 - P021**

### Electrode impedance changes in cochlear implant users

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**Keywords:** electrode impedance, cochlear implant,

**Background:** Electrode impedance measurements are routinely performed during the cochlear implantation and at follow up visits. These measurements make possible to check, whether all electrodes work correctly, and are useful in the monitoring of implant's functioning during rehabilitation. The analysis of the electrodes impedance's changes makes possible to estimate, what processes happen in tissues and liquids of the inner ear around the electrode.

**Material and Methods:** Measurements of the impedance was performed on each electrode inserted into the cochlea. Impedance measurements were investigated in 42 adult patients implanted at the Department of Otolaryngology and Laryngological Oncology. The impedance of electrodes in cochlear implants users was measured during cochlear implantation, during the first fitting of the speech processor and during following fitting session of the speech processor.

**Results:** During activation of the speech processor we have observed increased values of the impedances, higher than intraoperative measurements. On the second fitting impedances decreased and then were stable at this level during one year follow-up.

**Conclusion:** Increased values of electrode impedance during first fitting of the speech processor support the hypothesis that a layer of fibrous tissue forms around the electrode because of the inflammatory changes or due to exudation of protein. Such changes could be observed after cochlear implantation. Impedance values decrease after first fitting and remain stable. This may suggest that electrical stimulation prevents from adverse changes in the cochlea.

ID: 03916 - P022

## Benefits after cochlear implantation – results from an observational study

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**Keywords:** cochlear implant, quality of life, subjective assessment

**Background:** The reported data show wide disparity in clinical experience, practices and the subsequent outcomes of the cochlear implant recipients. Real clinical usefulness of that intervention in a real world environment in different groups of patients require further investigation. The objective of this work is to obtain the patient - related data for implanted patients including true baseline interval data gathered prior to implantation or at first activation of the device and subsequent longitudinal follow-up at annual intervals.

**Material and Methods:** Each patient is evaluated at baseline to obtain baseline responses related to their hearing experiences and perception of quality of life in their pre-implant hearing condition. Evaluation tools include standardized subjective self-assessment scales: the SSQ (Speech Spatial Qualities questionnaire) and HUI Mark III (Health Utility Index) and a non-standard general patient profile forms in two versions: for clinician and for the patient. Each patient is to be followed up through routine clinical procedures and in parallel asked to complete the post-implant versions of the questionnaires at annual follow-up appointment.

**Results:** Twelve patients who received a cochlear implant in the Department of Otolaryngology of the Medical University in Lublin were included in the study. There were 7 female and 5 males. The average age was 60,8 years. Demographic and epidemiological data were gathered and will be presented. Results obtained through standard clinical questionnaires: the SSQ and HUI Mark III as well as from the nonstandard general questionnaires were analysed.

**Conclusion:** Cochlear implantation increases the ability and quality of speech understanding and spatial hearing already after 1 year of the implant device usage in a subjective assessment of implanted patients.

ID: 03922 - P023

## Patients life quality after cochlear implantation

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**Keywords,** cochlear implant, rehabilitation results, adults with cochlear implants Background, Cochlear implantation

(CI) is a standard treatment method in case of severe to profound hearing loss in adults. Our goal was to find, how the implantation influenced the life of our patients.

**Material and methods,** We have 73 adult patients with CI (Cochlear Ltd.) in our database. Each patient was implanted with one of the following implants: CI24R (CA), CI24R (ST), CI24RE (CA), CI24M, CI512 or CI522. We sent to all the patients from our database a questionnaire prepared by ourselves, to assess their activity and quality of life after the surgery. The questionnaire contains questions concerning e.g.: demographic data, professional activity, social contacts, rehabilitation aspects and self-perception. The questionnaire was divided into two parts: the first one containing closed-ended questions, and the second one containing open-ended question, in which patients were asked about their personal feelings, opinions and changes in their life after cochlear implantation.

**Results,** General information: Among 73 questionnaires, we have received back 21 – 15 females and 6 males patients responded. The average age was 60.5 (min 27, max 81). Patients are CI users from average 6,1 years (min 1.5 month, max 15 years). 65% of patients use their sound processor more than 12 hours per day. 23% of patients use Nucleus Freedom processor, 11% use Nucleus 5, 55% of patients are the users of Nucleus 6 processor and 11% use Nucleus 7. Among all patients who responded to our questionnaire, only 10% use any of accessories (5% are the users of MiniMic, and 5% use PhoneClip). Patients activities: Results show the differences between patients' activities before and after cochlear implantation. 71% of patients emphasized, that the contact with their family members is better after cochlear implantation in comparison to the situation before the surgery. 76% of recipients declare that after cochlear implantation they have better speech understanding and better contact with other people. 72% of implanted patients indicates that their self-confidence is higher after receiving the implant.

**Conclusion,** Cochlear implantation helps patients to increase their life quality and is strongly recommended by recipients as a good solution in case of profound hearing loss or deafness.

**Conflict of interest:** no.

ID: 03971 - P024

## Effects of the cochlear implantation on saccule and utricle function

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**Keywords:** Cochlear implant, vestibular evoked myogenic potential, vestibular function

**Background:** Cochlear implants (CI) allows the recovery of hearing function in patients with hearing loss. The surgical insertion of CI electrodes into the cochlea can potentially damage the vestibular function because of the proximity of the vestibular organs to the cochlea. Many studies conclude that this surgery can cause direct trauma to the saccule, perilymph loss, a foreign body reaction with labyrinthitis or obstruction of the ductus reuniens. The present study aims to investigate the impact of unilateral cochlear implantation on otolithic organs.

**Material and methods:** This prospective study included twenty-eight adult patients (15 women, thirteen men) who underwent unilateral cochlear implantation surgery. The mean age was  $43.1 \pm 14.9$  years, and the majority had an aetiology of acquired ( $n=20$ ) and progressive ( $n=19$ ). Vestibular-evoked myogenic potential (VEMP) test and subjective visual vertical (SVV) test using a bucket, were performed before surgery and repeated four weeks after surgery in the CI.

**Results:** Before surgery, cervical VEMP (cVEMP) response was present in 15 (53.5%) for the surgical side (SS) and 16 (57.1%) non-operated side (NOS), the ocular VEMP (oVEMP) response was present in 11 (39.3%) for the SS and 12 (42.8%) for the NOS. The SVV average was  $0.91 \pm 1.36$ . After surgery, both cVEMP and oVEMP responses exhibited significant deterioration relative to the pre-operative results (cVEMP 3 (10.7%) SS and 15 (53.6%) NOS; oVEMP 2 (7.1%) SS and 8 (28.5%) NOS. The SVV average was  $1.91 \pm 1.44$ . There was significant difference for cVEMP and oVEMP ( $p=0.000$ ;  $p=0.004$ ), only the SS and the SVV ( $p=0.001$ ).

**Conclusion:** Patients with unilateral cochlear implant showed a lower function of saccular and utricular receptor after surgery, especially on the side of the surgical intervention. Despite this saccular and utricular injury, the absence of clinical signs in the majority of the patients (78.6%) can be explained by their adaptation that aims to compensate such vestibular deficit.

**ID: 04014 - P026**

## Coffee effects on the auditory system

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**Keywords:** coffee; auditory processing; frequency pattern test; dichotic digits test

**Background:** Coffee is a psychoactive drink whose consumption has been increasing exponentially over the last decades. The stimulating substance in coffee, the caffeine, also found in tea, chocolate and soft drinks, it is known to affect the central nervous system and ending up having an impact at various levels of human behaviour. After ingestion, the caffeine blocks adenosine receptors and neurotransmitters like norepinephrine and glutamate are increased having an effect on the central nervous system. This study goal was to evaluate the central

auditory processing and search if there are differences in temporal processing and dichotic listening between subjects that consume coffee daily and a group that doesn't consume coffee.

**Material and methods:** On this study took part 20 subjects of both genders aged between 19 and 23 years. The subjects were divided in two groups: 9 integrated the group that consume two or more coffees on their daily routines and 11 were part of the control group that doesn't consume coffee daily. Smokers were excluded from the study as well as subjects with a hearing pathology and/or neurologic history. The sample was submitted to anamnesis, otoscopy, pure tone audiometry by air conduction and two auditory processing tests (frequency pattern test and dichotic digits test).

**Results:** In this study no statically significant differences were found on the results of the frequency pattern test and dichotic digits test between the two groups. However, it was revealed a difference on the performance of the two tests among both groups, verifying that the group who drink coffee daily has a higher percentage average of correct answers on both tests.

**Conclusion:** There are not many studies that report the possible affects that caffeine might cause on the auditory processing, nevertheless, some believed that the neurotransmitter glutamate is related with the effect of the caffeine on the auditory system. Given the many factors that can affect the auditory information processing and the slight differences found we consider that the scientific community should continue to explore the many variables that might affect the auditory processing performance, as the caffeine effect.

**Conflicts of interest:** None to declare.

**ID: 04136 - P029**

## Application of new virtual reality tools in rehabilitation of balance instability and vestibular dysfunction

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**Background:** virtual reality (VR) is already used in a variety of medical conditions, ranging from post-stroke disabilities to orthopedic rehabilitation or improvement of cognitive abilities. VR techniques have been successfully applied in vertigo and balance disorders using both medical and commercial systems. The aim of this study is to assess the effectiveness of Virtual Reality (VR) training in rehabilitation of patients suffering from vertigo, dizziness and balance instability.

**Materials and methods:** Prospective study including 50 patients with vestibular system dysfunction diagnosed in the Balance Disorders Unit, Otolaryngology Department of the Medical University of Lodz. Patients' history of diseases, otoneurological examination and videnystagmography (VNG) tests were conducted. Rehabilitation results in two patient groups (Group 1, n =25 ) with peripheral vestibular impairments vs (Group 2 n=25) with central vestibular dysfunction were compared. We used a hybrid VR unit (Neuroforma 2016 manuf. Titanis, Poland). All subjects underwent 10 sessions over 10 days, lasting 45 minutes under physiotherapist supervision. Additionally, habituation exercises at home were introduced. Patient assessment included Dizziness Handicap Inventory (DHI), clinical tests: Berg Balance Scale (BSS) Dynamic Gate Index (DGI), Timed UP and Go (TUG) and stabilometric measurements at baseline and 3 months after therapy. We compared the results of questionnaires and posturography platform measurements.

**Results:** All patients completed a full course of therapy and there were no reports of side effects. After therapy patients demonstrated a decrease in the severity of symptoms in subjective assessments. Statistically significant differences were found in DGI questionnaires, total DHI score ( $p < 0.005$ ) and three DHI subscales: physical, emotional, functional ( $p < 0.05$ ). Patients improved in clinical tests: BBS, DGI, TUG. Sway area and sway length measured in different test decreased after treatment, although the results were statistically significant only for the group with peripheral dysfunction.

**Conclusions:** Virtual Reality training is an effective tool for rehabilitating patients with vestibular system impairment.

**ID: 04160 - P30**

### Realization of International Healthy Hearing Program in Poland – Hearing screening evaluation in participants of Special Olympics with intellectual disability (ID)

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**Background:** International Healthy Hearing (HH) Program developed by International Special Olympics Committee in Washington DC performs hearing screening during athletics competitions in people with intellectual disability (ID). HH Program is designed to study to prevalence of hearing loss in athletes competing in sport events and notify them and their coaches if follow-up care is needed. The aim of this study was to introduce hearing evaluation performed according to Special Olympics Incorporated (SOI) Healthy Athletes Program realized in Poland during last ten years.

**Material and Methods,** The study was performed in Polish participants of Special Olympics during periodic Summer and Winter National Special Olympics Games between

2010-2018. HH evaluation was divided into 4 screening sequences: otoscopy, otoacoustic emission (DPOAE), screening tympanometry for measure of middle-ear function and screening pure-tone audiometry and full pure-tone threshold audiometry if necessary. During athletics competitions 500 Polish participants with intellectual disability (ID) were examined. All HH Program participant were thoroughly examined and entered into the Polish database and results were statistically analyzed.

**Results,** Of the total 500 athletes screened: 75.5% passed the DPOAE screen, 20.2% of athletes passed pure tone screening at 25 dB HL (2kHz and 4kHz) and 2.4% more passed the pure tone threshold test and therefore required no further testing. Approximately nineteen per cent of athletes failed the HH screening. It means that total of ~80% athletes passing hearing testing. However, nearly 40 per cent of them received recommendations for further follow-up and laryngological care. Hearing perceptible impairments were detected in 4.8% athletes and 2.4% of them needed hearing aids. All these athletes were covered by further specialist ENT and audiological treatment.

**Conclusions:** The Special Olympics Healthy Hearing Program provides a unique opportunity to determine the hearing service needs of individuals with intellectual disabilities participating in athletic endeavors in many countries, as well in Poland. Moreover, HH Program enables a more precise analysis of the hearing organ in the group of ID athletes and a recognition of subjects who need audiological care.

### Poster Discussion 04

**ID: 03761 - P049**

### The long-term effect of unilateral and bilateral otitis media history on the central auditory nervous system

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**Keywords:** children, otitis media, electrophysiology, hearing, speech perception.

**Background:** For the development of speech and language is fundamental importance an active and functional auditory system. The central auditory nervous system can be harmed by several interurrences, including otitis media. Otitis media is considered to be one of the most common causes of medical care in childhood and often causes temporary hearing loss of a floating character. This inconsistency at the entrance of the sound signal can lead to an impaired sound stimulation and compromise the responses of the central auditory nervous system. The aim this study was to analyze the auditory evoked potentials responses with verbal and non-verbal sounds in children with unilateral and bilateral otitis media in the first years of life.

**Material and methods:** Electrophysiological responses was recorded in 61 children aged from 8 to 16 years divided into three groups: (i) control group with no history of otitis media, (ii) bilateral experimental group submitted to surgery for insertion of bilateral ventilation tubes and (iii) unilateral experimental group submitted to surgery for insertion of unilateral ventilation tubes. All children underwent basic audiological assessment (tonal audiometry, logoaudiometry, and immittance testing) and electrophysiological evaluation (click-ABR; Frequency Following Response - FFR; Long Latency auditory evoked potentials - LLAEP with verbal and non verbal sounds).

**Results:** The sample consisted of 106 students divided into three groups, which are homogeneous in terms of age and sex ( $p \geq 0.05$ ). There were no significant differences between the groups for audiometric frequencies tested in the airways and bone ( $p \geq 0.05$ ). Click-ABR evaluation showed that control group differs from otitis media groups ( $p \leq 0.05$ ) and FFR was observed that control groups differs from bilateral group for all waves and unilateral group for all waves with exception wave F ( $p \leq 0.05$ ).

**Conclusion:** The analyze the auditory evoked potentials responses with verbal and non-verbal sounds in children with unilateral and bilateral otitis media history in the first years of life demonstrated that this pathology can cause negative effects on the maturation and functioning of the auditory pathways.

**Conflicts of interest:** No exist

**ID: 03763 - P088**

### Clinical implication of cochlear dead region in tinnitus-prospective study

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**Keywords:** Cochlear dead region, Threshold Equalizing Noise test, Tinnitus

**Background:** The cause of tinnitus in normal hearing patients is not well known, and recently, the hypothesis that the cause of tinnitus is damage of hair cells is emerging. In this study, we performed a Threshold Equalizing Noise (TEN) test to identify the cochlear dead region (CDR) and to confirm the possibility of the prognosis of tinnitus patients.

**Material and methods:** We performed a prospective study of 40 patients with normal hearing among the patients complaining of tinnitus. Tinnitus Handicap Inventory (THI) was used for the evaluation of tinnitus prognosis and TEN test was performed to compare CDR positive group and CDR negative group. Patients undergo a pure tone audiometry (PTA) and determine the intensity of the TEN at a 10 dB higher intensity at the absolute threshold. The CDR was determined to be present when the masking threshold was more than 10 dB above the

patient's absolute threshold. Treatment of patients with tinnitus was the same as ginkgo biloba extract 40 mg.

**Results:** 25 patients (63%) had a positive TEN test positive, and rest of the patients did not show cochlear dead region. The THI was performed to confirm the prognosis of the tinnitus. There was a significant difference between the two groups in the follow-up THI. In the CDR positive group, THI decreased by an average of 5, but in the CDR negative group, it decreased by an average of 17, meaning that the THI significantly decreased more in the CDR negative group. ( $p < 0.05$ ) In the tinnitus test, the tinnitus was not significantly different before and after the treatment in the CDR positive group, but the tinnitus was significantly decreased in the CDR negative group. On the other hand, the PTA and speech audiogram showed no significant change in the follow-up test. This suggests that there is no difference between baseline and follow-up because it is based on normal hearing patients.

**Conclusion:** CDR negative group relatively showed alleviation of tinnitus symptoms. This study confirmed the possibility of a TEN test as a new test for predicting the prognosis of tinnitus patients, and it was possible to consider early initiation of tinnitus rehabilitation therapy in CDR positive patients.

**ID: 03775 - P060**

### Study of absolute ABR latencies in microcephalic children and intrauterine infection presumed by zika virus: review of 178 cases.

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**Keywords:** Electrophysiology, Auditory Evoked Potential, zika virus

**Background:** The effects of congenital infection by zika virus on the central auditory pathway are not fully understood. It is believed to be potentially damaging throughout the periphery of the auditory cortex. Our objective is to study the absolute latency values of the I, III and V waves (LA I, III, V) of the Brainstem Auditory Evoked Potential (ABR) and to investigate the correlation between cephalic perimeter (CP) and absolute latencies (LA) found.

**Material and methods:** A retrospective study of medical records of 178 children attended at IEC-RJ from March / 2016 to May / 2018, with a clinical and / or laboratory diagnosis of congenital infection by Zika Virus (ZV). We studied the LA I, III, V obtained at 80 dBnHL and

compared to the values of normality described by Kelly and Hall (2007). We later correlated these findings with CP using Spearman's correlation.

**Results:** In 66.9% we found LA I, III and V normal. In 5.6% the LA I, III and V were increased and 27.6% were decreased. There was a correlation between the latency of the I wave ( $p = 0.014$ ), wave III ( $p = 0.031$ ), and wave V ( $p = 0.037$ ) and the PC of the subjects with microcephaly, and this correlation was positive for waves III and V, indicating that the higher the cephalic perimeter in individuals with microcephaly, the greater the latency of waves III and V. Although this correlation is traditionally used in its positive form, it is not incorrect to use it in its negative form, in other words, it can be assumed that the lower the PC, the lower the LA. For LA I, a negative correlation was found, that is, the lower the PC greater the LA I in subjects with microcephaly.

**Conclusion:** Apparently there is a positive correlation between LA III and V with PC, a fact that we did not observe in LA I. However, we emphasize that other studies should be carried out to broaden the results of this research.

There is no conflict of interest.

**ID: 03777 - P063**

### The Innovative generator of the magnetic field in tinnitus treatment

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**Keywords:** innovative inductor, magnetic field, tinnitus

**Background:** The aim of the study was to evaluate the effectiveness of subjective tinnitus treatment in patients with sensorineural hearing loss of screw origin using the magnetic stimulation of the ear using a prototype device for electro-magnetostimulation of the ear.

**Material and methods.** The research was conducted in 20 patients (24 ears) with tinnitus, aged 30-74 (mean 62.5 years), including 8 women and 12 men. Bilateral tinnitus occurred in 8 people, and in 12 patients unilateral (left-sided in 7 and right-sided in 5 people), of which permanent in 16 ears and periodic in 6 ears. Typical audiology and imaging diagnostics were performed depending on the indications. Before the treatment, immediately after the end of treatment and after 3 months, tinnitus was assessed in the VAS scale (Visual Analyze Scale for loudness). In analogous periods, hearing in threshold audiometry was evaluated. The treatment cycle included 10 five-minute stimulations performed daily 5x a week. The stimulation coil of the prototype device for electro-magnetostimulation was placed in the external auditory canal.

**Results:** Immediately after the end of treatment the following results were obtained: in 18 ears (75%) improvement (reduction of tinnitus in the loudness range by 50-85%);

in 2 ears (8.4%), the noise completely subsided; in 8 ears (33.3%) periodical tinnitus recurrence was obtained; in 4 ears (16.6%) the noise has not changed; none of the subjects was diagnosed with worsening of symptoms. The nature of tinnitus was as follows: before treatment - fixed in 20 ears and periodic in 4 ears; immediately after treatment - fixed in 10 ears, periodic in 12 ears and resolution of noise in 2 ears; 3 months after treatment - permanent in 8 ears, periodic in 14 ears and resignation of noise in 2 ears. Based on the VAS scale for volume: before treatment 4.9 points; after treatment 2.0 points and after 3 months 1.8 points.

**Conclusion:** Preliminary results of the study indicate a high efficiency of magnetic stimulation in the treatment of tinnitus using a prototype device for electro-magnetostimulation of the ear. There was no negative effect of stimulation on hearing and tinnitus.

**Conflict of interests:** None

**ID: 03781 - P049**

### Influence of stuttering on the P300

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**Key-words:** Stuttering, Evoked potential auditory, P300

**Background:** Stuttering is a disturbance of language that affects 1% of the adult population and about one hundred thousand Portuguese people. This speech disturbance may show changes in the processing of information received through the sense of hearing. After several theories, the need to evaluate neurophysiological processes in individuals with stuttering arises and in this sense, electrophysiological tests can be used.

**Material and methods:** The sample consisted of 10 individuals with stuttering (study group), and 10 fluent individuals (control group), with an age range between 19 to 57. All subjects have undergone an otoscopy, tympanogram and a research of the Stapedial Reflex in 1000 Hz and 2000 Hz frequency, pure tone audiogram screening (pass-fail) at the frequencies of 1000 Hz, 2000 Hz and 4000 Hz. To collect the electrophysiological responses (P300), we used some inclusion criteria, such as being aged between 18 to 60, speaking the European Portuguese, without diagnosis of psychiatric and/or neurological alterations, otoscopy without alterations, the Tympanogram being of type A or C1 and getting response up to 40 dB in the frequencies 1000 Hz, 2000 Hz and 4000 Hz in the pure tone audiogram screening. Then, every subject did the evoked auditory potential of long latency (P300).

**Results:** There were statistically significant differences ( $p = 0.005$ ) between the right ear latency values in subjects with stuttering ( $347.10 \text{ ms} \pm 18.24$ ) compared to fluent individuals ( $315.80 \text{ ms} \pm 22.51$ ). In the left ear there were also statistically significant differences ( $p = 0.023$ ) in mean values of latencies that were higher in stutterers ( $344 \text{ ms} \pm 32.50$ ) compared to fluent individuals ( $311 \text{ ms} \pm 20.75$ ).

**Conclusion:** In this study it was verified a change in the electrophysiological response of the P300 in individuals with stuttering. Although the values of latency are within the normal range, in both groups (300-400ms) the individuals with stuttering need more time to process and discriminate auditory stimuli.

**ID: 03803 - P061**

### **Audiological evaluation in the traumatic brain injury case study**

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**Keywords:** traumatic brain injury; auditory dysfunction, hearing, auditory pathways

**Background:** Traumatic brain injury (TBI) is one of the leading causes of death and disability worldwide and in Brazilian cities. The leading causes of TBI may be varied, in Brazil, specifically; motor vehicle accidents are mainly responsible for TBI cases. The evaluation of the central auditory nervous system (SNAC), a complex system of neural pathways, then becomes crucial in individuals with TBI, precisely because there is a relationship with brain deformation after extreme acceleration and deceleration of the head.

**Material and methods:** A young-adult, male, who had suffered from severe TBI caused by a motorcycle accident were evaluated. The subject was submitted to a craniotomy in the left hemisphere associated with a cranial prosthesis insertion. The patient underwent a peripheral hearing evaluation (pure tone audiometry, speech audiometry, impedance with ipsilateral and contralateral acoustic reflexes) and electrophysiological assessment (auditory brainstem response, middle latency response and long latency response).

**Results:** The pure tone audiometry revealed unilateral profound sensorineural hearing loss in left ear and a speech reception threshold (SRT) of 15 dB HL in right ear. Tympanometry findings revealed type A in both ears, ipsilateral and contralateral acoustic reflex present in right ear and absent in left ear. Auditory Brainstem Response with click stimuli indicated normal results (80 dB HL) in right ear and absence of response at 90 dB HL in left ear. Altered responses on electrode effect (C3) and ear effect (A1) and responses within the limits of normality in the right ear and absence of responses in the left ear were observed in the Middle Latency Response and P300, respectively.

**Conclusion:** Electrophysiological measures are effective in substantiating the auditory complaints of these patients and for best intervention practices of TBI population.

**Conflicts of interest:** There is no conflicts of interest

**ID: 03816 - P051**

### **The long-term effect of unilateral and bilateral otitis media history on the central auditory nervous system**

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**Keywords:** children, otitis media, electrophysiology, hearing, speech perception.

**Background:** For the development of speech and language is fundamental importance an active and functional auditory system. The central auditory nervous system can be harmed by several interurrences, including otitis media. Otitis media is considered to be one of the most common causes of medical care in childhood and often causes temporary hearing loss of a floating character. This inconsistency at the entrance of the sound signal can lead to an impaired sound stimulation and compromise the responses of the central auditory nervous system. The aim this study was to analyze the auditory evoked potentials responses with verbal and non-verbal sounds in children with unilateral and bilateral otitis media in the first years of life.

**Material and methods:** Electrophysiological responses was recorded in 61 children aged from 8 to 16 years divided into three groups: (i) control group with no history of otitis media, (ii) bilateral experimental group submitted to surgery for insertion of bilateral ventilation tubes and (iii) unilateral experimental group submitted to surgery for insertion of unilateral ventilation tubes. All children underwent basic audiological assessment (tonal audiometry, logoaudiometry, and immittance testing) and electrophysiological evaluation (click-ABR; Frequency Following Response - FFR; Long Latency auditory evoked potentials - LLAEP with verbal and non verbal sounds).

**Results:** The sample consisted of 106 students divided into three groups, which are homogeneous in terms of age and sex ( $p \geq 0.05$ ). There were no significant differences between the groups for audiometric frequencies tested in the airways and bone ( $p \geq 0.05$ ). Click-ABR evaluation showed that control group differs from otitis media groups ( $p \leq 0.05$ ) and FFR was observed that control

groups differs from bilateral group for all waves and unilateral group for all waves with exception wave F ( $p \leq 0.05$ ).

**Conclusion:** The analyze the auditory evoked potentials responses with verbal and non-verbal sounds in children with unilateral and bilateral otitis media history in the first years of life demonstrated that this pathology can cause negative effects on the maturation and functioning of the auditory pathways.

**Conflicts of interest:** No exist

**ID: 03824 - P052**

### The importance of electrophysiological auditory evaluation in clinical practice: a case study.

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**Keywords:** Electrophysiology, neuroma, vestibulocochlear nerve, functional disorders of the inner ear.

**Background:** The benign tumors of the vestibulocochlear nerve originate from the Schwann sheath. 90% of the cases originate in the vestibular nerve growing inside the internal auditory canal towards the cerebellar angle (Gruskin et al., 1997). They comprise approximately 6-10% of all tumors of the central nervous system. Tinnitus is the most common symptom, followed by hearing loss. Other symptoms are described: sudden deafness (24%) and imbalance. Vertigo and facial paralysis are rare. Facial paresthesia may occur by compression of the trigeminal nerve. Headache may be due to obstruction of CSF flow in larger tumors (Angeli and Jackson, 1997). For the diagnosis of cerebellopontine tumors, we used threshold tonal audiometry, vocal audiometry, brain auditory evoked potentials. However, the gold standard is the nuclear magnetic resonance of the posterior cranial fossa.

**Material and methods:** Clinical case report

**Results:** Female patient complaining of aural fullness on the left and whistling type whistle and intermittent for 6 months. There was no dizziness or hearing loss. She has been treated for a long time with allergic rhinitis, but without improvement of the condition. The physical examination was normal. Tone audiometry showed mild sensorineural hearing loss with a moderate drop of 8 kHz in OE. Type A tympanometry bilaterally and presence of bilateral contralateral stapedial reflex (except in 4kHz in the left ear). In the Auditory Brain Response we observed a clear increase in the absolute latencies of waves III and V and an increase in Interpeak Intervals III-V and I-V, compatible with alteration of the left auditory pathway. Magnetic resonance imaging of the skull and posterior cranial fossa showed a mass occupying the left internal auditory canal

and the cistern of the pontocerebellar angle, measuring about 19 mm x 12 mm x 11 mm and causing compression of the brainstem. The aspect of the lesion is compatible with vestibular schwannoma 4b.

**Conclusion:** The SV is a rare tumor, however we eventually come across this pathology in our offices. In this case, the inclusion of electrophysiological tests proved to be a very useful tool in the diagnosis, since besides being a rapid and non-invasive examination, it was necessary to diagnose the pathology.

I declare there is no conflict of interest

**ID: 03900 - P053**

### “Wave I amplitude”: an invaluable index for the assessment of hidden hearing loss

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**Keywords:** electrocochleography, extratympanic, hidden hearing loss, normative value

**Background:** Common causes of sensorineural hearing loss are often associated with hair cell damage or loss. Recent studies in animal models suggest a much more insidious process. Small rodents exposed to even a moderate level of noise have normal cochlear outer hair cells but damaged cochlear synapses. This so-called synaptopathy or “hidden hearing loss”. The electrocochleography (Ecog) has been proven an effective diagnostic method for detecting cochlear synaptopathy. Indeed, the decreases in SP/AP or wave-I amplitude have been attributed to the loss of the cochlear synapses. Thus, it seem unavoidable to be efforts to develop clinically available measures and also to normalize SP/AP or wave-I amplitude. Indeed, the usual method involves an invasive transtympanic needle insertion, actually it is possible to record non invasive Ecog with an electrode placed closed to the tympanic membrane or with a gold foil Tiptrode electrode placed in the ear canal.

**Material and methods:** To get quality Ecog recordings in patients, the goal of this study is to evaluated in normal-hearing adult volunteers (both sex, aged between 18 to 25 years) the impact (on SP/AP or wave-I morphology) (1) type of electrode (cup or Tiptrode electrode) (2) electrode position (vertical or horizontal montage) (3) sound pressure level of the acoustic stimulation in the ear canal (4) type of acoustic stimulation (clic vs tone burst).

**Conclusion:** After this first stage of normalization, our research project will be to assess -with this protocol- Ecog recordings among people with normal hearing but who complain difficulty understanding speech in noisy environments.

ID: 03917 - P062

### Fast and robust objective hearing threshold estimation in infants with multiple Auditory Steady-state Responses (ASSR) to chirp stimuli

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**Keywords:** Auditory Steady-state Responses, Auditory brainstem responses, Chirp stimuli, Objective hearing threshold estimation

**Background:** Since the 1980s, auditory brainstem responses (ABR) to clicks and to tone pips have been used for objective hearing threshold estimation in infants. In the following years, two innovations were introduced to improve the robustness and accuracy of these measurements substantially: (i) Multiple Auditory Steady-state Responses (ASSR) as proposed by Lins & Picton (1995) and (ii) broadband and narrow-band chirps as proposed by Elberling & Don (2010). In this study, we describe a two-step procedure for a time-efficient estimation of frequency specific hearing thresholds in infants using broadband and narrow-band chirps.

**Material and methods:** 40-Hz-ABR and 40-Hz-ASSR were recorded in 80 infants below the age of 12 months under sedation or general anaesthesia. ABR were evoked by a broad-band chirp stimulus. Subsequently ASSR were recorded simultaneously from both ears with an adaptive multiple stimulus paradigm using four narrow-band chirps centred at 500, 1000, 2000 and 4000 Hz. To save recording time, the threshold of the broadband-chirp-ABR was taken as the starting level for the ASSR recordings.

**Results:** Broadband-chirp ABR with a residual noise level below 35 nV could be recorded within 20 s per response. Starting the ASSR recordings at the ABR threshold and using an adaptive multiple stimulus paradigm, ASSR thresholds at four frequencies in both ears were estimated within 20 minutes in all infants.

**Conclusion:** 40-Hz-ABR for broadband chirps and 40-Hz-ASSR for narrow-band chirps allow for a fast and robust estimation of hearing thresholds in infants. A combination of chirp-ABR with subsequent chirp-ASSR reduces the recording time considerably.

ID: 03947 - P054

### Mismatch negativity in children with speech sound disorder

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**Background:** Mismatch Negativity (MMN) is a negative, event-related potential generated by changes in some repetitive aspect of auditory stimulation, which reflects the abilities of discrimination and auditory memory's responses. Such potential has been used in different populations, however, few studies investigate the electrophysiological responses of this potential in children with speech sound disorder. Therefore, the aim of this study was to analyze the influence of the speech sound disorder on the variables, latency, amplitude and area of the MMN using verbal stimuli.

**Material and Methods:** Observational, descriptive, cross-sectional and quantitative study, approved by the ethics in research committee of the institution of origin. 33 children of both genders, aged between five and eight years and 11 months participated in the study, being 19 children with typical speech development and 14 with speech sound disorder, previously diagnosed. All of them were submitted to the following procedures: visual inspection of the external auditory meatus, pure tone audiometry, *imitancymetry and central auditory processing tracking, performed through the Scale of Auditory Behaviors (SAB)*. These procedures were performed aiming to discard possible disorders that could influence the MMN's record and analysis. After these procedures, the MMN was recorded, using *Intelligent Hearing Systems's (IHS) Smart EP module*, with verbal binaural acoustic stimuli, being the syllable /da/ the frequent stimuli and the syllable /ta/ the rare stimuli, presented in the intensity of 60 dBHL, via insertion phones. In order for the MMN to be elicited, the stimuli were governed by the *Oddball* paradigm, and 750 stimuli were presented with the objective of obtaining at least 150 rare stimuli. For data analysis, the *Mann-Whitney* and *Student's T* statistical tests were used.

**Results:** The speech sound disorder group of children presented higher latency values, although statistical significant differences were not observed for the studied variables.

**Conclusion:** The speech sound disorder does not influence the latency, amplitude and area variables of MMN with verbal stimuli.

ID: 03968 - P055

### Analysis of the components of frequency-following response in phonological disorders

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**Background:** In order to identify the perceptual-auditory characteristics of children with phonological disorders, researchers support the hypothesis that this population presents normal peripheral hearing, however, the responses at central levels are found to be atypical. In this context, the objective of this research was to investigate the influence of the Phonological Disorders on the time domain responses of Frequency-Following Response.

**Methods:** Participated in the study 60 subjects, of both sexes, aged 5 to 8:11 years, with auditory thresholds within the norms of normality and absence of middle ear alterations. The sample was divided into two groups: Group with a typical phonological acquisition composed of 30 subjects, who did not present any language or speech changes. In addition, a group with Phonological Disorder composed of 30 subjects, previously diagnosed with DF and awaiting the start of speech therapy. All subjects were submitted to the Frequency-Following Response evaluation. This potential was realized through the Smart Ep module of Intelligent Hearing Systems (IHS), with electrodes positioned in: M1, M2, Fz and Fpz and using insertion earphones. The stimulus used was the syllable [da], 40 ms duration, presented monaural in the right ear, with a presentation rate of 10.9/s, in the intensity of 80dBnHL. The subjects were submitted to two scans of 3000 stimuli, which were summed to generate the resulting wave. The time domain data were extracted from the resulting plot: absolute latencies (V, A, C, D, E, F, and O) and slope measurement. For the statistical analysis, the Student's T-parametric test was used. The significance level considered was 5%.

**Results:** It was found a numerical increase in the latency of all components evaluated in the group of children with Phonological Disorders, with significant statistic difference for the components V (0,015 \*); A (<0,001\*); C (0,022\*); F (<, 001\*) and O (0,001\*). The results also demonstrate reduction of the Slope measure in the group with Phonological Disorders (p-value = 0,004\*).

**Conclusion:** The electrophysiological responses of the Frequency-Following Response evaluation suffer influence of the Phonological Disorders and demonstrate that this population presents disorganization on the neural codification of complex sounds. This context may compromise the development of the linguistic-phonological skills, especially, abilities and bring consequences to daily communication.

ID: 04024 - P056

### Sound localization and auditory memory in right-handed and left-handed individuals

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**Keywords:** Left-handed; Right-handed; Cerebral Hemispheric Specialization; Sound Localization; Auditory Memory.

**Background:** The auditory system consists of structures that have specific auditory characteristics and the elements that allow the individual to locate and memorize acoustic information, which are interpreted hemispherically according to a cerebral organization of each individual, and can be defined as right-handed or left-handed. The aim of this study was to investigate the occurrence of differences in the cerebral level between right-handed and left-handed individuals using the Sound Localization and Auditory Memory Tests in order to observe the succession in the performance inequalities of these individuals in the same tests.

**Material and methods:** The sample consisted of 12 subjects, 6 left-handed and 6 right-handed individuals aged 17 to 25 years and of both genders. For the information collection, the Sequential Memory Test for Non-Verbal Sounds and the Sound Localization Test were used.

**Results:** The results revealed statistically significant differences between right-handed and left-handed individuals only in the Sound Localization Test in relation to the Y axis, with a better performance by the left-handed group.

**Conclusion:** We conclude that there are differences regarding the performance in the sound localization between right-handed and left-handed subjects, which may be indicative of hemispherical inequalities in localization ability, at least in relation to elevation.

ID: 04028 - P057

### Simple screening questionnaire to detect hearing loss in children

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**Keywords:** Hearing Loss; Child; Mass Screening.

**Background:** Risk indicators for hearing impairment may not be present in some children at birth, so additional efforts to detect changes in hearing in early childhood through a second phase of pre-school screening appear justified.

**Material and methods:** The present study is part of an international cooperation between the Federal University of Minas Gerais (UFMG) and the Laboratory of Neurosensory Biophysics of Auvergne University, project, Capes-Cofecub n° 861/15. The purpose of the project was to validate questionnaires for hearing screening of children aged 12 to 48 months, enrolled in day care centers in the city of Belo Horizonte / MG. The questionnaires contain binary questions (yes or no) about hearing and language child development in the following ages: 12 to 18 months – Form 1 (F1), 19 to 36 months – Form 2 (F2), and 37 to 48 months – Form 3 (F3). The questionnaires had nine questions divided in two: Axis I that was composed of three questions related to previous newborn hearing screening and the Axis II composed of six questions about the development of auditory and language landmarks in each age group that defined the risk factors for hearing loss. The Axis I was the same for all the three forms and the Axis II varied according to the landmarks of each age group. To validate sensitivity and specificity, 201 children aged 12 to 48 months were evaluated. The children were submitted to tests considered gold standard by the literature (Impedanciometry, audiometry and otoacoustic emissions).

**Results:** The factorial analyses shown that to consider a child with risk to hearing loss the questionnaire should contain at least one question marked not on Axis II. After the audiological exams the instrument showed a sensitivity of 50.00% and specificity of 81.02% in the identification of children with bilateral conductive hearing loss. And in the identification of hearing loss of the type Neurosensorial found a sensitivity of 100.00% and specificity of 73.15%.

**Conclusion:** Through the instrument it was possible to identify 100% of hearing loss of the sensorineural type, considered permanent changes, proving the effectiveness of the instrument.

ID: 04055 - P058

### Learning preferences and soundscapes through intelligent interfaces

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**Keywords:** personalization, behavioral pattern, soundscape, intelligent interfaces.

**Background:** with hearing aids (HA) connected to a smartphone, it has become possible to enable HA to learn behavioral patterns (BP) inferred from users' HA adjustments

(e.g. volume or program switching), users' motion (from smartphone), and the corresponding soundscape (SS). This means that these types of HA have the potential to adapt to the HA users' own preference depending on the acoustical environment. The data presented in this poster are based on different research projects carried out at Eriksholm Research Centre. The focus is to investigate to what degree it is possible to learn HA users' actual intents when they adjust their HA settings based on BP and SS. Rehabilitation-wise this has the potential to increase overall HA satisfaction, because the HA will adapt to the given SS, and thereby become a more integrated part of the everyday life.

**Material and methods:** 1 female and 11 male test subjects (TS) participated in the research projects. They were fitted with research prototype HA, EVOTION extending Oticon Opn. The HA were programmed with four different programs. The TS used either Android or iOS based smartphones. Data was logged for a period of 6 weeks or more. The TS were instructed to explore the HA settings, and during that time the SS were categorized in to four clusters "quiet", "noise", "speech in noise", or "speech in quiet". These clusters were based on five parameters (sound pressure level (SPL), noise floor, modulation envelope, modulation index, and signal to noise ratio (SNR)) which was recorded once every minute by the HA.

**Results:** the data show that even though the TS seem to appear in similar SS in terms of SPL and SNR it looks as though the intents behind the adjustments are very different. The most informative context data have been the motion data as it makes sure that the SS is divided into sequences when a HA user moves between different listening situations.

**Conclusion:** being able to combine learned preferences from HA, smartphone, and SS into intelligent augmented hearing interfaces is potentially a radical paradigm shift in hearing health care. Having HA learn users' BP and being able to adapt to different SS, based on motion, can potentially be a way to engage HA users more actively in their own hearing rehabilitation. This will hopefully also improve their quality of life.

**Conflicts of interest:** none.

ID: 04070 - P065

### Oxford's experience with the Cochlear™ Carina® fully implantable middle ear implant

Jane Humphries

Oxford Auditory Implant Programme

**Keywords:** Carina, middle ear implants, totally implantable

**Background:** The Carina® middle ear implant is indicated for people with a moderate to severe sensorineural (SNHL) or mixed hearing loss, who do not benefit from conventional hearing aids or qualify for other implantable hearing solutions. The system is comprised of a totally implantable

microphone, processor and rechargeable battery, and an electromagnetic actuator. The actuator can be coupled to different middle ear structures (incus, stapes, round window), driving sound transmission directly to the cochlea.

**Material and methods:** Ten patients have been implanted with the Carina system in Oxford between 2015 and 2019. Two patients have received bilateral sequential Carina implants. The indications for implantation were: 1)  $\geq 15$  years old; 2) moderate to severe SNHL; 3) unable to benefit from conventional hearing aids or bone conduction devices; 4) outside UK NICE (2009) audiometric guidelines for cochlear implantation ( $>90$  dB at 2 & 4 kHz). All Carina patients are seen for activation of the implant 8 weeks post-implantation, an initial follow up at 6 weeks post-activation, and then on an annual basis. Audiological and patient satisfaction data have been collected for each Carina recipient.

**Results:** Preliminary results demonstrate an improvement in hearing threshold, and significant improvement in speech intelligibility, when compared with the unaided condition. We have found that patients with pre-operative thresholds towards the limits of the manufacturer's indicated fitting range often prefer to use the external microphone (Button® processor), to improve clarity of speech. Results from the Glasgow Hearing Aid Benefit Profile questionnaire show a reduction in overall hearing disability, and high patient satisfaction with the Carina System.

**Conclusions:** The Carina middle ear implant offers a safe, effective hearing solution for patients who cannot receive benefit from conventional hearing aids but do not meet cochlear implant criteria. Being totally implantable, Carina also offers additional lifestyle benefits, including better aesthetic outcomes, hearing night and day, and fully waterproof.

ID: 04081 - P059

### Evaluation of psychomotor development of children that were qualified for cochlear implantation

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**Keywords:** psychomotor development, cochlear implant, children

**Background:** Deafness can affect the psychomotor development of children. On the other hand, it is known that early cochlear implantation enables deaf children to develop speech and language at a level similar to their hearing peers. The present study is aimed to evaluate not only speech and language, but other psychomotor skills of the children qualified for cochlear implantation as well.

**Material and methods:** The study involved 86 (41 M, 45 F) children (average age: 14 months). All participating children were bilaterally congenitally deaf, aged 8–26 months. The children were divided into two age groups of similar size: 8–14 months and 14–26 months. To examine psychomotor development of the children Children Development Scale (CDS) by Matczak et al. 2007 was used. The CDS is a Polish age-specific behavioral test for children from 2 months to 3 years of age. It consists of the sub-tests describing skills and behavior: Manipulation, Motor Skills, Perception, Scribbling and Drawing, Toy blocks, Comparisons, Memory, Speech, Vocabulary, and Social Behaviors.

**Results:** Assessed children showed significantly lower overall CDS scores than the norm. Younger children showed better overall results than older ones in relation to the age norm. Children that had benefits from hearing aids showed better overall results than children without benefits relative to the norm and higher raw results in test of speech. Raw results in the tests of speech and dictionary were higher for older children, however all but two of them were still classified as low performers according to the age norm in both speech and vocabulary. Only 6 % children had a non-zero score in the comparisons test, which is not an auditory test, but requires communication skills and strategies in order to cooperate with investigator conducting the assessment.

**Conclusion:** Results indicate that the earlier the implantation, the smaller the delays compared to the peers from the normative group. In consequence one can expect also smaller impact of deficits on the other aspects of functioning. The use of hearing aids before implantation can have a beneficial effect on early development of speech and language. Acknowledgement: The research is funded by the National Science Centre (2013/08/W/HS6/00333)

**Conflicts of interest:** The authors declare that there is no conflict of interest

### Poster Discussion 05

ID: 03799 - P031

### Central auditory processing in singers with complaint of difficulty in high frequency sounds production

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**Keywords:** voice/ singing/ central auditory processing/ auditory processing/ auditory disorders

**Background:** central auditory processing has a strong correlation with the correct production of musical sounds and can interfere with the performance of singers in case

there is some intercurrency in this system. The complaint of the difficulty of production of high sounds, referred by singers, can have several causes: organic, functional vocal technique and even auditory. The purpose of this study was to analyse auditory abilities of singers complaining about the difficulty of producing high frequency sounds.

**Material and methods:** Seventeen professional singers, both sexes, aged 18 to 40 years old, were separated into two groups, one with 12 singers with specific complaints of difficulty in producing high sounds, and one group with 5 singers without vocal complaints. All participants underwent otorhinolaryngological, basic audiological and behavioural tests to evaluate competitive speech, distorted speech, and temporal processing. They also answered the questionnaire The Auditory Processing Domains Questionnaire.

**Results:** The study group presented a statistically significant worse performance in the tests of competitive speech perception with: dichotic disyllables, monotonic sentences and temporal processing tests of short and successive melodic tones and pure tones of different durations and frequencies, in relation to the comparison group. In the questionnaire, the study group reported a greater number of complaints to listen in environments with competitive message, in noise message and temporal processing, with statistical significance.

**Conclusion:** The profile of the hearing abilities was worse in the group of singers with complaint than in the group of singers without complaint. This difference in auditory competence may contribute to the self-reported complaint of high sounds. An auditory enhancement can help singers with this type of complaint. New studies in the area should be performed to better understand the involvement of auditory abilities in the production of high sounds in singing.

**ID: 03813 - P032**

### Deficits in auditory rhythm perception in children with Auditory Processing Disorder are unrelated to attention

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Auditory processing disorder (APD) is defined as a specific deficit in the processing of auditory information along the central auditory nervous system, including bottom-up and top-down neural connectivity. Even though music comprises a big part of audition, testing music perception in APD population has not yet gained wide attention in research. This work tests the hypothesis that deficits in rhythm perception occur in a group of subjects with APD. The primary focus of this study is to measure perception of a simple auditory rhythm, i.e. short isochronous sequences of beats, in APD children and to compare their performance to age-matched normal controls. The secondary question is to study the relationship between cognition and auditory processing of rhythm perception. We tested 39 APD children and 25 control children aged between 6 and 12

years via a) clinical APD tests, b) Isochrony task, a test measuring the detection of small deviations from perfect isochrony in an isochronous beats sequence, and c) two cognitive tests (auditory memory and auditory attention). APD children scored worse in Isochrony task compared to the age-matched control group. In the APD group, neither measure of cognition (attention nor memory) correlated with Isochrony tasks. Left (but not right) speech in noise performance correlated with Isochrony task. In the control group a large correlation ( $r=-.701$ ,  $p=.001$ ) was observed between Isochrony task and attention, but not with memory. The results demonstrate a deficit in the perception of regularly timed sequences in APD that is relevant to the perception of speech in noise, a ubiquitous complaint in this condition. Our results suggest a) the existence of a non-attention related rhythm perception deficit in APD children and b) differential effects of attention on task performance in normal vs. APD children. The potential beneficial use of music/rhythm training for rehabilitation purposes in APD children would need to be explored.

**ID: 03814 - P033**

### A retrospective study regarding APD battery test in children 5 and 6 year old

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**Keywords,** APD, early detection, younger children, battery test.

**Background,** The fundamental need in medicine for early diagnosis of a disorder urged us to examine the ability of 5 and 6 year old children to participate in APD battery tests. A retrospective study of children visiting our lab in the years 2014-2016 was performed.

**Material and methods,** In total 34 children were examined using the existing battery tests for older children. 58.8% of the children were previously diagnosed with speech and language disorder and 17.6% were diagnosed with ADHD, autism, dyslexia etc. Adaptation of the existing battery test in order to meet the needs of this specific age group provided an extra tool in the quest for early diagnosis.

**Results,** The results were encouraging since the majority of children managed to complete two tests (Speech in bubble (91.2%), Dichotic test (64.7%). The children of the retrospective study were not able to participate in any other testing because of either time limit or inability to understand the instructions of non verbal tests.

**Conclusion,** Additions of more tests and alterations of SinB and Dichotic test were decided since children responded well in this attempt. Changes to these two tests and addition of two other tests in a more age friendly format (Gaps in noise, Pitch pattern test) revealed a new perspective to our effort. Preliminary data on the performance of the children will be presented.

**Conflicts of interest,** none.

ID: 03825 - P034

## Towards a French language version of the Children's Listening and Processing Skills Scale (ECLiPS)

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**Key-words:** Cultural adaptation of health related questionnaires; children's listening skills; Speech language impairment

**Background:** The Evaluation of Children's Listening and Processing Skills (ECLiPS) is a scale created by J. Barry and D. Moore which assesses listening and communication difficulties among children aged between 6 and 11. It has been designed to be filled by a parent or anyone close to the child (a teacher for instance). The scale is composed of 38 items phrased as statements of behaviors observable on a daily basis. The person completing the ECLiPS is asked to rate on a 5-point scale the extent to which they agree or disagree with each statement. The scale has been validated and normed in English in the United Kingdom. This study aims to validate a French language version of the scale, adapted to French culture.

**Material and methods:** A French language version of the ECLiPS (F\_ECLiPS) was obtained, in agreement with the latest European guidelines pertaining to cultural adaptation of health related questionnaires. We used a translation committee and a focus group. In a pilot study, we asked people attending a French annual event aimed at people involved in learning disabilities (mostly families), to complete anonymously the F\_ECLiPS on site. We added a 6-item questionnaire, rating from 0 to 10 how well participants perceived the F\_ECLiPS, including duration, difficulty, relevance of the items, and global presentation.

**Results:** Sixty-seven participants (53 parents) completed the questionnaire. The mean duration of the F\_ECLiPS completion was less than 7 minutes (SD=2 min). The relevance of the items was rated 7.5 (SD=2.7). For the 53 children aged between 6 and 11, the raw scores have been converted to normative scores, according to the UK norms. The scores concerning the group of 28 children diagnosed with speech language impairment and/or dyslexia reached a clear pathological score: 3.64 (SD=2.13) and all the individuals without learning disorders showed a normal score according to UK ranges. The normed global score was related to the rating of the ecological aspect: The greater were the difficulties identified by the ECLiPS, the more relevant the items were considered, suggesting that the chosen items were effectively pointing out challenging situations.

**Conclusion:** The F\_ECLiPS was very well perceived by all respondents. The follow-up of this pilot study includes establishing French norms by age, including children below 6 years of age.

ID: 03831 - P035

## Test-retest reliability of SinB as a screening tool for auditory processing disorders

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**Keywords:** auditory processing disorder, screening techniques, validation, pediatric audiology, speech-in-babble.

**Background:** The Greek Speech-in-Babble (SinB) recognition test is a novel speech-in-noise test that was lately evaluated under controlled audiology laboratory conditions, to be a valid tool for the assessment of central auditory processing competence. The current study aims to further explore its validity, this time as a screening tool, by estimating its test-retest reliability under appropriate conditions.

**Material and methods:** Ten health professionals coming from various disciplines administered the SinB test twice, under conditions similar to those encountered when using it as a screening tool, and test-retest reliability was assessed. Ninety-three Greek-speaking individuals; adults and children aged five years old and more, served as our study sample. The time interval between the two testing sessions ranged from two weeks to two months. The intraclass correlation coefficient (ICC) was calculated as the primary outcome measure.

**Results:** For the right ear, the average intraclass correlation coefficient (ICC) was 0.858 with a 95% confidence interval (CI) between 0.786 and 0.906, results consistent with 'good' to 'excellent' reliability. Slightly better conditions apply for the left ear, as the average ICC was 0.873 with 95% CI from 0.89 to 0.916, which shows 'excellent' reliability.

**Conclusions:** Our results suggest that the test may be effectively used, under analogous conditions, to evaluate a subject's hearing abilities in background competition. It could be thus used as a screening tool for populations considered as being at increased risk for Auditory Processing Disorders

**Conflicts of interest:** None declared.

ID: 03883 - P036

## Detection and treatment of children with auditory processing disorder in Republic of Serbia

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**Key word:** auditory processing disorder, speech and language pathology

**Background:** Following European developmental trends in the domain of medicine and speech and language pathology in Republic of Serbia, only few experts have tackled this issue. The predominant medical model has enabled audiological assessment to be, first of all, directed to diagnostic and treatment of ear illness which jeopardizes patients' health. The social model has encompassed the support to people with hearing impairment and deafness. It seems that auditive processing disabilities and disorders, which most frequently represent the causes of speech and language disorders, still remain neglected and presented as subtle deficits for which there is still neither a professional interest, nor a defined procedural detection pattern. Currently, auditory processing evaluation in the clinical setting is largely based on psychoacoustic test batteries dominantly verbal. Logopedic testing is focused on Hearing Sensitivity (HS), mainly through the use of Dichotic listening. Auditory Processing (AP) through Speech in noise. Treatment procedures are more clearly defined and include work with the application of logopedic technology such as Digital Signal Processing of sound.

**Conclusion:** It was concluded that in Serbia there is a necessary but open interest in the diagnosis and treatment of children with APD.

**ID: 03890 - P037**

### Effect of noise exposure on hearing of pavilion athletes

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**Background:** Traditionally, hearing is divided into peripheral (how much we listen) and central (as we hear - quality). Exaggerated exposure to noise in reverberant environment can have negative effects on how much we hear but on the discrimination capacity and auditory memory of the word its effects can be positive. Pavilion athletes are subject to constant noise in a closed and reverberant environment, are a good example to ascertain the impact of noise on hearing. The present study aims to understand the effects of noise exposure on hearing athletes (training 3 to 4 times a week), comparing the results with the results of a matched non-sports control group in age and sex.

**Material and Methods:** For the study, the sample consisted of 32 individuals, 16 non-athletes and 16 athletes of pavilion, aged between 18 and 25 years. A simple tonal audiogram was performed by air, a repetition test of words, in the silence and with noise and a test of repetition of pseudo words in the silence and with noise.

**Results:** In the simple tonal audiogram, only in the right ear in the frequencies of 1000 and 10000 Hz, we found statistically significant differences, with worse thresholds in the athletes group. In the repetition tests of words and pseudo words, the performance of athletes was better, both

in silence and in noise, with statistically significant differences in word repetition in silence and repetition of pseudo words in noise.

**Conclusion:** The need for verbal communication in a noisy and reverberant environment, evidenced during a sports training in pavilion, trains the abilities to discriminate and memorize the word heard in noise, having a positive impact on these abilities of the central auditory nervous system.

**ID: 03956 - P038**

### Speech language impairments and hearing in noise: a new French hearing-in-noise screening test. Case studies.

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**Keywords:** central auditory processes; speech-in-noise; phonological distance; forced-choice task; case studies

**Background:** Central auditory processing deficits, and especially hearing in noise deficits, show a strong comorbidity with learning disorders, especially Specific Language Impairment (SLI) and certain forms of dyslexia. The aim of this study was to assess systematically, using a new hearing-in-noise screening test (Audimages), the speech perception capabilities of children diagnosed with SLI, and /or dyslexia, in a reference clinical center for language impairments.

**Material and methods:** The hearing-in-noise screening test is implemented on an ipad and consists in a 4 alternative forced-choice auditory perception task, whereby the child is asked to choose, among 4 pictures, the one corresponding to the word he heard in headphones. The sets of 4 pictures are arranged in two levels of difficulty: an easy level, where the words are phonologically very different, and a difficult level, where the words are very close phonologically to one another (phonological neighbors). As it is a forced-choice paradigm, contextual influences, which have major impact on open-set speech perception scores in children with SLI, have less influence on the scores, and the same test can be repeated in silence and different background noises. The different conditions (silence, type and intensity of noise) were tailored to each child, depending on their scores and attention level.

**Results:** The normative values of some conditions have been established in a population of children of similar age and most children with SLI investigated showed a clear decreased performance in cocktail party noise, especially with the difficult condition (words phonologically close), comparatively to children the same age. As expected, greater differences in performance between the easy and difficult levels were obtained in children with SLI.

**Conclusion:** The hearing-in-noise test (Audimages) seems a very promising test for screening auditory processing disorders in noise. In addition, the possibility of being able to repeat the test in different types of noise, in a single ear or binaurally, could help identifying the specific cognitive processes subtending the hearing difficulties.

**ID: 03979 - P039**

### Audiovisual training and auditory-only training: effects on temporal processing in children with history of middle ear disease

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**Background:** The presence of otitis media in childhood may result in changes on auditory system. Individuals with central auditory processing disorders, especially temporal processing, may present difficulties in the acquisition of speech, language and reading. When central auditory nervous system does not demonstrate normal functioning in some auditory abilities, auditory training is a technique used as rehabilitation.

**Material and methods:** 12 subjects (aged 9 to 14 years old) with history of otitis media were equally divided into three groups: GI – auditory training; GII – audiovisual training and GIII – control group. All participants had normal air conduction threshold and normal middle ear function. Auditory and audiovisual training programs were applied through a website in 8 sessions of 45 minutes each, once a week. Frequency Pattern test (FPT) and Gaps in Noise test (GIN) composed the pre and post- assessment.

**Results:** Analysis of mean percent difference indicated an improvement in correct answers comparing pre and post-auditory training evaluation for the FPT [RE: +105.92% - LE: +92.45%] and a decrease in the GIN threshold [RE: -26.92% LE: -23.07%]. After the audiovisual training, there were also improvements in the FPT [RE: +33.33% LE: +76.50%], and especially in the GIN test [RE: -36.66% - LE: -36.66%] that presented higher gains when compared to group submitted to auditory training. For control group, a slight changes in mean score were found both for the FPT [RE: -2.65% - LE: -1.58%] and for the GIN [RE: +18.18% - LE: +14.28%].

**Conclusion:** Auditory training and audiovisual training may be considered an effective rehabilitation for temporal processing abilities in children who undertook bilateral myringotomy surgery. The restricted number of participants in this study calls for further research.

**Conflicts of interest:** There is no conflicts of interest

**ID: 04004 - P025**

### Residual hearing in cochlear implant patients with CI532 electrode

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**Key words:** hearing preservation, precurved electrode, intraoperative imaging; tip fold over

**Introduction:** Patients with cochlear implants benefit from a functional residual hearing particularly in complex hearing situations (i.e. noise). The modioli-close CI532 electrode shall allow for an improved residual hearing due to its thin and flexible structure.

**Methods:** 37 CI532 patients (>18 years) were divided into 2 groups prior to surgery: 1. patients with residual hearing (RH, n=14); 2. without residual hearing (noRH, n= 23). Residual hearing was defined by the following criteria: a. bone conduction of <85 dB in frequencies of 125, 500, 1000, 2000 in pure tone audiogram and/or less than 60 dB hearing loss of digits or c. > 50 % monosyllables maximum in Freiburger speech test. Audiometry was assessed preoperatively and within the regular check-ups (1day, 3 months, 6 months, 12 months postOP). In addition, NRT data were collected intra- and postoperatively. 3D C-arm was used to check the correct position of the electrode; likewise CI522 patients were assessed (RH522, n=16).

**Results:** After implantation a continuous decrease in RH was observed. (1 day postOP 7/13 patients with RH (54%), 3 months postOP 2/8 (25%), 6 months postop 1/9 (11%), 12 months postOP 0/8 (0%). Interestingly low frequencies tended to be lost more easily. Three electrode tip fold-over in 532 patients were recognized by 3D C-arm scans. CI522 RH patients had a better outcome compared to CI532, there was no tip fold over.

**Conclusions:** So far there is no evidence for long term residual hearing preservation, but still it cannot be totally excluded. One reason could be the trauma caused by the exoscelett used for insertion of the electrode or a progress of the natural hearing loss.

ID: 04080 - P027

## Frequential discrimination in musicians and non-musicians: an auditory electrophysiological response with the mismatch negativity

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**Keywords:** frequencial discrimination; mismatch negativity; auditory electrophysiological response; musicians; music training.

**Background:** Several studies have shown an increase of many cognitive abilities, in consequence of auditory training, including musical training, due to the neural plasticity that training provide. One of these abilities is the auditory frequencial discrimination that can be study with Mismatch Negativity (MMN), that reflects automatic and unconscious processing of auditory stimuli and cognitive processes, and can be triggered by discriminative alterations in the auditory stimulus. The aim of this work is to study the frequencial discrimination in 2 groups (musicians and non-musicians) using MMN in order to evaluate the changes introduced by musical training more specifically to identify electrophysiological differences: between groups, between musicians with more or less musical activity, and between different oddballs paradigms and between ears in each group.

**Material and methods:** The sample was organized in 2 groups (10 musicians; 10 non-musicians) aged 19-26 years. The musicians had at least 3 years of continuous musical practice. No participant had a history of otologic and neurological pathology and all had behavioural thresholds  $\leq 20$  dB HL and normal ABR. The IHS equipment was used, and the MMN was evoked in passive attention with 2 oddball paradigms (1000/1010 Hz; 1000/1002 Hz) each with 80 presentations of deviant stimuli with a probability of 10 in paradigm. The stimulation was binaural at 70 dB nHL via insert earphones, with rate at 1.10/sec in rarefaction. The electrodes derivation was Fz (non-inverting) and mastoids (inverting), with bandpass filter 1-30 Hz and analysis window at 512 msec.

**Results:** We studied latencies, amplitudes and area of the MMN and we verified statistically significant differences between: musicians and non-musicians, in latency of the left ear with the 1000/1002 oddball paradigm; and ears, in the area of the MMN of the musicians with the same paradigm.

**Conclusion:** The results showed differences in electrophysiological response between musicians and non-musicians being suggestive that the musical training promoted the increase of frequency discrimination ability, facilitating the processing of subtle auditory differences relevant for musical processing. The differences between ears can be related to differences in musical training to which the musicians are exposed.

**Conflicts of interest:** None.

ID: 04114 - P028

## Case report: Musical Auditory Training: Elderly with hearing loss and hydrocephalus

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Audicare

**Background:** Users of hearing aids with central auditory disorders need a comprehensive speech-language intervention and that contain different auditory training strategies with exercises that involve challenge and repetition. In the last decade, the use of music has occupied a prominent place in auditory rehabilitation, presenting satisfactory results in the improvement of central auditory abilities and higher functions, such as attention, memory and language. Based on these data, Freire (2015) developed the Musical Auditory Training (T.A.M.) that is one of the therapeutic strategies available in the scientific community for the hearing impaired, to improve the auditory abilities. It is a website with challenging exercises which uses instrumental sounds and music to train the brain to listen better. The goal of this study verifies T.A.M.'s efficiency in the elderly users of hearing aids and other comorbidities, in binaural integration skills and temporal processing related to frequency and duration of sound, ordering and temporal resolution.

**Methodology,** Transversal analysis of an elderly patient who uses hearing aids and presents a hydrocephalus condition. The T.A.M was performed in acoustic booth and free field using musical auditory training, involving sequential memory skills, temporal ordering, temporal integration and temporal resolution. Twenty sessions of 1 hour, were held once a week.

**Results,** We noticed an improvement in the auditory ability of binaural integration from 0% to 15% in the left ear, when comparing pre and post musical auditory training assessments, as well as in the ability of frequency pattern recognition and temporal ordering with result for the naming pattern from 70% to 76%. The auditory ability of temporal resolution presented a significant result from 15ms to 7.5ms, considering the average results. The patient and family reported improvement in the environmental sounds localization, in the oral communication process, reading comprehension and fluency, better performance in the social life communication.

**Conclusion,** TAM proved to be effective to be used as a therapy for elderly users of hearing aids, even when the patient has other comorbidities, such as hydrocephalus, and to improve the integration of hearing binaural skills and temporal processing.

## Poster Discussion 06

ID: 03838 - P067

**Bilateral implantation of bone anchored hearing aids in children**M. Smiechura<sup>1</sup>, M. Struzycka<sup>1</sup>, W. Konopka<sup>1,2</sup><sup>1</sup> Department of Otolaryngology, Polish Mother's Memorial Hospital Research Institute, Lodz, Poland<sup>2</sup> Department of Paediatric Didactics, Medical University in Lodz, Poland**Keywords**, BAHA, bilateral, children

**Background**, Bilateral hearing is very important in daily life. It allows to locate sounds, to improve speech recognition in noise and to avoid head shadow effect. In USA the percentage of bilateral implantation is still increasing (1984- 25%, 1994-65%, 2002-74%, 2009-81%).

**Material and Methods**, There are 87 patients implanted with Cochlear Baha® in our center, and 17 of them is implanted bilateral (34 implants during sequential surgeries including 18 Baha® Connect and 16 Baha® Attract systems) – 7 females and 10 males at the age of 4 -16 years old. The second surgery was performed after 4-7 months. In 2 cases an interval between surgeries was longer: 10 and 11 years. All bilateral implanted children have a congenital craniofacial malformation, such as bilateral atresia and microtia (11) and Treacher-Collins syndrome (6). The audiological assessment included pure tone audiometry, speech audiometry and surveys concerning the quality of life and the quality of hearing.

**Results**, Pure tone audiometry shows bilateral, symmetric hearing improvement and complete air-bone gap closure. After stimulation of the non-implanted ear, the speech recognition improves from 35% to 100%. The results from the surveys are positive in all subcategories. Parents and pedagogues agree that the quality of life, making new friends and ability to concentrate are improved after the second implantation.

**Conclusion**, The decision before the bilateral Baha® implantation has to be aware and preceded by testing a sound processor on the soft band. The benefits from the bilateral Baha® prosthesis are effective hearing and improving a quality and comfort of life.

ID: 03856 - P067

**Audiological evaluation of the novel bone conduction hearing device Adhear in patients with conductive hearing loss**Piotr Henryk Skarzynski<sup>1,2,3</sup>, Anna Ratuszniak<sup>1</sup>, Bartłomiej Krol<sup>1</sup>, Henryk Skarzynski<sup>1</sup><sup>1</sup> World Hearing Center, Institute of Physiology and Pathology of Hearing, Warsaw / Kajetany, Poland<sup>2</sup> Institute of Sensory Organs, Kajetany, Poland<sup>3</sup> Heart Failure and Cardiac Rehabilitation Department of the Medical University of Warsaw, Poland

**Objective(s)**: The ADHEAR is a novel non-implantable bone conduction hearing system, in which audio processor is connected directly to the skin via a special Adhesive Adapter that is placed behind the ear. It is intended for treatment of patients with conductive hearing loss. The objective of this acute clinical study was to assess the audiological efficacy with this hearing.

**Methods**: Material of this study consists of five native Polish adults with uni- or bilateral conductive hearing loss. Unaided and two aided conditions with the ADHEAR and the BC device on softband will be compared using the following tests: (1) Sound field audiometry with warble tones. (2) Speech in quiet by determining the word recognition score in sound field with Polish monosyllables. (3) Speech in noise by determining the SRT50 in sound field using the Polish Matrix Test with speech and noise coming from the front.

**Results**: Preliminary results of pilot tests showed comparable performance between the ADHEAR and a bone conduction hearing device on a softband.

**Conclusions**: The new bone conduction hearing device ADHEAR as a non-implantable solution could be a good alternative to the other bone conduction hearing devices and shows comparable audiological benefit in patients with pure conductive hearing loss. It seems that the ADHEAR can be a good solution for patients with small mastoids, especially for babies and children, who are waiting for surgical procedure or are not suitable for it.

ID: 03857 - P074

**Auditory rehabilitation in young children up to 2 years old after the usage of hearing aids**Katarzyna Cywka<sup>1</sup>, Anna Sztabnicka<sup>1</sup>, Beata Dziendziel<sup>1</sup>, Piotr Henryk Skarzynski<sup>1,2,3</sup><sup>1</sup> World Hearing Center, Institute of Physiology and Pathology of Hearing, Warsaw / Kajetany, Poland<sup>2</sup> Institute of Sensory Organs, Warsaw / Kajetany, Poland<sup>3</sup> Heart Failure and Cardiac Rehabilitation Department of the Medical University of Warsaw, Poland

The aim of study is evaluation of progress of auditory rehabilitation in children up to 2 years of age after the use of

hearing aids and comparison of hearing perception with children which are hearing correctly.

The research and control groups consisted of 30 children to 2 years old. The control group included 20 children to 2 years old with the normal hearing. Polish version LitlEars questionnaire was applied.

The results of audiometric BOA test have shown improvement auditory reactions.

**ID: 03877 - P075**

**The 15iSSQ: a 15 item SSQ short-form: factor: cluster: reliability and comparative analyses**

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**Keywords:** Speech Spatial and Qualities of Hearing Scale, Short-forms of Health Related Questionnaires, Hearing Loss, Auditory Rehabilitation

**Background:** Amongst the wide range of auditory questionnaires available, the Speech Hearing and Qualities of Hearing scale (SSQ) designed by Gatehouse and Noble (2004), is becoming one of the most widely used self-report measure for hearing deficits. However, with 50 different items organized into three different subscales, it requires substantial time from patients and some items appear more relevant than others. Using recommended approach for short-form building, we aimed to develop and validate a SSQ short form of 15 items, the 15iSSQ, respecting the 3 subscale SSQ internal structure.

**Materials and Methods.** SSQ items were selected based on their desirable properties, such as a low number of missing answers, a high score and a low variability in normal-hearing subjects, clear-cut definitions of the items in factorial analysis, and face validity, based on data from multiple studies. The 15iSSQ was subsequently tested against the SSQ using an independently obtained sample of 88 hearing-impaired individuals and 35 normal-hearing subjects. Finally, test/retests of the 15iSSQ were performed on a population newly equipped with hearing aids and on a population of long-term hearing-aid wearers.

**Results.** Cluster analyses confirmed an internal structure with three subscales for the 15iSSQ very similar to the

full SSQ, and demonstrated good internal validity. Overall and subscale scores for the 15iSSQ were highly correlated with corresponding scores for the full SSQ, with a linear relationship. Receiver-operating characteristic analyses revealed that the newly created 15iSSQ was superior to the SSQ in discriminating between normal-hearing and hearing-impaired individuals.

**Conclusion.** The 15iSSQ provides an advantageous alternative to the SSQ in all clinical contexts or experimental studies in which swift yet reliable assessments of hearing abilities are desirable.

**ID: 03901 - P079**

**Pupillometry: new insights to effectively assess listening effort in hearing impaired people**

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**Keywords:** Pupillometry; listening effort; hearing impairment; hearing-aid

**Background:** Previous studies showed that task evoked pupil dilation is an objective indicator of cognitive and listening effort. Most studies have used complex tasks such as sentence processing. The aims of this work was to (1) assess the complementary information provided by pupillometry when behavioural perceptions scores are close to 100% and (2) to compare different pupillometry signal processing methods in the assessment of listening effort in hearing impaired patients, recorded using simpler stimuli such as single word perception.

**Material and methods:** Pupil dilation was recorded continuously using an SMP<sup>®</sup> RED 250 eye-tracking system, during a single word perception task, in thirty hearing-impaired patients, long-term hearing aid wearers. A trial consisted in a single bisyllabic word, presented 1.5 s after an auditory cue. A second auditory cue allowed the patient to repeat the word heard. Blocs of 2x12 trials were used, presented in 5 randomized conditions: words presented in silence and in noise with and without hearing-aids, words presented in noise with the hearing-aid noise reducing function turned off. Intensities levels were set individually for each patient as to obtain behavioural scores close

above 80% and patients were asked to self assess their listening effort for each trial, on a 0 to 10 visuo-analog scale.

**Results:** In hearing-impaired listeners, when the average pupil dilation were averaged only across the trials with a correct response (i.e. 100% speech intelligibility), pupil dilation didn't show any statistically significant differences according to the different conditions, although it tended to be lower with hearing-aids. The pupil response matched the self-assessed listening effort. However, significant differences were obtained in pupil dilation prior to word presentation, showing an anticipated response of pupil dilation suggesting a heightened arousal state in the most adverse conditions. Different methods of data processing are compared, in order to take into account this anticipation.

**Conclusion:** Pupillometry remains a robust tool to assess listening effort in hearing impaired people, but new processing methods, such as adapted baseline correction, jitter in stimulus presentation, should be considered to effectively assess listening effort even at a single-subject level.

**ID: 03981 - P082**

### Rural worker's occupational exposure to agrochemicals: hearing screening and dosage of cholinesterase

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**Keywords:** hearing, agrochemical, farmer, occupational health.

**Introduction:** Little is known about the demand for rural workers with hearing impairment in the southern region of Brazil, a region highly exposed to agrochemicals and lacking in studies aimed at the rural population. Brazilian legislation provides for the biological monitoring of workers exposed to organophosphorus and carbamate pesticides through blood analysis of cholinesterase. The objective of this study was to describe and correlate the results of auditory screening and dosing of plasma and erythrocyte cholinesterase of rural workers exposed to pesticides.

**Material and method:** A quantitative research with a descriptive and explanatory scope, with a cross-sectional design, carried out with 71 rural workers exposed to pesticides, attended in the Unified Health System (UHS), in a municipality in the southern region of Brazil. Data was collected in two ways: (i) auditory screening in frequencies from 250Hz to 8000Hz with the Interacoustics brand AD229 audiometer in a silent room, and (ii) blood collection for plasma and erythrocyte cholinesterase dosage. To determine the degree of hearing loss, the classification was adopted by the World Health Organization. Regarding the laboratory examination, 50 (70.4%) workers attended at this stage of the collection and as normal values, the one recommended by the laboratory itself was used. The results

were submitted to statistical analysis using the Spearman correlation coefficient, through software R and presented by absolute and relative frequencies.

**Results:** 31 (43.7%) rural workers presented hearing loss in both ears, ranging from mild to moderate, 28 (39.4%) normal hearing and 12 (16.9%) unilateral hearing loss. Also, 23 (32.4%) workers reported having tinnitus. In the dosage of erythrocyte cholinesterase, all rural workers presented values within normal limits. In the plasma cholinesterase dosage, one participant presented a lower than normal value. There was no significant correlation between hearing screening and cholinesterase value.

**Conclusion:** There were a significant number of rural workers with hearing loss and tinnitus. Health professionals should include audiological assessment in the health care of these workers and occupational control should not be restricted to the dosage of cholinesterase because it is a biomarker with many limitations.

**ID: 04015 - P077**

### The cost-effectiveness of cochlear implantation in adults

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**Background:** Research has shown significant improvements in clinical outcomes and quality of life following cochlear implantation in adults. Cochlear implant devices have advanced in technology and cochlear implant eligibility criteria have broadened to provide greater access to adults and children. Cost-effectiveness evidence considers both the clinical and economic evidence, and may inform decisions concerning the subsidisation of cochlear implants in Europe.

**Objectives:** To evaluate the cost-effectiveness of unilateral and bilateral cochlear implantation among adults aged 18 years and over with severe to profound hearing loss, using the UK as a case-study.

**Method:** A Markov model was developed, taking a National Health Service (NHS) system perspective. Three interventions were assessed, including unilateral cochlear implants versus hearing aids, simultaneous bilateral cochlear implants versus unilateral cochlear implants; and sequential bilateral cochlear implants versus unilateral cochlear implants. Systematic literature reviews of economic evaluations and utilities were undertaken to inform the model. Cost data was sourced from the 2017/18 UK National Tariff Payment System and the 2018 Unit Costs of Health and Social Care. UK clinical experts were consulted to inform the treatment pathways and resource use.

**Results:** Our results indicate unilateral cochlear implants are cost effective for adults. The incremental cost-effectiveness

ratio (ICER) was estimated to be £12,253 per quality adjusted life year (QALY) gained for people who received some hearing aid benefit before their cochlear implant, and £10,780 per QALY gained for those who received no hearing aid benefit. The likelihood of bilateral cochlear implants being deemed cost effective was lower compared to a unilateral cochlear implant, although simultaneous bilateral implants (ICER of £56,017 per QALY gained) had a greater likelihood of being deemed cost effective compared to sequential bilateral implants (ICER of £94,025 per QALY gained).

**Conclusions:** Our results indicate that unilateral cochlear implants continue to be a cost-effective intervention for adults in the UK setting. Research is required to develop more robust estimates of incremental utility values for people receiving bilateral cochlear implants.

**ID: 04018 - P069**

### Case study - A prescriptive sound amplification method for tinnitus relief using hearing aids

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**Background:** Tinnitus represents the perception of sounds in the absence of an external source. Prevalence rates in adult populations is 8.2 - 20.0%, rising to 17.9 - 30.3% in those over 50 years of age. Some of the tinnitus sufferers are profoundly affected in everyday tasks. Some of the patients with tinnitus experience hyperacusis as well. Our hypothesis is that we can provide hearing aids with a customized algorithm of amplification of environmental sounds, capable of offering amplification and tinnitus relief. This method will eliminate the need of using a noise generator that will overlap with the useful auditory information amplified via hearing aids.

**Material and methods:** Group of patients: 8 patients with hearing loss and 4 patients with hearing loss and hyperacusis. We used amplification through hearing aids operating on at least 6 frequency channels. We offered the amplification prescribed by the NAL-NL2 method, with a 10% gain growth for the main tinnitus frequency and also for the frequencies above this.

We used different compression methods, as follows: For the patients with hearing loss and no auditory neuropathy we set up the compression ratio at 2 and used compression knees over 60 dB for the tinnitus' main and upper frequencies domain. For the patients with hearing loss and hyperacusis we used linear amplification. For all we added a 10% gain for the tinnitus frequency and the frequencies above this. For tracking the changes of patients' tinnitus perception, we used the TFI (Tinnitus Functional Index) developed in 2014 by Henry JA at al. at the first visit, 2 weeks, 1 month, 3 months and 6 months after hearing aid initial fitting.

**Results:** Out of the 8 patients with hearing loss without hyperacusis, the TFI score improved with a mean of 10 points after 2 weeks, 12 points at 1 month, and more than

13 points at 3 months and 6 months. Out of the 4 patients with hearing loss and hyperacusis, the TFI score improved with a mean of 6 points after 2 weeks and 1 month, 8 points after 3 months and 10 points after 6 months.

**Conclusions:** Based on the encouraging results obtained so far, we consider that the algorithm significantly reduces the intensity and frequency of appearance of the tinnitus in patients with no added hyperacusis. For the patients with hyperacusis added to hearing loss and tinnitus, it seems that improvement is taking a slower course, therefore we plan to retest them at 9 months and 12 months to see if the changes become significant.

**ID: 04020 - P083**

### Early hearing detection – 10 years experience of a newborn hearing screening program in Hospital Lusíadas Lisboa

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**Keywords:** newborn; universal newborn hearing screening; hearing loss; otoacoustic emissions; auditory brainstem response

**Background:** Unidentified hearing loss at early age negatively affects language and speech development of children; it can also adversely influence academic achievement and social-emotional development. Newborn hearing screening and early intervention are recommended practices because hearing loss identification can be performed using specific and sensible tests. The aim of this study is to evaluate a 10 year program of newborn hearing screening in a private Portuguese hospital between July 2008 and July 2018, characterizing newborn population and program effectiveness.

**Material and methods:** Retrospective study based on the hearing screening database. Following Joint Committee on Infant Hearing recommendations (2007), all newborns were screened using automated distortion product otoacoustic emissions (DPOAE) if no risk indicator was present and with automated auditory brainstem response if any risk indicator was identified. Newborns who referred at either ear repeated the test within 2 weeks. Children who failed the second stage were referred before 1 month for diagnosis ENT observation and diagnostic audiological tests: 1000Hz tympanogram, DPOEA and diagnostic ABR. Diagnosis is made until 3 months of life. When there was a risk indicator, all children were evaluated every 6 months until 3 years of age (high risk protocol).

**Results:** In our 10 year time period 15050 children were born, of which 14888 were screened (98,9%). In 121 newborns (0,8%) at least one risk indicator was present (the most prevalent risks were: 39,7% ototoxic medication; 20,7% family history; 10,7% citomegalovirus). Of the 722 newborns (4,9%) referred for the second stage, 49 newborns (0,3%) were referred for diagnosis. We had a lost to follow up of 27 newborns (0,2%). 26 newborns (0,17%)

were identified with permanent hearing loss: 20 newborns with sensorineural hearing loss and 6 with conductive hearing loss.

**Conclusion:** The screening program at our institution is well established and in compliance with international and national recommendations with 98.9% of all newborns screened. The prevalence of hearing loss is 1,7 per 1000 newborns. Due to this program all babies bearing significant hearing loss were early diagnosed and submitted to early intervention.

**Conflicts of interest:** The authors declare no conflicts of interests.

**ID: 04032 - P084**

### Tip fold-over detection in cochlear implantation: case series

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**Keywords:** Spread of Excitation (SOE), electrically evoked compound action potentials (ECAPs), medical imaging, quality protection

**Background:** In daily routine intraoperative measures of impedance and electrically evoked compound action potentials (ECAPs) are used to confirm device integrity and electrode array position. In rare cases the apical part of the electrode can fold over during insertion. This behavior is also called “Tip fold-over” and can result in a later operational revision if not detected during the cochlear implementation. The medical imaging is therefore implemented in the process of cochlear implementation at university hospital Essen. After electrode insertion the position of the electrode is determined with a mobile 3D C-arm. The aim of our study was to identify and characterize the tip fold-over behavior in the spread of excitation (SOE) measurements.

**Material and methods:** The spread of excitation (SOE) measurements were used to analyze the electrical field distribution of the cochlear implant and were based on the measurement of electrically evoked compound action potentials (ECAPs). For this study in total 70 implantations ECAP thresholds and SOE measurements were recorded intraoperatively. The probe electrodes 22, 19 and 16 have been stimulated above the electrodes T-ECAP, the measurement results are compared to the results of mobile 3D C-arm imaging.

**Results:** Overall, three cases of a tip fold-over occurred and all cases were detected by spread of excitation (SOE) measurements due to their increasing N1-P1 amplitudes towards the most apical masker electrode 22. Three tip fold-overs that occurred with the CI532 implant could be corrected immediately during surgery since this implant offers the possibility of a second insertion with a reloading

tool. The ECAP thresholds didn't show a reliable indicator of tip fold-over in this case.

**Conclusion:** Spread of excitation (SOE) measurements are suited to determine a tip fold-over. SOE measures is a striking addition to medical imaging after cochlea implantation.

**Conflicts of interest (if any):** No conflict of interest has been declared by the author(s)

**ID: 04061 - P076**

### How can we support hearing impairment in people with dementia? Perspectives from professionals: service users and care partners

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**Keywords:** hearing impairment, dementia, assessment, treatment

**Background:** Up to 90% of people living with dementia (PwD) have hearing impairment, and most cases hearing impairment are not identified or treated. Untreated hearing difficulties exacerbate the impact of cognitive impairment on functional ability and may hinder standard management strategies for PwD. Effective identification and management of hearing impairment in PwD is crucial for improving quality of life and other dementia-related outcomes. We explored the perspective of health care professionals, service users and their care partners with respect to the impact, assessment and support needs for PwD who have concurrent hearing impairment.

**Material and methods:** We conducted semi-structured interviews and focus groups with PwD (n=18), their care partners (n=15) and health care professionals (including audiologists, clinical psychologists, psychiatrists; n=18) at three European sites (Manchester, UK; Bordeaux, France; Nicosia, Cyprus). Data were transcribed and analysed using Mayring's content analysis in an inductive coding procedure, with a behavioural change model as a deductive coding paradigm.

**Results:** PwD and care partners identified that cognitive impairment was their main concern, and this has had an impact on hearing difficulties. They expressed that comorbid impairments limited social participation and exacerbated burden on care partners. They expressed a need for support from both hearing and dementia services,

including training in the use and maintenance of hearing devices. Health care professionals identified the importance of obtaining the perspective of both PwD and care partners with respect to establishing baseline functioning and identifying goals for treatment.

**Conclusion:** PwD, caregivers and health care professionals recognise the impacts of untreated hearing impairment and a need for individualised hearing support for PwD that includes both the PwD and their care partner(s).

**Conflicts of interest (if any):** none to report

**ID: 04069 - P071**

### Involving older adults with dementia and hearing and/or vision impairments in a multi-site European research programme

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**Keywords:** Dementia, hearing impairment, vision impairment

**Background,** Involvement of older adults with dementia and hearing and /or vision impairments in research has traditionally been considered impractical. However, without involving older adults with dementia and hearing and /or vision impairments and their caregivers in research it will be challenging to ensure that research findings have meaning and enable the effective promotion of mental wellbeing.

**Material and methods,** Research User Groups (of older people with memory, vision and/or hearing problems) have been established in Manchester, Nice, Nicosia and Athens to involve older adults and their carers with lived experiences of these problems in a European Union funded research programme (SENSE-Cog). SENSE Cog aims to investigate the combined impact on patients of memory, vision and / or hearing problems, and to develop new tools and at-home support to improve older people's quality of life and to optimise health and social care budgets and resource allocation across the research sites. The groups received research awareness training to increase their awareness, and understanding of research and their confidence in becoming meaningfully involved in the SENSE Cog study. The training has been adapted for local implementation in Manchester, Nice, Nicosia and Athens to ensure it is appropriate in terms of language, culture, age and, cognitive and sensory disabilities. To evaluate the RAT, we selected the Training Acceptability Rating Scale (TARS). The TARS is a self-administered paper questionnaire and takes approximately 5-10 minutes to complete.

**Results:** The results of the quantitative questions show overall satisfaction with the acceptability and perceived impact of the Research Awareness Training. 67% of participants rated 'a great deal' on the overall satisfaction with

the training, participants commented that they found the whole experience enlightening, of interest and informative.

**Conclusion:** The study has helped us to understand the acceptability and appropriateness of training to support patient involvement in European dementia research. On the basis of the findings from this study, the RAT package can be used to train older adults with dementia and hearing and/or vision impairment provided they are supported and key factors outlined above are implemented, including tailoring the training to the group's needs. SENSE Cog Group submission

**ID: 04072 - P072**

### Auditory screening at school age: about the grounds

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**Introduction** Hearing loss is a pathology with high prevalence among school-age youth and when unidentified can lead to school failure, affecting behavior, self-esteem and socio-emotional skills. Auditory screening tests, which are essential for the early detection of hearing loss, are currently being implemented, aiming at the earliest possible intervention. The Newborns Hearing Screening is the first, effective, rapid and noninvasive auditory screening test to be performed. The multifrequency tympanometry test is also important for auditory evaluation, up to seven months of age, since with a specific probe (1000 Hz) the changes in the middle ear (namely the presence of otitis media) are detected. Later in school age, the Auditory Screening at School Age is also important, because audiological pathologies can be detected and controlled when the intervention is timely.

**Goals** Verify the relationship between the children who did not perform auditory screening tests (for newborns), versus those who performed it, assessing the incidence of hearing loss; which are the otological factors related to the highest prevalence of hearing loss between six and eight years of age.

**Methodology** Evaluation of 150 children (81 females and 68 males) who attended the 1st year of primary education, belonging to five schools distributed by four school groups. The Auditory Screening at School Age was performed with the following protocol: otoscopy; tympanometry; tonal audiometry.

**Results** After collecting and analyzing the data, it was concluded that 74.3% of the sample evaluated did not perform the Newborns Hearing Screening. It was also verified that no element of the sample performed multifrequential tympanometry. Regarding otological findings, 63% of the sample population presented alterations: most of them identified by type B tympanogram (21%) – serous otitis - and tympanogram type C (11%) - characteristic of tubal dysfunction. There was also a prevalence of 3% of situations with hypoacusis, but no relation with the performance of the Newborns Hearing Screening was evidenced.

**Conclusions** The results obtained are in agreement with the literature: in the studied age group, the children are propitious to middle ear dysfunctions, which result in the described as otological alterations; the existence of a clear relationship between the presence of hearing loss and the performance of the Newborns Hearing Screening is not described. Early detection of hypoacusis - at school-age or before - is evidenced and fundamental to children's well-being and to ensuring a complete and harmonious development of children.

**ID: 04073 - P073**

### **Carina changes in actuator impedance measurements: what does it mean for patients?**

**Jane Humphries**

*Oxford Auditory Implant Programme*

**Keywords:** Carina, middle ear implants, totally implantable, actuator, impedance measurements

**Background:** The Carina® middle ear implant is indicated for people with a moderate to severe sensorineural (SNHL) or mixed hearing loss, who do not benefit from conventional hearing aids or qualify for other implantable hearing solutions. The system is comprised of a totally implantable microphone, processor and rechargeable battery, and an electromagnetic actuator. The actuator can be coupled to different middle ear structures (incus, stapes, round window), driving sound transmission directly to the cochlea.

In Oxford we have fitted 10 Carina implants. Outcomes have generally been positive. We present our outcomes in a separate poster.

Carina implant patients are seen for switching on of the implant, 8 weeks post surgery, an initial follow up 6 weeks later and then on an annual basis. During the Carina implant operation and at each appointment, a test is carried out which looks at the impedance of the actuator on the middle ear structures. This verifies that the implant's actuator is correctly loaded and verifies the correct electrical connection between the actuator and the implant body.

In Oxford we have seen some changes in these impedance measurements and in this poster we show those changes and discuss the implications.

**ID: 04087 - P080**

### **Better Hearing Rehabilitation (BEAR) study in Denmark: introducing the Centralized Clinical Database**

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**Keywords,** Audiology, Hearing aid, Clinical data, Subsets

**Background,** The purpose of the BEAR project is to improve hearing loss management by revising diagnostic techniques and hearing aid fitting practices based on individual hearing profiles, expectations and lifestyle. As a starting point, a large clinical database has been prepared to better characterize the current clinical status in Denmark. The analysis will be used to identify the main challenges faced by hearing aid users in order to develop appropriate tools to improve performances.

**Method,** The study is a multicentre, prospective, open, non-randomized, single-arm trial with sequential enrolment of all qualified patients, conducted under a common clinical investigation plan. Up to almost 2,000 evaluable patients have been enrolled from two Danish clinics. After having undergone medical and audiological examination and other assessments (health related and quality of life questionnaires), the patients were prescribed a hearing aid and got a fitting. Approximately 2 months later, a follow-up visit took place and whenever needed an adjustment was offered (plus other assessments). An across-center database, hosted independently from clinics, universities and hearing-aid manufacturers but accessible by all parties, was created to gather the data (access granted to each partner if data managers adhere to ethical permissions and requirements for data security).

**Results,** The investigation generated approximately 30'000 patient records and we started by characterizing the general distribution of audiometric data (air and bone conductions, speech tests) and questionnaires (health, speech, hearing aids, tinnitus and quality of life related). The analysis focused specifically on correlations detection between demographics, audiometric tests and questionnaires in order to classify patients into subsets.

**Conclusion,** The present clinical database should be seen as a starting point for other BEAR work packages. We believe that such large variety of data generated will lead to a more comprehensive picture of the hearing-aid user and will bring benefits to both clinicians and manufacturers. Indeed, this first step represents the baseline against which new fitting strategies will be tested. Alternatively, clinically relevant subpopulations with low hearing-aid benefit will be identified and studied to tentatively bring alternatives in rehabilitation.

**ID: 04096 - P081**

### **Bilateral facial paralysis as initial manifestation of Wegener's granulomatosis**

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Vladimir R. Pavicevic, Aleksandra Lakovic-Tatar**

RH "Danilo I"

**Key words:** Wegener's granulomatosis; Chronic otitis media; Facial nerve palsy

Wegener's granulomatosis is a multisystem disease, of unknown etiology, whose hallmark features are: necrotizing, granulomatous inflammation of the mucous membrane of the upper and lower respiratory tract, necrotizing focal vasculitis of small vessels of various organs and focal necrotizing glomerulonephritis (the so-called Wegener triad) (14,15,3,4). The paper presents the case of a male patient, 56 years old, with bilateral facial nerve paralysis, sensorineural hearing loss, granulomatous changes in the mucous membrane of the nose, and nodular infiltration of the lungs. The clinical presentation, although atypical, indicated a systemic illness. Setting the diagnosis further was complicated with the whole range of diseases with similar symptomatology. A definitive diagnosis was set after 3 months, which was a major failure. In our case, the pathohistological finding of the nasal mucosa biopsy was negative, as well as the tissue from the tympanic cavity. The concentration of antineutrophil cytoplasmic antibodies (c-ANCA) was negative. After a lot of searching, the diagnosis was set on the clinical presentation criteria for this disease, and therefore adequate therapy was given, which enabled a better general condition of the patient.

**ID: 04113 - P078**

### **Electrophysiological evaluation of hearing in individuals with vascular loop of bilateral antero inferior cerebellar artery (Aica): case study**

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**Background,** Sensorineural hearing loss (SHL) and tinnitus can be many possible etiologies: hemangioma, schwannoma, glomus tumor, among others. We can observe in the imaging examination, in some cases, the presence of a vessel, most often the anterior inferior cerebellar artery (AICA) in relation to the internal auditory meatus (IAM) and coming into contact with the VIII cranial nerves and, there are many questions whether this anatomical variation can actually be seen as the cause of the symptoms mentioned.

**Objective,** This study aims to discuss whether AICA can be considered a differential diagnosis between the causes of SHL and tinnitus. A patient case with SHL associated with tinnitus have been reported, and the presence of bilateral AICA was the only alteration found to justify the clinical picture.

**Material and methods,** Woman, 65-year-old, complaining of tinnitus in the left ear with no pitch variations and significant interaural asymmetry in the conduction of sound through the area for high frequencies. In addition to hearing evaluation (pure tone audiometry, impedance with ipsilateral and contralateral acoustic reflexes) and electrophysiological assessment (auditory brainstem response, VEMPc and electrocochleography), laboratory tests were performed, Computed Tomography (CT) of Mastoid and Magnetic Resonance Imaging (MRI) of the cerebellar point angle for investigation of the clinical picture.

**Results:** The patient presented to the MRI types II or III vascular loops of the Chavda classification insinuating to the inside of the IAM bilaterally, moderately-severe sensorineural hearing loss with interaural asymmetry in the high frequencies, which presented a higher degree of hearing loss in left ear. The absolute latency of V-wave presented an increased interaural difference of 0.64 ms, normal electrocochleography in the right ear and absence of records in the left ear. The other tests were normal. After analyzing the various rehabilitation and treatment options, we opted for the attempt of ambulatory control and adaptation of bilateral hearing aids with auditory training.

**Conclusion:** AICA within the IAM, asymmetric sensori-neural audiometric and BERA with an increased interaural difference of the absolute latencies of the V-wave may be important indicators to consider the differential diagnosis in patients with tinnitus and SHL and always associated with a quality image examination, given the enormous possibility of other retrocochlear diseases.

**Conflicts of interest:** There is no conflicts of interest.

## POSTERS

**ID: 03990 - P064**

### Evaluation of different AGC settings in bimodal cochlear implant subjects

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**Background:** The parameter setting of Automatic Gain Controls (AGCs) has a significant impact on the loudness percept of cochlear implant (CI) and hearing aid (HA) patients. Studies have shown that the AGC time constants do influence the hearing performance, particularly in noise. With the growing population of bimodal patients having a cochlear implant in one ear and a hearing aid in the other, a similar behavior of the AGC in the two devices might improve speech understanding in those subjects.

**Method:** Our aim was to investigate whether matched knee points and time constants of the AGC of a CI and a HA would improve speech intelligibility in noise in bimodal listeners. We compared the matched condition with the mismatched default AGC settings between a Cochlear Nucleus 6 processor and a GN Resound Enzo hearing aid. Eighteen patients participated in the experiment. For speech tests in quiet, we used Freiburg monosyllabic words at 50 and 65 dBA. For the speech in noise test, we used the adaptive OLSa sentence test with a Swedish competing talker. The study comprised three visits: The initial visit, where subjects were first tested with their own devices in the above mentioned tests. After that the subjects received the study devices with either default parameter settings (group 1) or the matched AGC settings (group 2) with four weeks of acclimatization. At the next visit, subjects were tested again with these settings and were switched over to the alternative parameter settings (cross over design) with another four weeks of acclimatization. Tests were conducted once more and subjects were reverted to their own clinical devices. At each visit the subjective benefit was assessed with the SSQ questionnaire. We also tested the participants' short term memory skills to assess whether they can predict the speech intelligibility in noise benefit that comes with the time constants.

**Results:** A significant improvement was found for speech in noise with the study devices compared to the baseline results with the subjects' own devices. However, no advantage in speech understanding could be found for the actual matching of the AGC parameters in the study devices,

i.e. with the study devices, no difference between matched and unmatched AGCs could be observed.

**Conclusion:** With the devices and parameter sets used in our study, no advantage for matched AGCs in bimodal subjects could be found.

**ID: 03908 - P097**

### Contralateral suppression or enhancement of otoacoustic emissions in elderly people

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**Keywords:** otoacoustic emission, suppression/enhancement of distortion product otoacoustic emission, age related hearing loss.

**Background:** Today, age related hearing loss is becoming more common phenomenon. There are many causes of presbycusis. It can arise from changes in the middle or inner ear, or from complex changes along the nerve pathways, as well as from central auditory part. The effects of ageing on the cochlea can be evaluated by mean of analysis of otoacoustic emission, which is a sensitive indicator of the functions of the cochlea. Atypical medial olivocochlear feedback from brainstem to cochlea has been considered to contribute to presbycusis. The aim of the study was to assess age-related changes of transitory evoked otoacoustic emissions (TEOAE) and distortion product otoacoustic emissions (DPOAE) as well as to evaluate age changes of suppression of DPOAE in adult subjects with normal hearing and presbycusis.

**Material and methods:** Only women participated in the study: 28 elderly women (60-74 years old) with normal hearing, 28 elderly women with presbycusis (mild to moderate hearing loss) and 26 young women with normal hearing (20-31 years old) as a control group. Audiologic assessment included: pure tone audiometry, impedancemetry, registration of TEOAE, DPOAE measurements with and without 65-dB SPL broadband noise presented to the contralateral ear.

**Results:** Age-related decrease of prevalence and amplitude of TEOAEs and DPOAEs was proved to be significant; no significant differences of these data for left and right ears were revealed. Contralateral suppression of DPOAE was noted more often and was the greatest in young listeners, in whom it was revealed in all frequency range, meanwhile the suppression was minimal and rarely noted in patients with presbycusis. The DPOAE amplitude enhancement in the contralateral noise condition was recorded in all groups of listeners, more often in aged patients both with normal hearing and hearing loss. Analysis

of ipsi/contralateral acoustic reflex presence or absence at all frequencies has shown a significant difference between young and elderly subjects, regardless of the hearing level.

**Conclusions:** These results may indicate age-related changes of medial olivocochlear complex, which depend not only on the hearing level.

The authors declare no conflict of interest.

**ID: 03923 - P098**

## Validation of Lithuanian version of Hearing Handicap Inventory for the Elderly

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**Keywords:** Hearing Handicap Inventory, hearing related quality of life, elderly, validation.

**Background,** Hearing Handicap Inventory for the Elderly is a 10-item self-administered questionnaire (0-40 points) created for the assessment of hearing related quality of life for the elderly. There was no specialized subjective method to measure hearing problems for elderly in Lithuania so far. The aim of the study was to determine the reliability and validity of the Lithuanian version of the Hearing Handicap Inventory for the Elderly (HHIE-LT).

**Material and methods,** Linguistic and cultural adaptation was made according to guidelines including professional translators, re-translators, editors, ENT specialist committee and pilot study. After getting the final version of HHIE-LT, a total of 102 subjects were included in the study: 72 patients who had hearing complaints (patients group) and 30 healthy elderly people (control group). All subjects filled HHIE-LT as well as had an audiological evaluation. To assess construct validity, participants completed the Lithuanian version of 36-Item Short Form Health Survey (SF-36). Test-retest and internal consistency reliability as well as construct validity were calculated.

**Results,** The Lithuanian version of the HHIE and its subscales showed a robust internal consistency reliability (Cronbach's  $\alpha=0.95$ ) as well as retest questionnaire stability (Cronbach's  $\alpha>0.89$ ). There was no statistically significant difference within test-retest results over time ( $p=0.25$ ). Statistically significant correlations were observed between the HHIE-LT and SF-36 social ( $r=0.54$ ) and emotional ( $r=0.46$ ) scales. There was a statistically significant difference ( $p<0.001$ ) between the mean scores of the patients ( $29.36\pm 8.7$  points) and control groups ( $1.7\pm 8.7$  points). ROC analysis showed that the cut point differentiating people with and without hearing loss is 8 points with sensitivity of 96% and Specificity of 99%. A statistically significant high correlation ( $r=0.8$ ) was observed within HHIE-LT points and audiological hearing loss degree.

**Conclusion,** Translated and culturally adapted HHIE-LT has high level psychometric properties and is considered

to be a valid and reliable tool for self-assessment of hearing related quality of life in Lithuanian-speaking elderly people.

**ID: 03774 - P099**

## Auditory profile of children with microcephaly and intrauterine infection presumed by Zika virus: analysis of 217 cases of the Brain Institute.

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**Keywords:** zika virus, auditory pathway, hearing loss,

**Background:** Congenital infection with zika virus has not yet been completely studied from the auditory point of view. It is believed that it may be potentially harmful to the peripheral organ of hearing, and may cause damage to the central auditory pathway. For this reason it is necessary to study the incidence of peripheral and / or central hearing loss in the pediatric population affected by this condition.

**Methods:** Retrospective study of the records of 217 children attending the IECRJ from March-2016 until May-2018 presenting clinical and / or laboratory diagnosis of congenital infection by Zika Virus and / or microcephaly at birth. Objective: to draw a panel of the auditory findings obtained through electrophysiological methods. The electrophysiological auditory evaluation protocol was composed of Auditory Brainstem Response (ABR) at 80 dB nHL; AC ABR by Specific Frequency (AC ABR SF) using NB-CE-Chirp at 0.5 and 2 kHz at 35 and 30 dB nHL respectively. In the case of increased auditory thresholds, we also performed AC FS ABR at 1 and 4 kHz, FS ABR BC (Bone Conduction) and ASSR thresholds.

**Results:** We analyzed the exams of 217 children (42.9% men and 57.1% women). 82.9% normal hearing bilaterally; 2.5% normal hearing in the left ear (LE) and 2.1% normal hearing in the right ear (RE). 4.1% conductive hearing loss bilaterally; 2.1% conductive hearing loss in the RE and 1.8% in the LE. 3.7% sensorineural hearing loss bilaterally; 0.7% sensorineural hearing loss in the RE. Of the children with hearing loss ( $n = 38$ ), 28.9% had sensorineural hearing loss. Regarding the sample ( $n = 217$ ), 5.1% had sensorineural hearing loss.

**Conclusion:** The incidence of sensorineural hearing loss in this group followed the incidence of hearing loss in at-risk children (1-4: 100 newborns). However, studies are needed to isolate the congenital infection by zika virus as the causative agent of sensorineural hearing loss.

**There is no conflict of interest.**

ID: 03827 - P100

**The cross-check principle - current and necessary: case report****Daniela Capra<sup>1</sup>, Caroline Donadon<sup>3</sup>, Natália Ferrazoli<sup>3</sup>, Milaine Sanfins<sup>1</sup>**<sup>1</sup> *Centro de Eletrofisiologia e Neuroaudiologia Avançada, CENA, Brasil*<sup>2</sup> *Instituto Nacional de Neurociência Translacional, INNT, Brasil*<sup>3</sup> *Clínica Respirare, Departamento de Audiologia Clínica*<sup>4</sup> *Universidade Estadual de Campinas, UNICAMP, Brasil***Keywords:** Electrophysiology, hearing, cross-check principle

**Background:** In 1976, James Jerger and Deborah Hayes first described the Cross-Check principle in audiology. According to them, no result should be accepted until it is confirmed by an independent measure. At that time, the battery of audiological tests was restricted and remained unchanged for approximately 20 years. In 2000, JCIH advocated the routine application of Frequency-Specific ABR (FS-ABR) and bone conduction ABR measurement for pediatric auditory evaluation. ASSR emerged as a clinically feasible technique for objective estimation of auditory thresholds, especially in children with severe to profound hearing loss. Today we have a very complete battery of audiological, behavioral, electrophysiological and electroacoustic tests that can and should be used for accurate and reliable diagnosis.

**Material and methods:** Case report

**Results:** Female child, 3 years old. At 18 months presented sudden stop in the global development and regression of the language. At age 2, she was diagnosed with Autism Spectrum Disorder. Today it presents an important delay in the acquisition of language. The child was prematurely mild (32 weeks) with no other complications in the neonatal period. He passed the Neonatal Hearing Screening. Mother with a report of deafness, but never did auditory evaluation. He has a first cousin with unilateral deafness diagnosed at 5 years. The click ABR showed an increase in the absolute latencies of waves III and V bilaterally; (I-III and I-V), a common finding in individuals with ASD (Rosenblum et al., 1980; Kwon et al (2007). The electrophysiological thresholds in the ASSR were within normal limits. In the electrophysiological evaluation through FS-ABR, electrophysiological thresholds were elevated at frequencies of 500 and 1000 Hz (50 and 40 dBNA, respectively).

**Conclusion:** The use of two or more methodologies in children's auditory evaluation was extremely sensitive in this case. The double checking of auditory thresholds proved to be sensitive in the diagnosis of unilateral mild hearing loss in a child with other sensory impairments. The diagnostic power of objective hearing tests is only achieved when they are carefully selected and applied in a judicious test battery.

**There is no conflict of interest.**

ID: 03849 -P101

**Phonological memory in patients with head and neck tumors****Natália Trigueiro, Flávia Pina, Ana Rita Nobre, Margarida Serrano**<sup>1</sup> *Instituto Politécnico de Coimbra, ESTESC-Coimbra Health School, Audiologia, Portugal*<sup>2</sup> *Instituto Português Oncologia de Coimbra Francisco Gentil E. P. E., Portugal*

**Background:** Hearing loss is one of the major complications of head and neck tumors. The combination of chemotherapy with cisplatin and radiotherapy, increased survival, becoming the standard of treatment for locally advanced tumors. However, all types of treatment, radiation therapy and chemotherapy with cisplatin, are known for their ototoxic effects. These treatments also impact the memory and brain structures associated with it. The present study aims to evaluate auditory thresholds and phonological memory changes in the individual with head and neck tumors submitted to chemotherapy and radiotherapy compared to a matched control group of age and sex who have never undergone this type of treatment, in order to alert about the hearing loss in these patients and to be created measures for the cognitive training plans in oncological patients submitted at these treatments.

**Material and Methods:** The sample was constructed by 24 patients with head and neck tumors of the Portuguese Oncology Institute of Coimbra Francisco Gentil E. P. E. and 24 individuals without oncological disease. The tests used were: pure tone audiogram (500Hz, 1000Hz, 2000Hz, 4000Hz, 6000Hz, 8000Hz), words repetition test, pseudowords repetition test (phonological memory test), memory test and all were realized at 65dB, in silence and noise conditions.

**Results,** The performance of the group of patients with tumor was worse in all tests. Statistical differences between groups were found in auditory thresholds, in words repetition and in pseudowords repetition test ( $p < 0.05$ ).

**Conclusion:** The ototoxicity of the treatments was confirmed by the pure tone audiogram that auditory thresholds are worse in head and neck tumor patients. Regarding phonological memory, considering the result of the repetition test of words and pseudowords, it can be seen that it is impaired by chemotherapy and / or radiotherapy as a treatment of head and neck tumors. It's essential to alert health professionals and family members about hearing loss in tumor patients, to be created measures for the evaluation and training of patient's memory.

ID: 03997 - P102

### Presentation of a questionnaire test made to assess the status of postlingually hearing impaired adult people

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**Keywords:** cochlear implantation, postlingual hearing loss, deafness, patient satisfaction

**Background:** After cochlear implantation (CI), postlingually hearing impaired adults live a much more active life than before. However, the improvement in Clear Sound Hearing Threshold often does not result in better listening comprehension. This phenomenon can significantly affect the quality of life after the operation. The question arises whether it is possible to forecast the rehabilitation chances of patients, especially the elderly.

**Material and method:** We have gathered from earlier operated patients the most typical complaints and statements before and after CI. To assess the patient's state before the operation (hearing and understanding speech, speech production, psychosocial difficulties caused by inadequate verbal communication) we compiled a list containing 22 statements. The patient points out to what extent the given statement is typical of him/her. Besides this, we named 10 causes which can be the patient's expectation or hope concerning the CI. We recorded the other symptoms relating to the cochleovestibular system (tinnitus, vertigo), those diseases which can further corrupt communication skills (vision loss, musculoskeletal disorders), diseases significantly affecting general state of health (hypertonia, diabetes, kidney disease). To describe the patient's state after the operation we compiled a list of 22 statements. The patient estimates to what extent the given statement is typical of him/her. Besides, in connection with the possible outcome of the CI, we listed 10 statements which, according to the patient, were "fulfilled", "partially fulfilled" or "not fulfilled". We recorded the other symptoms (tinnitus, vertigo) pertaining to the cochleovestibular system.

**Results and conclusion:** Rehabilitation results, success are not primarily influenced by age. Psychosocial conditions matter much more; to what extent the person with the hearing loss is motivated to utilize the chances offered by the implant set. The attained results can be expressed in figures too, and comparison can be made between patients or on the same patient depending on time. We cannot give a reliable prognosis, but we can help the patients and their relatives to set realistic expectations and evaluate the obtained results. If we take other recorded parameters into consideration, there may be a chance to establish prognostic groups.

**Conflicts of interest (if any):** None.

ID: 03835 - P103

### Elucidating pathological mechanisms of hearing loss induced by hypothyroidism using *Duox2* mutant mice

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**Keywords:** *Duox2*, hypothyroidism, hearing loss, growth retardation, thyroid hormone

**Background:** Developmental thyroid disorders can lead to hearing loss. Previous studies showed that the tectorial membrane, middle ears, and otic capsule were defective in various mouse models of hypothyroidism. However, it is still unclear how the lack of thyroid hormones leads to such defects in the inner and middle ear structures, which may be responsible for the hypothyroidism-induced hearing loss. In this study, pathological mechanisms of hypothyroidism-induced hearing loss in *Duox2* mutant mice was elucidated, and exogenous thyroid hormones were supplied to rescue hypothyroidism-induced hearing loss.

**Material and methods:** To investigate the pathological mechanisms of the hypothyroidism-induced hearing loss, we analyzed the inner ears of a spontaneous mutant from the Jackson Lab, which carries a mutation in dual oxidase 2 (*Duox2*). *Duox2* is an essential enzyme in thyroid hormone synthesis, and mutations in the *DUOX2* gene in humans have been shown to cause typical phenotypes of congenital hypothyroidism. We evaluated serum levels of T4, hearing function by ABR analysis, histological phenotypes, and gene expression patterns by in situ hybridization.

**Results:** *Duox2* mutant mice suffered from hypothyroidism and growth retardation and severe hearing loss, and their tectorial membrane was severely thickened. To understand the molecular mechanisms of thickening of the tectorial membrane, we examined expression patterns of receptors for thyroid hormones. Size of round window is decreased and middle ear ossicles were enlarged. To rescue hearing loss of *Duox2* mutants, we supplied exogenous thyroid hormones and growth was recovered and hearing ability was significantly improved. Tectorial membrane, middle ears and round window developed normally.

**Conclusion:** Hypothyroidism-induced hearing loss in *Duox2* mutants is resulted from abnormally thickened tectorial membrane and enlarged middle ear ossicles. And exogenous thyroid hormone treatment during neonatal stages can rescue structural defects of the inner and middle ears and significantly improve hearing ability in *Duox2* mutant mice

ID: 03948 - P104

## The effects of auditory deprivation on visual reaction time and language abilities of adolescents with and without cochlear implants

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**Keywords:** deafness, cochlear implantation, reaction time, education

**Background:** Previous studies have reported that deafness in the early childhood leads to visual compensation in the form of much faster peripheral visual reaction time. The response of time visual advantage is consistent with the plasticity benefits to vision of auditory deprivation and use of a visual spatial language. Therefore, the objective of the study was to investigate whether hearing loss had an effect on a reaction time to a visual stimulus and language abilities of adolescent with and without cochlear implants.

**Material and methods:** A group of 68 deaf adolescents, and a matched group of 30 normal hearing adolescents participated in the study. All deaf participants exhibited hearing loss of above 80 dB and were divided into two groups, ie., those with cochlear implants (the Nucleus 22-electrode CI) and the non-CI group used hearing aids. The times of simple reaction times (RTs) and language abilities of CI adolescents were compared to those of non-CI participants and the control group (CG). The RTs test were carried out with the use the MRK reaction meter (MRK 433 Zabrze, Poland) designed to measure the time of reaction to visual and auditory stimuli. The test were involved 18 light stimuli and 7 sound signals. All subjects participated in a formal assessment of their language competence according to the examination standards (the Final Gymnasium Examination Test, FGET).

**Results:** The groups of adolescents with CI, non-CI, and hearing participants were compared for age, gender, and somatic variables. Deaf adolescents with CI and without CI demonstrated significant faster mean visual RT (428 ms vs 410 ms, respectively) compared to hearing subjects (480 ms;  $P < 0.01$ ). There were no significant differences in RTs between the CI and non CI groups. A significantly higher mean RTs to auditory stimuli was observed in deaf adolescents with CI compared to hearing adolescents (595 ms vs 348 ms  $P < 0.001$ ). The results of the FGET test did not differ significantly between CI and non-CI students, however, were lower compared to hearing participants ( $P < 0.01$ ).

**Conclusions:** Hearing loss in the early stages of child development may lead to improvement in visual reaction time which may be important for proper voice therapy and rehabilitation. Cochlear implantation significantly alter the

auditory reaction time, however, did not improve language competence in relation to hearing peers.

**Conflict of Interest:** The authors declare no conflict of interest

ID: 04284 - P105

## A bio-inspired coding (BIC) strategy for cochlear implants

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**Keywords:** ECAP, CI coding strategy, MCI, OLSA

**Background:** Temporal response properties of auditory nerve fibers in addition to the spatial spread of neural excitation (SOE) can impose limitations for electrical stimulation of cochlear implants (CIs). Therefore, a coding strategy that takes into consideration such neurophysiological characteristics would be beneficial for CI users. The aim of this study is firstly to extract these characteristics such as refractory recovery, facilitation and SOE with NRT recordings and then integrate the extracted characteristics in a bio-inspired coding (BIC) strategy for CIs. The BIC strategy is compared in a melodic contour identification (MCI) and an adaptive OLSA in noise test to the ACE coding strategy.

**Material and methods:** 11 CI recipients implanted with the Nucleus® implants participated in the study and individual AGFs were recorded for three test electrodes (E6, E12 and E18) with a masker offset of +10 CL. The ECAPs were measured with the modified forward masking method (recovery and facilitation functions) and the standard forward masking paradigm (SOE function). The probe level was set to LAPL in the recovery and SOE measurements while for the facilitation recording it was equal to the current level that yielded 100µV ECAP response amplitude. The MCI experiment was tested with 5 melodic patterns and 3 intervals between successive notes. The OLSA sentence test in noise was conducted with two training lists of 20 sentences and two test lists of 30 sentences.

**Results:** The results from 11 CI recipients in the MCI and the adaptive OLSA in noise experiments in comparison to the ACE strategy will be discussed. In addition, a function for the facilitation effect will be fitted to data collected from all CI participants in the study and the goodness of fit will be evaluated. Collected facilitation data will be compared to the former studies.

**Conclusion:** The probe level showed an effect on the recovery time constant and absolute refractory period while the facilitation effect showed no dependency on the probe level. CI subjects showed better performances in the MCI test with the BIC strategy, however, most of the CI users in this study had musical background and good experience of playing musical instruments. Therefore, it would

be interesting to conduct experiments with CI subjects without musical background in future studies.

**Conflicts of interest:** All authors declare no actual or potential conflicts of interest.

**ID: 03975 - P106**

### Primary hearing health: action to raise awareness on secondary education

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**Keywords:** health literacy, school, noise, hearing loss

**Background.** With the evolution of technology, young people increasingly use portable devices for entertainment, learning and as a means of communication. Most of the use of these devices involves excessive and unnecessary exposure to noise and/or high intensity sounds, which can cause hearing loss. The aim of this work was to know the receptiveness on lecturing sessions to raise awareness of hearing health and risk behaviors in the eighth year of secondary education and what are the activities/exercises more appropriate for knowledge consolidation.

**Materials and Methods.** Within the curricular unit “Clinical Education” programme of the bachelor of science degree in Audiology from the School of Health, Polytechnic of Porto (ESS-P.Porto), a lecture was held to raise awareness for students attending the eighth year of secondary education, complemented with a set of age-appropriate activities, promoting hearing health literacy. The acquisition of knowledge was assessed with 3 activities: legend of figures (first), matching pictures (second) and crosswords (third).

**Results.** A total of 98 students (47 female and 51 male) participated, regarding the number of 100% Correct/Wrong answers completed, the first activity with a score of 30/0, the second 1/12 and the third a score of 8/16. It appears that figure labelling (first activity) is the most effective for content acquisition, comparing to the crosswords with the lowest score (16 students not hit a single correct answer) may be due to the complexity of the terms (anatomy and symptoms): “eardrum, stapes, incus, malleus, cochlea, sound, ear wax, tinnitus, otitis, deafness”.

**Conclusions.** The educational sector, due to its scope, is an important partner for the implementation of awareness and promoting individual and group preventing behaviors, aiming to the well-being of the entire school community. Thus, secondary education schools are the best institutions for health literacy on hearing preservation, being the figures labeling the most effective knowledge consolidating activity in 8th grade.

**ID: 04025 - P107**

### P300: hemispheric differences with verbal and non-verbal stimuli and age effect

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**Keywords:** P300; Verbal and non-verbal stimuli

**Background:** P300 is a result of focusing attention on rare stimuli, among other stimuli and investigates skills such as attention and memory. The latency of the P300 is an evaluation parameter that changes with age and acoustic signal processing occurs differently between verbal and non-verbal stimuli, and may interfere with latency and amplitude patterns. This study aims to verify if there are hemispheric differences when comparing the values of latencies and P300 amplitudes with verbal stimuli and nonverbal stimuli, and to evaluate the effect of age.

**Material and Methods:** Twenty-five individuals from both genders in the age group of 20 to 55 years were divided into two groups, which differed in terms of age, being a group of 20 to 39 years and another group of 40 to 55 years. We evaluated P300 right and left results with verbal and nonverbal stimuli.

**Results:** There were no statistically differences between the two groups of different ages; in comparison with the two types of stimulus, was only significant in the right ear for both verbal stimuli as nonverbal; between the two ears only when the stimuli were verbal.

**Conclusion:** It is important to note that latencies and amplitudes show differences only in right ear with both types of stimuli and between the ears is only significant when the stimuli are verbal.

**ID: 04038 - P109**

### Usher syndrome - hearing and balance disorder plus visual impairment

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**Keywords:** Usher syndrome, hereditary hearing loss, vestibular dysfunction, retinitis pigmentosa

**Background:** Usher syndrome is characterized by the association of sensorineural hearing loss with or without vestibular dysfunction and visual impairment (retinitis pigmentosa). With a prevalence estimated to be 3-8 per 100,000 individuals, Usher syndrome can be divided in three types, where type I is the most severe form. Most individuals with Usher syndrome type I are born with severe to profound hearing loss, abnormalities of the vestibular system and progressive vision loss becomes apparent in childhood. Usher syndrome type II is characterized by mild to severe hearing

loss from birth and progressive vision loss that begins in adolescence or adulthood. They present normal vestibular function. Usher syndrome type III patients can present a variable onset of progressive hearing loss and visual impairment; some have vestibular dysfunction. Usher syndrome is usually inherited in an autosomal recessive pattern. There are mutations reported in 14 genes: 9 of them associated to type I, 3 genes to type II and only 2 genes have been linked to type III so far. In some people/patients with this syndrome, the genetic cause of the disease has not been identified yet, probably they are associated with other genes and also some patients have compound heterozygosity.

**Material and methods:** Using molecular genetic techniques, the identification of genes associated with Usher syndrome will allow screening the hearing impaired. Using interaction analysis techniques, the identified gene products could be shown to interact with one another in one or more larger protein complexes.

**Results:** Most of the gene mutations responsible for Usher syndrome lead to a loss of hair cells in the inner ear and a gradual loss of rods and cones in the retina. If one of the components is missing, the protein complex cannot fulfil its function in the living cell, and it probably comes to the degeneration of the same. The function of this protein complex has been suggested to participate in the signal transduction or in the cell adhesion of sensory cells.

**Conclusions:** In reporting the different manifestations of Usher syndrome, we hope to help in the correct diagnosis and treatment at an early stage.

**Conflicts of interest:** None.

**ID: 04063 - P110**

### A systematic review of cognitive assessments for people with acquired hearing impairment

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**Keywords:** dementia, hearing impairment, cognitive tests, assessment

**Background:** Sensory impairments are common in older adults and hearing impairments commonly go unrecognised and untreated. Sensory impairments can imitate cognitive problems, affect cognitive testing and increase functional difficulties in daily living. It is thus important to rule out and treat sensory problems in people complaining of memory problems. Tests used to identify dementia rely on good sensory functioning, so someone might do poorly because they have sensory rather than cognitive problems. Sensory impairment may result in people not receiving appropriate treatment or support. We carried out a systematic review of screening tools for the identification of dementia in adults with acquired hearing impairment.

**Materials and methods:** Electronic databases were searched using subject terms “hearing disorders” AND “cognitive assessment”, supplemented by exploring reference lists of included papers and through consultation with professionals to identify additional literature.

**Results:** Four papers related to tests adapted for hearing impairment met inclusion criteria. The most commonly adapted tests were the Mini-Mental State Examination and the Montreal Cognitive Assessment. Adaptations for hearing impairment typically involved deleting sensory-dependent items or replacement written versions. No study reported the validity of the adapted test in relation to the detection of dementia. Item deletion had a negative impact on tests’ psychometric properties.

**Conclusion:** The validity of tests adapted for people with hearing impairment is unknown. Potential solutions include adaptation via item substitution and re-validation of the adapted test.

**Conflicts of interest:** none declared

**ID: 03772 - P111**

### Irish school entry screening and referral trends and cohort comparison with preschool specialist referrals

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**Objectives:** 1) To analyse referral cohorts from School Entry Screening, Hearing Screening (=SHS) and Vision Screening (=SVS), and to evaluate the impact of documented SHS National protocol changes in 2016. 2) To summarise referrals to preschool Allied Health and Medical specialists, relative to hearing status.

**Design:** A randomized, anonymised cohort audit analysis of the Child Health Records of 882 mainstream pupils was completed jointly by Wexford Audiology and Public Health Nursing staff in 2015–2018. Relevant Audiology file data enabled assessment of SHS programme yield. We measured the impact of introducing Schools (Public Health) Nurses and also a new National SHS Protocol in 2016.

**Results:** Significant age and referral rate differences existed between Hearing and Vision Screening for all birth cohorts. Hearing (SHS), but not Vision (SVS), referrals were impacted by nursing staff changes. SHS protocol changes did not cause a significant referral rate change. Preschool Audiology referrals far outnumbered SHS referrals. SHS yielded children with conductive hearing loss only, not sensori-neural. Similar SHS referral rates occurred for preschool Speech Language Therapy referrals compared to children not referred (also true for other preschool specialist referrals, e.g. Developmental Clinic, Ophthalmic and Social Work referrals). Only 16% of preschool Speech Language Therapy referrals went on to Audiology.

**Summary and Conclusions:** Referral percentages: SHS fell; SVS remained unchanged. Low SHS referral rates and yield have modest impact upon Audiology services, but audiometrically screened school-aged referrals deserve higher priority than unscreened children. The study also showed the importance of consistent filing on UNHS results so that they are available to other services through Child Health Records. Extended comparisons and European SHS research collaboration are encouraged.

**ID: 03913 - P112**

### Analysis of the diagnostic results of children who have not passed the hearing screening test in PUNHSP

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**Keywords:** newborn hearing screening, hearing loss, OAE

**Background:** The Polish Universal Neonatal Hearing Screening Program (PUNHSP) has been running in Poland for over 16 years and it is the biggest preventive health Program in Poland. It was created as a civil initiative with the cooperation of a charitable organization, The Great Orchestra of Christmas Charity Foundation, and the cooperation of neonatologists, otolaryngologists and audiologists.

**Material and methods:** The Polish Program is based on three levels: early detection of hearing loss, audiological diagnosis and intervention. From 1 January 2003 to 21 November 2018 there were 5 931 466 children registered in the Central Database of Polish Universal Neonatal Hearing Screening Program. It represents 96.5% of the newborn population born at that time in Poland.

**Results:** 8.8% (522 500) children who has been screened on first level, were sent for further diagnosis. In the last decade, the number of children who have not passed the OAE test ranged from 2.3% to 3.2%, on average maintaining at 2.8%. Recently, the percentage of children who do not pass OAE increased from 2.5% in 2017 to 3.2% in 2018.

**Conclusion:** The reason for the increase in the number of children who have not passed the OAE test may be the replacement of equipment in all neonatal centers in Poland.

**Conflicts of interest:** There is no conflict of interest.

**ID: 04127 - P113**

### Thirteen year experience with BAHA

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**Keywords:** Bone Anchored Hearing Implant; Hearing Outcome

**Background:** Osseointegrated auditory devices (OADs) are hearing devices that use an external receiver/processor that stimulates bone conduction of sound via a titanium prosthesis that is drilled into the bone of the cranium. Bone-anchored hearing aids (BAHA) are indicated in patients with conductive or mixed hearing loss unsuitable for conventional air conduction hearing aids and ineligible for surgical rehabilitation. The indications for BAHA have been more recently extended to single sided deafness as several studies have demonstrated improved speech understanding in noise and improved hearing comfort related to attenuation of the “screen” effect of the head in these patients, under certain conditions. Complications include inflammation/ infection and fixture loss due to inadequate osseointegration.

**Material and methods:** A retrospective study was conducted of all patients receiving implantation of a BAHA in our center from January of 2005 to December of 2018. All clinical process were consulted and data collected included: patient age, gender, side operated, type of processor, otological pathology, type of deafness, audiometric results previous and post operatory and complications. The statistical analysis was performed using analysis of variance (ANOVA), Tukey pairwise comparison, chi-square, and paired t -test. Statistical significance was determined using a level of  $p < 0.05$ .

**Results:** we gathered a sample of 97 patients, 39 women and 58 men. 37 had left BAHA, 1 had bilateral implant and 59 had right. The most common otological pathology was sensorineural hearing loss and the most frequent complication was skeen inflammation. Every patient had improved in vocal and tone audiometric results.

**Conclusion:** BAHA are an easy and feaseble method of improving hearing, with good audiometric results and low complication rates.

ID: 03895 - P114

**Impact of stroke on hearing ability**Raquel Assis<sup>1</sup>, Vasco Oliveira<sup>1,2</sup><sup>1</sup> *Escola Superior de Saúde, Politécnico do Porto, Portugal*<sup>2</sup> *Consulta de ORL, Hospital das Forças Armadas, Pólo do Porto, Portugal***Keywords:** Hearing loss, Internal Auditory Artery, Ischemic stroke, Stroke, Tone audiometry

**Background:** Stroke is essentially a disease in which there is a failure to deliver oxygen to brain cells. The symptoms of this lesion begin to appear in the regions of the body that are controlled by these same cells, and one of the symptoms is the hearing loss. Since the inner ear is irrigated by the internal auditory artery, when an occlusion of this artery occurs a hearing loss appear, which remains one of the neglected and underestimated symptoms of stroke. This hearing loss is usually sensorineural, and may be unilateral or bilateral, depending on the area affected by the stroke.

**Material and methods:** The objective of this paper is to determine if there is and what the impact of strokes on hearing ability, evaluate the audiological results after the stroke, and which is the type of hearing loss. This is a bibliographical review of the literature and the scientific database used for the research was PubMed, using the terms “Stroke” AND “Hearing Loss” AND “Auditory”.

**Results:** From the research carried out, a research diagram resulted, with initial results of 135 articles, of which 17 are eligible and with full text for the analysis. The relationship between the existence of cerebrovascular accident and hearing loss, supported by the articles used, was verified. There is a consensus regarding the type of predominant stroke, the hearing loss present in this population, and in relation to the frequencies most affected.

**Conclusion:** Tone audiometry, speech audiometry, impedancimetry, and otoemissions are the most present tests in the studies observed in this review. There is a great need to implement a standard audiological protocol, which will allow a hearing monitoring and, in this way, it will allow to assist in the medical decisions regarding the therapeutic intervention in order to ensure the best possible functioning of the hearing.

ID: 03898 - P115

**Type 2 diabetes and hearing loss, but also possible auditory neuropathy, a French study**Ludivine Beaud<sup>1</sup>, Igor Tauveron<sup>2</sup>, Paul Avan<sup>1</sup>, Fabrice Giraudet<sup>1</sup><sup>1</sup> *Laboratory of Neurosensory Biophysics, UMR INSERM 1107, School of Medicine, University Clermont Auvergne, Clermont-Ferrand, France*<sup>2</sup> *Department of endocrinology and diabetology, University Hospital, Clermont-Ferrand, France***Keywords:** type 2 diabetes mellitus, audiological evaluation, cochleopathy, auditory neuropathy

**Background.** Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. T2DM is the most common form of DM, which accounts for 90% to 95% of all diabetic patients. T2DM is a serious and common chronic disease resulting from a complex inheritance-environment interaction along with other risk factors such as obesity and sedentary lifestyle. T2DM and its complications constitute a major worldwide public health problem. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Many aspects in overall health are affected by DM and the disease is also an important risk factor for the development of hearing loss.

**Material and methods:** Auditory function was measured through transient evoked otoacoustic emissions (TEOAE), distortion product otoacoustic emissions (DPOAE), tympanometry and acoustic reflexes, pure tone audiometry. The hearing complaints or difficulties was assessed with a simple questionnaire Results were compared to normative data and correlated regarding age, presence of nephropathy, retinopathy, peripheral neuropathy scores, number of hypoglycemics and glycosylated hemoglobin.

**Results:** A total of 166 patients with T2DM were included in the study (66 women vs 97 men, mean age 60 ± 12 years (23-79y), disease duration 12 ± 10 years (0-42y)). 116 out of 166 patients (70%) report to have a hearing complaints and 58 patients (35%) have a subjective tinnitus. 57 out of 166 patients (35%) report to have been exposed to noise exposure during the work and leisure activities. The otoacoustic emissions responses were considered abnormal in 60% patients. The acoustic reflex was present in 57%. The hearing threshold were compared to the statistical distribution of hearing thresholds related to age and gender (ISO 7029:2017)

**Conclusion:** Audiometric analysis showed that type 2 diabetic patients present an increased prevalence of hearing loss in relation to normative values according to age. Results indicate that probable auditory neuropathy (abolition of the stapedial reflex) and cochlear pathology (reduced/absent OAE) may coexist in this population.

ID: 03899 - P116

**Type 1 diabetes and the risk of incident hearing loss: a French study****Ludivine Beaud<sup>1</sup>, Igor Tauveron<sup>2</sup>, Paul Avan<sup>1</sup>, Fabrice Giraudet<sup>1</sup>**<sup>1</sup> *Laboratory of Neurosensory Biophysics, UMR INSERM 1107, School of Medicine, University Clermont Auvergne, Clermont-Ferrand, France*<sup>2</sup> *Department of endocrinology and diabetology, University Hospital, Clermont-Ferrand, France***Keywords:** type 1 diabetes mellitus, audiological evaluation, cochleopathy,**Background,** Diabetes mellitus (DM) is characterized by a metabolic disorder in which there is a state of hyperglycemia. While type 2 DM (T2DM) is a result of insulin resistance, type 1 DM (T1DM) is mainly due to a lack of insulin caused by the destruction of beta cells in the pancreas by an autoimmune process. T1DM manifests at earlier ages than T2DM and therefore its complications tend to present at young adulthood.**Material and methods:** Auditory function was measured through transient evoked otoacoustic emissions (TEOAE), distortion product otoacoustic emissions (DPOAE), tympanometry and acoustic reflexes, pure tone audiometry. The hearing complaints or difficulties was assessed with a simple questionnaire Results were compared to normative data and correlated regarding age, presence of nephropathy, retinopathy, peripheral neuropathy scores, number of hypoglycemics and glycosylated hemoglobin.**Results:** A total of 114 patients with T1DM were included in the study (73 women vs 41 men, mean age  $46 \pm 16$  years (18-79y), disease duration  $18 \pm 13$  years (0-60y)). 68 out of 114 patients (60%) report to have a hearing complaints and 17 patients (15%) have a subjective tinnitus. 43 out of 114 patients (38%) report to have been exposed to noise exposure during the work and leisure activities. The otoacoustic emissions responses were considered abnormal in 35/114 (31%) patients. The acoustic reflex was present in 84%. The hearing threshold were compared to the statistical distribution of hearing thresholds related to age and gender (ISO 7029:2017)**Conclusion:** The results indicate a reduced cochlear function in T1DM. The underestimation of hearing loss, while patients report hearing complaints, can be revealed using otoacoustic emissions. The recurrent hypoglycemia could be one of the hypothetical and observable consequences of diabetes on the hearing function.

ID: 03915 - P117

**Audiological evaluation using computational methods****Fernanda Gentil, Marco Parente, Carla Santos, Bruno Areias, Renato Natal**

ESS

**Keywords:** Biomechanics, Ear, Audiological, Finite Element Method**Background:** The biomechanical studies of the ear use medical images like Computerized Tomography with the purpose to build 3D computational models with the same morphological characteristics and dimensions. Computational techniques are used to construct the model representative of normal ear and it is possible to compare this model with others simulating different pathologies, like eardrum perforations, myringosclerosis, tympanosclerosis, otosclerosis, tumours and others. It can present a key role in diagnosis and treatment of the ear diseases, because in addition, through the computational modelling of the ear, anatomical abnormalities can be easier identified. It is still possible to establish a comparison with the existing diagnostic audiological testing.**Materials and Methods:** A biomechanical study of the middle ear, using the Finite Element Method, was made [1]. Mechanical properties from the literature were applied in all model. The finite element mesh and the numerical simulations were carried out using the software Abaqus® Standard. The study includes the comparison of the movement of the umbo and stapes footplate between models. Different simulations are done comparing with the healthy ear model.**Results:** The aim of this study is to analyse different situations to improve the understanding of ear pathologies and its rehabilitation. In this work, we can compare the results obtained in some middle ear pathologies, like perforations, myringosclerosis and otosclerosis.**Conclusion:** Different sizes of eardrum perforations results in different displacements, being smaller with bigger perforations. In cases of myringosclerosis, eardrum vibrates less with the increased stiffness due to myringosclerosis presence, not having significant differences in high frequencies. When simulating otosclerosis, we can conclude that there was a decrease of the displacements for all frequencies, with the increase of stiffness of annular ligament. The present study allows to conclude that the audiological evaluation / rehabilitation of the ear may be easier with the computational strategies.

ID: 03961 - P118

### Auditory health of adolescents using personal stereo: an analytical study with questionnaire of inquiry

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**Keywords:** auditory health; Earphone; analytical questionnaire.

**Background:** Currently the headset has become an almost indispensable accessory in daily life. This equipment offers sounds of up to 120 decibels directly in the ear-drum therefore it is considered by the very harmful doctors. There are several studies on occupational noise, but there are not so many studies with young people exposed to high noise levels. Thus, the present work presents the result of a questionnaire about the habits of adolescents about the use of the headset. The questionnaire is part of the doctoral project, whose final objective is the development of a transmedia documentary on Hearing Health Education.

**Objective:** To analyze the relationship between adolescents' habits regarding the use of the headset and the possible auditory impairments.

**Methodology:** This is a cross-sectional analytical study that investigated, through a questionnaire, the habits of adolescents about the use of the headset, applied in 195 adolescents of both sexes, with a mean age of 16.7 years during the second half of 2018. The adolescents answered the questionnaire, with closed questions, before the workshops to develop the documentary. The questionnaire was structured addressing the habits of use of the equipment, hearing symptoms after use and the degree of awareness about the possible risks that can cause the hearing. The project was approved by the Ethics Committee of the University of São Paulo under CAAEE 84323618.3.0000.5417.

**Results:** The analysis showed that 77.4% of the young people increase the earphone volume when they are in a noisy environment, 54% listen to music at high volume. Of the symptoms already apparent after using the handset, 20.8% have tinnitus and 32% have a muffled ear sensation. However, 47% say they have "never paid attention" to "hearing symptoms". All respondents say they know that earphone use can cause hearing problems, but 98% say they will continue to use it.

**Conclusion:** Although they admit to knowledge about the damage that earphone use can cause hearing, young people's behavior evidences the inappropriate use of headphones identified by high sound intensities, long periods of exposure and frequent use. Indications of symptoms after use suggest a greater risk for the hearing of these young people.

ID: 03984 - P119

### Congenital hypothyroidism and cochlear disorders

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**Keywords:** Congenital hypothyroidism; Thyroid hormones; Hearing loss; Cochlear disorders; Auditory thresholds.

**Background:** The thyroid is an endocrine gland, where large concentrations of thyroid hormones are stored. A decrease in the concentrations of these hormones during the embryonic period may cause damage to the cochlear function causing sensorineural hearing loss. The purpose of this work is to study the influence of congenital hypothyroidism on auditory system and hearing level, as well as, understand which mechanisms and structures that suffer changes due to the influence of decrease or absence of the concentrations of the thyroid hormones and their receptors.

**Material and Methods:** A systematic review of the literature was carried out, based on a review of original studies published from 2007 to 2018, that correlating congenital hypothyroidism with cochlear disorders/malformations and hearing loss. The research of scientific articles was done at the electronic databases B-on, Medline, PubMed, SciELO, ScienceDirect and Google Scholar with the keywords: congenital hypothyroidism, hearing loss, cochlear alterations, thyroid hormones, thyroid receptors and respective terms in Portuguese.

**Results:** Among 41 articles found, were included 5 for this review which study possible mechanisms that lead to hearing loss, through evaluation of the damage caused by changes in hormones and thyroid receptors, and through the assessment of the auditory system of individuals with congenital hypothyroidism.

**Conclusion:** Congenital hypothyroidism it seems to be responsible for the decrease in auditory acuity, since the decrease or absence of thyroid hormones concentrations leads to changes in morphology and cochlear function. According to the results obtained in otoacoustic emissions in analysed studies it is possible to demonstrate the existence of cochlear lesions in individuals with congenital hypothyroidism. To complement this factor indicative of cochlear lesions, the results of studies with imaging tests show that there is a thickening along the entire length of the tectorial membrane being more evident in the apical zone. From studies' results we consider important that individuals diagnosed with congenital hypothyroidism regularly make audiological evaluations to assess and monitoring their auditory system.

**Conflicts of interest:** None to declare.

ID: 04065 - P120

**Glutathione - Involvement in the antioxidant defense of the auditory system**Paula Lopes, José Vieira*Escola Superior de Saúde do Politécnico do Porto*

**Introduction** Glutathione (GSH) is the most abundant low molecular weight thiol at the cellular level and is mostly located in the plasma membrane. GSH is one of the most important antioxidants in the human body and plays a important role against free radicals, specifically Reactive Oxygen Species (ROS) in systems that are subject to oxidative stress. However, this molecule does not act exclusively as an antioxidant agente, because it also has other functions at the cellular level such as intervention in metabolism and regulation. The association with the increase of oxidative stress and the metabolism of GSH, in the hair cells of the cochlea, has been related as one of the factors of hearing loss due to exposure to high sound levels. However, it is important to see if the mechanisms to increase the concentration of this substance contribute to prevent the death of the hair cells and, consequently, prevent hearing loss. There are two types of cell death: necrosis and apoptosis. Necrosis is usually induced by a noxious agent and apoptosis - or programmed cell death - is an active mechanism that plays a role in regulating the amount of cells in the body. Oxidative stress is one of the intracellular stimuli that can lead to its activation of the mechanism of apoptosis.

**Objectives** Determine if GSH plays a major role in hearing protection and identify what strategies exist to increase the concentration of this antioxidant in the human body, in particular in the cochlea.

**Methodology** Systematic review of existing literature on Glutathione as an agent in the antioxidant defense of the auditory system, with a detailed approach of the literature to answer the question: *what is the GHS involvement in the antioxidant defense of the auditory system?*

**Conclusions** Regarding GSH, it seems clear that it is the most important substance in the process of free radical neutralization (ROS) in the tissues of the cochlea. This increase seems to be related to several factors: exposure to high sound levels, aging, genetic factors, health status (diabetics, smoker...) and ototoxic agents. The use of N-acetylcysteine amide (NAC) - as a precursor of GSH - appears to be the most effective in hearing protection since it leads to an increase in GSH in cochlear tissues.

ID: 04093 - P121

**Sudden sensorineural hearing loss related to vertebrobasilar arterial insufficiency – a challenge in clinical practise**Lea Zupan, Marko Zupan*General Hospital Celje, Slovenia***Keywords:** Sudden sensorineural hearing loss, stroke

**Background:** Sudden sensorineural hearing loss (SSNHL) is defined as greater than 30 dB hearing reduction, over at least three contiguous frequencies, occurring over a period of 72 hours or less. It is a medical emergency with multifactorial causes, of which viral, autoimmune and vascular insufficiency are the most common. In clinical studies isolated SSNHL has been rarely related to vertebrobasilar arterial insufficiency (VAI).

**Material and methods:** In our observational study we analysed 22 cases affected by SSNHL eventually associated to vestibular symptoms but in absence of other neurological involvement to describe clinical course and report the incidence of SSNHL related to VAI. In the period from 1st January to 31st October 2018 we treated 70348 patients in our Emergency Center. Those with sudden hearing loss had been referred for diagnostic treatment to otorhinolaryngologist. We diagnosed 22 patients (15 males/7 females; aged 21 to 85 years) with idiopathic SSNHL by careful history, physical examination, looking for infections, systemic diseases, ototoxic medications and by documenting recent decline in hearing. For the diagnostic audiologic evaluation we performed pure tone audiometry, tympanometry, measuring otoacoustic emissions and brainstem auditory evoked potentials. In all patients we performed balance tests and Computer Tomography (CT) or Magnetic Resonance Imaging (MRI) of the brain.

**Results:** In all cases only one ear was affected. 20 patients (90,90%) had tinnitus and fullness in the ear and 5 (22,73%) had vertigo. 13 patients (59,09%) had cardiovascular risk factors. In 2 cases (9,09%) we diagnosed infratentorial stroke. Both patients were men with cardiovascular risk factors.

**Conclusion:** SSNHL is the presenting symptom of an emergency for which we have to find a convincing course and reliable treatment. The clinical presentation of our cases emphasizes that a careful follow-up of any patient with SSNHL is warranted. Our results confirm 9,09% incidence of VAI as the cause of SSNHL. This should be suspected in patients with cardiovascular risk factors. Acute audiovestibular disturbance can be the harbinger of more widespread posterior circulatory ischemic stroke. We underline the necessity of its early recognition and proper management.

ID: 04138 - P122

### An unusual case of facial palsy caused by penetrating head trauma without temporal bone fracture- case report

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**Keywords:** Head trauma, facial nerve palsy, electromyoneurography, stapedial reflex

**Background:** A 32 year old male patient was admitted to the emergency department with a penetrating injury on the right side of the neck just behind the right ear, accompanied with evident right facial nerve palsy, evaluated as House Brackmann grade IV. He acquired the injury when a construction protractor with a sharp tip fell from a height. An emergency MSCT-scan described a retroauricular subcutaneous gas collection measuring 0.6 cm, which corresponded the presumed sharp object entry trajectory. The right parotid showed normal morphology, without a hematoma or signs of bone trauma. Pure-tone audiometry verified normal hearing on both ears. Tympanometry showed type A tympanogram bilaterally. Acoustic stapedial reflex was intact bilaterally. The case we present is unique, because facial nerve palsy after head trauma without temporal bone fracture resulted in recovery of facial nerve motor function after severe acute injury of the upper motor branch of the right facial nerve (80% axons degenerated), severe acute injury of the middle and lower motor branch (70% axons degenerated), severe acute injury of the sensory part of facial nerve (n. intermedius).

ID: 03907 - P123

### Efficiency of distortion product otoacoustic emissions as ototoxicity monitoring method

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**Keywords:** ototoxicity, DPOAE, hearing impairment

**Background:** Cisplatin and carboplatin are effective chemotherapy medications against different kinds of malignant tumors. Their known ototoxic adverse effect can cause hearing impairment and affect patient's quality of life.

**Materials and methods:** First time in Armenia, starting October 2018, program for monitoring of ototoxicity is implemented. This is taking place in Nairi MC and being funded by Science Committee of Ministry of Education and Science of Armenia from 09/2018 to 09/2020. 22 patients receiving

cisplatin and carboplatin are being monitored. Methods of monitoring were chosen to be Pure Tone Audiometry, DPOAE and questionnaire filled by patients about the level of hearing impairment at current moment and the timing of noticing hearing impairment. Patients were evaluated prior to chemotherapy, before each cycle of chemotherapy, one month after chemotherapy. Also, there is a plan to evaluate them in 3 and 6 months after chemotherapy. Boston Ototoxicity Scale is used to define ototoxicity by PTA method. By DPOAE method ototoxicity was defined as 10dB for each frequency and more in case it was retested.

**Results:** 10 patients from 22 had baseline mild to moderate hearing loss, so DPOAE method wasn't informative. As per PTA and questionnaire data 2 of them (1 receiving cisplatin and 1 receiving carboplatin) had worsening of hearing impairment 1 month after chemotherapy. 12 patients did not have baseline hearing impairment prior to first chemotherapy. 2 of them did not have hearing impairment after 1 month of chemotherapy as per PTA and questionnaire methods, but as per DPOAE results, there were more than 10dB changes in 4000, 6000 and 8000Hz frequencies. 1 patient had mild hearing loss after 1 month of chemotherapy as per PTA, DPOAE and questionnaire results. For final diagnosis of all patients there is plan to evaluate them in three and six months after chemotherapy.

**Conclusion:** Monitoring of ototoxicity is important for early detection of hearing loss, potential treatment modifications and prevention of further loss. DPOAE can be very useful and effective tool for monitoring ototoxicity. We need to evaluate more patients to estimate more precisely the effectivity of DPOAE method and to implement our own protocols for ototoxicity monitoring.

ID: 04077 - P124

### Prevalence and characteristics of distortion product otoacoustic emissions in a representative sample of 70 year olds

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**Introduction:** Epidemiological studies of age related hearing loss are important to understanding the frequency and characteristics of hearing problems at population level. There is a wealth of research on how pure tone audiometry is affected by ageing. However, considerably less has been published regarding otoacoustic emissions in old populations.

**Aim:** To determine the prevalence and characteristics of Distortion Product Otoacoustic Emissions in an un-screened population-based sample of 70-year olds.

**Methods:** As part of a geriatric population-based study in Gothenburg, Sweden, representative samples of 70-year olds (N=251) were tested with pure tone audiometry and DPOAE. DPOAEs were registered at six test frequencies from 1-6 kHz. A signal to noise ratio of 6 dB was required for considering an emission as being present. Ears with abnormal tympanometry were excluded.

**Results:** The prevalence of DPOAEs were in the range of 13-70 % for male participants, depending of the test frequency, and in the range of 27-74 % for females. The prevalence was significantly higher for women in the high frequencies (3-6 kHz), whereas the opposite was true at 1 kHz. Of those with present DPOAEs the average amplitudes varied between 6-14 dB with standard deviations between 5-8 dB. There was no significant difference between men and women in terms of amplitude. Both prevalence and amplitudes of DPOAEs were weakly to moderately associated with the equivalent pure tone thresholds ( $p < 0.001$ ).

**Conclusions:** DPOAEs are present in the majority of 70-year old ears. DPOAE may thus be a useful test to include in screening and differential diagnosis of hearing loss in this age group.

**ID: 04027 - P125**

### Sound localization and auditory memory in children with or without middle ear alteration

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**Keywords** Middle Ear Alteration; Sound Localization; Auditory Memory

**Background,** According to studies, there is a relation between the alteration of the middle ear (ME) with the abilities of sound localization and auditory memory. Changes in the ME can lead to a lack of auditory stimulation with structural and functional consequences on the brain system. If there is a limitation in the literature regarding the consequences that these alterations may have on cognition and memory, it is known that they can cause the impairment of sound localization and auditory memory. This study aims to investigate the influence of ME alteration on auditory processing abilities, such as sound localization and auditory memory.

**Material and methods,** In the study there were 47 children on what 19 were registered with ME alteration, while the remaining 28 had no changes. The elements of the sample were later submitted to an audiological screening, impedance and a sound localization test (LOC) and the sequential memory test for nonverbal sounds (MSNV) were performed according to the authors Pereira & Schochat, 1997. They also performed a spatialized sound localization, using a PC equipped with a VGA 23" monitor and 2 loudspeakers set at an angle of 30° at the mid-vertical of the screen.

**Results,** In the sound localization tests and in the sequential memory test of nonverbal sounds were children with ME alteration who failed the most.

**Conclusion,** There were statistically significant differences between the two groups proving the idea that ME alterations may influence auditory processing skills

**ID: 03967 - P126**

### Single sided deafness and hearing asymmetry: specific patterns on several hearing questionnaires.

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**Key-words:** Single side deafness; spatial hearing; Spatial Hearing Questionnaire (SHQ); speech spatial and qualities of hearing scale (SSQ).

**Background:** Two spatial hearing questionnaires, the Spatial Hearing Questionnaire (SHQ) by Tyler et al. (2009) and Gatehouse and Noble's (2004) "Speech, Spatial, and Qualities of Hearing Scale" (SSQ), and its different shortforms, were used to compare responses of patients with single sided deafness (SSD) with patients matched for hearing loss on the best ear, age and level of education, in order to determine the SSQ and SHQ items the most sensitive to SSD and to hearing asymmetry.

**Material and methods:** Three groups of patients were matched for their hearing loss on their best ear, age and education level, and differed by their degree of hearing asymmetry: single sided deafness, hearing asymmetry, no asymmetry. Disability degree criteria, based on scores obtained in a population of normal-hearing young subjects (mean - 2 \* standard deviations), were used.

**Results:** 90 % of the patients with SSD met the criteria for handicap against only 30% of the control patients, for both SHQ and SSQ scores. The group of SSD had significantly lower scores than matched patients (mean score of 4.7, (SD = 1.7) versus 7.4, (SD = 2.5)), for 19 out of 49 items for SSQ and 8 items out of 24 for the SHQ. The subscales with the largest differences were the "spatial" subscale of the SSQ and "location" of the SHQ, with some subscales showing almost identical scores between the different patient groups.

**Conclusion:** The comparison with literature data allowed to define a pattern specific to SSD in the SHQ and SSQ scores. Our results suggest also the calculation of indices based on differences in scores between subscales of the SSQ, including the 15iSSQ shortform. Those indices

are more sensitive and specific to the handicap linked to SSD than individual subscale scores. They could be used as indices sensitive specifically to the benefits of rehabilitation strategies of SSD.

**ID: 03902 - P127**

### Self-reported listening effort measured by an extended version of the Effort Assessment Scale (EEAS)

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**Keywords:** Hearing in noise; Effort Assessment Scale; Speech Spatial and Qualities of hearing scale.

**Background:** The listening effort can be measured for specific auditory perception tasks, but does not necessarily reflect the listening effort experienced by patients in daily life. The Speech Spatial and Qualities of hearing questionnaire (SSQ) comprises a few items linked to listening effort but is more devoted to the self-perceived capacity of performing the tasks depicted. Inspired by those items, Alhanbali et al. (2017) created a 6 item Effort Assessment Scale (EAS) and showed a similar increased listening effort in 3 groups of patients with diverse hearing deficits compared to a control group. The aim of this study was to assess the listening effort and the differences reported according the situation depicted: quiet versus noisy, using an extended version of the EAS scale, the EEAS, and to compare it with the SSQ scores.

**Material and methods:** The EEAS comprised 10 items: the 6 items of the EAS, whose 3 items were duplicated as to depict the same situations in quiet and in noisy environments. A tenth item was added, pertaining to listening to a message conveyed by a loudspeaker in a public place. A global score (average of the 10 items) and 2 subscores for listening effort in quiet and in noise (averages of 3 items) were obtained. Both the EEAS and a short version of the SSQ (the 15iSSQ) were given to 3 groups of subjects: young normal-hearing subjects and 2 groups of hearing-impaired patients (HI), long-term hearing aid wearers, or newly equipped with hearing aids. HI were tested twice at 1 month interval, with a speech in noise task, for which the listening effort was self-assessed on a visuo-analog scale.

**Results:** The EEAS scores correlated significantly with speech in cocktail party noise scores in normal hearing subjects and showed a good reproducibility in long-term hearing aid wearers. In newly hearing aid wearers, at 1 month, the EEAS scores showed a significant decrease in listening effort, especially in noise, decrease that correlated

significantly with an increase in the SSQ speech score. There was no systematic correlation between the task induced listening effort, and the listening effort measured in daily life situations by the EEAS.

**Conclusion:** The EEAS seems to be (1) able to screen for difficulties in hearing in noise in otherwise normal hearing young subjects, (2) reproducible and (3) sensitive to hearing-aid induced changes.

**ID: 04092 - P128**

### Speech recognition and pupillometry – exploring new tools to be used in clinical practice

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**Keywords:** pupillometry, pupil capture, speech test, speech recognition, listening effort

**Background:** In the last few years the topic of assessing hearing rehabilitation outcomes beyond pure tone aided thresholds and speech tests is at the forefront of research. The measurement of cognitive load is one of the indicators, which may directly reflect on the benefits of a treatment modality. Our initial experiences with pupillometry showed that cognitive load associated with a listening task may be reliably objectivization of speech recognition. A special novel Hungarian ‘Sentence Test’ material was used in the study, that was optimized for lexical closing skill. [1]

**Materials and methods:** The ‘Sentence Test’, that consists of 7-8 syllabic sentences were presented in free-field, in random order and various Signal-to-Noise Ratios (SNR) in an audiometric cabin. In the study cohort, both of the eyes were monitored simultaneously by an eye-tracking system capable of high-speed image recording. The high-resolution cameras, detached to a specially designed spectacle-frame, have been able to a high-speed tracking of binocular eye movement. The software, which the “glasses” are connected, could capture video with tone and have been able to recognize/mark the eyes of the candidate, track the gaze and its environment, also save the data in real-time. During the post-processing phase, peak pupil dilation (PPD) was evaluated and compared with the SNR of speech signal.

**Result:** Preliminary results suggest that the PPD correlates with the SNR. At high SNRs, in difficult listening tasks, the drop of PPD clearly shows the loss of motivation of the test persons. At lowest SNR levels strong concentration have not been required, ergo in pupil dilation has not presented any dominant values, same like at high SNR.

**Conclusion:** This rather simple approach to measure listening effort may be integrated into the currently available

'test battery' of hearing technology evaluation. To include pupillometry in the daily clinical practice and outcome assessment, further adjustments and investigations have to be made.

**ID: 04051 - P129**

## Clinical use of the Dizziness Handicap Inventory

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**Background:** Dizziness Handicap Inventory (DHI) is widely used in clinical practice for screening patients with balance diseases. However, its clinical value in differential diagnostics of such patients is still to be established.

**Objective:** The aim of the study was to assess clinical value of DHI (Polish version).

**Material and Methods:** The study included 343 patients selected from our database of 628 subjects with dizziness. The neurotological examination and laboratory tests were the base to extract 7 clinical groups with: non-compensated (NC) and compensated vestibular (C) paresis, benign paroxysmal positional vertigo (BPPV), migraine, central and psychogenic vertigo, and bilateral vestibular loss (BV). Factor structure (Principal Component analysis, PCA), internal consistency (Cronbach's alpha), and discrimination ability (ROC curve analysis) were examined.

**Results:** In PCA, the five factor solution was obtained. Factors were related to: F1 – restricted participation, F2 – activities aggravating vestibular symptoms, F3 – positional vertigo, F4 – handicap/anxiety, F5 – depression. C group revealed the lowest DHI scores, while the scores in remaining groups were similar. The cutting point between NC and C groups was set at 52, with sensitivity of 76%. The differences revealed the factors F2 and F4. As it could be predicted, F3 results showed the highest score for BPPV.

**Conclusion:** DHI (Polish version) may differentiate compensated and uncompensated vestibular patients. It possesses also some clinical value in screening positional vertigo.

**ID: 04106 - P130**

## Audio-vestibular symptoms of patients with Chiari syndrome

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**Keywords:** Chiari syndrome, Vertigo, VNG

**Background:** The aim of this study is to evaluate the vestibular system of patients with Chiari malformation and to compare the results with literature.

**Methods and Materials:** A prospective study is made with 8 patients (2 males and 6 females) who were diagnosed as Chiari malformation with mean age of 38,5±1,2. Patients were asked anamnesis questions first, followed by audi-ovestibular test of oculomotor tests, positional tests and Vng test batteries.

**Results:** All patients had headache on anamnesis, dizziness was found on 6 patients and only 4 of the patients had downbeat vertical nystagmus.

**Conclusion:** Most common symptom of Chiari malformation is observed to be headache where this result agrees with the literature data.

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## Communication in bimodal bilingual families with normal hearing children and deaf and/or hearing impaired parents

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**Keywords;** bimodal bilingual communication, CODA's, deaf parents

**Background;** Children who are raised by deaf and/or hearing impaired parents grow up differently than peers in normal hearing families. The differences mainly occur in the way of communication, considering that most deaf people communicate in Flemish Sign Language. These 'Children of Deaf Adults' (CODA's) are therefore raised bimodal and bilingual. This study focuses on if and how these children intervene spontaneously to prevent communicative frustrations. Is there a mutual obligation in Flemish bimodal and bilingual families with normal hearing children and deaf and/or hearing impaired parents to avoid barriers in communication?

**Materials and methods;** The data was inventoried and mapped by means of an online quantitative questionnaire for the CODA's (n=31), and analyzed using IBM SPSS Statistics 2.0. To further explore the responses given, two qualitative focus discussions were organized (n=5).

**Results;** Nearly all CODA's (94%) in this sample find that they spontaneously make efforts to avoid communication barriers, and all efforts made were related to spoken language. Also it appeared that both parents (71%) and CODA's (74%) communicate simultaneously in spoken Dutch and Flemish Sign Language. This is also called code-blending. Additional information of the qualitative investigation indicates that the grammar of the sign language is followed in 60% of the cases.

**Conclusion;** Normal hearing children from bimodal bilingual families with deaf and/or hearing impaired

parents spontaneously make efforts to avoid communication barriers. The CODAs mainly adapt their spoken language in order to achieve this. When using both languages, a small majority follows the structure and grammar of the sign language.

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## Hearing loss in persons exposed and not exposed to occupational noise

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**Keywords:** Hearing, auditory threshold, noise

**Background:** The study aimed at comparing hearing loss in individuals at risk for occupational noise and those not at risk and comparing working loss by gender.

**Material and Methods:** The analysis used data from a current Czech Ministry of Health grant project called Epidemiological and Genetic Study of the Frequency of Hearing Loss (NT12246-5/2011). Hearing was tested using pure-tone threshold audiometry, tympanometry and measurement of the stapedius reflex. Group 1 comprised those with no risk for occupational noise, a total of 3011 individuals. Group 2 included participants exposed to occupational noise, a total of 1977 persons.

**Results:** The mean length of exposure to occupational noise was 14.86 years for females and 18.36 years for males. Females at risk and not at risk for occupational noise younger than 44 years and older than 75 years were found to have no statistically significant differences at any pure-tone threshold audiometry frequencies. In those aged 45 to 74 years, statistically significant differences were found. In males, hearing loss was observed as early as at the age of 18 years. When comparing males and females at no risk for occupational noise, there were no statistically significant differences at any of the frequencies in those younger than 29 years. In females aged 30 years or older, statistically significant differences were observed at various frequencies in all age groups. When comparing males and females at risk for occupational noise, statistically significant differences were more frequent than in employees not exposed to noise.

**Conclusion:** Hearing loss in females does not significantly vary depending on occupational exposure. The opposite is true for males. However, maximum differences in mean levels did not exceed 10 dB. It is therefore clear that noise is a preventable factor and the use of personal protective equipment is warranted. As a results, the number of reported cases of occupational noise-induced perceptive cochlear hearing loss tends to decrease despite the fact that the numbers of jobs in which workers are exposed to noise continue to increase.

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