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LECTURES & COMMUNICATIONS

LECTURE

EVALUATION OF THE WHO HEARING-IMPAIRMENT GRADING SYSTEM

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The World Health Organization (WHO) has developed a hearing-impairment grade system based on the better-ear four-frequency pure-tone average. Based on the pure-tone thresholds at 500, 1000, 2000 and 4000 Hz, hearing loss is categorized as normal, slight, moderate, severe or profound. Here, we evaluate the validity of this hearing-impairment grading system by examining the results obtained for a variety of speech-recognition measures or self-report communication surveys from large-scale studies spanning a range of hearing-impairment grades. We examined datasets for both unaided and aided listening, although the data available were much more limited in the latter case. We used these datasets to address the following questions: (1) are there significant differences on these communication-related functional measures as the WHO hearing-impairment grade increased; (2) what are the effect sizes for these functional measures that are associated with sequential steps in the WHO hearing-impairment grade; and (3) do the benefits from hearing aids for these functional measures differ across WHO hearing-impairment grades? Answers to these questions will be presented and the implications discussed.

LECTURE

CHANGES IN SELF-REPORTED HEARING HANDICAP ACROSS THE LIFESPAN

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Hearing loss is one of the most common chronic conditions of aging. Patient-reported outcome measures, such as self-reported hearing handicap, are becoming an increasingly important component in the comprehensive assessment of the functional communication abilities of individuals with hearing loss. Cross-sectional studies report only modest associations between perceived hearing handicap and pure-tone thresholds and word recognition, suggesting that increased hearing handicap is not completely explained by reduced speech audibility. Most longitudinal studies of hearing loss have focused on changes in audiometric measures with increasing age, rather than on changes in self-reported hearing handicap. As a result, the demographic, health, and hearing-related factors that contribute to changes of self-reported hearing handicap with increasing age remain largely unknown. The Hearing Handicap Inventory for the Elderly (HHIE) and the Hearing Handicap Inventory for Adults (HHIA) was one of the first self-reported outcome measures intended for clinical use. The HHIE/A has 25 items designed to measure self-perceived hearing handicap on two subscales, emotional response and social/situational problems due to hearing impairment. Despite the extensive use of the HHIE/A in clinical and research settings, no verification has been reported showing that the items underlying the two subscales identify two distinct factors. Indeed, there is some evidence from factor analyses with small study samples that the HHIE/A does not resolve into the two defined subscales. As a preliminary step to address this question, the domain structure of the HHIE/A was explored using factor analysis of a large sample of adults from a longitudinal study of age-related hearing loss at the Medical University of South Carolina. In this ongoing study, the HHIE/A is being obtained every 2-3 years, along with demographic, general health, and hearing health data. For the current analysis, the subject sample included 1446 adults (804 females) whose ages ranged from 18 to 89+ years at the time of enrollment, with longitudinal data spanning 1-24 years. Using results from the factor analysis, associations between self-reported hearing handicap and age, sex, race, medical history, general-health quality of life, degree of hearing loss, noise exposure history, hearing-aid use, speech recognition, and auditory and cognitive function were explored. Mixed modeling was also used to determine the factors associated with changes in self-reported hearing handicap with increasing age with particular focus on how changes in the HHIE/A correlate with longitudinal changes in audiometric measures. [Work supported by NIH/NIDCD]

LECTURE

EXAMINING HEARING LOSS AMONG NOISE-EXPOSED WORKERS IN THE UNITED STATES: KEY FINDINGS FROM THE NIOSH OCCUPATIONAL HEARING LOSS SURVEILLANCE PROJECT

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Background: Approximately 22 million workers are exposed to hazardous noise each year in the United States, and hearing loss is one of the most common work-related illnesses. National surveillance data for occupational hearing loss (OHL) had traditionally been limited to U.S. Bureau of Labor Statistics incidence statistics, which may underestimate rates of hearing loss by as much as an order of magnitude. Most studies of OHL have also relied on self reports of hearing difficulty, and this reliance has been shown to sometimes underestimate the prevalence of the hearing-impaired. Longitudinal analyses were also precluded due to the cross-sectional nature of these data. A more comprehensive system utilizing the results of pure-tone audiometric testing, from which clinical determinations of hearing loss can be made, was necessary to identify populations at risk, evaluate the effectiveness of intervention strategies, and monitor progress in prevention. The NIOSH OHL Surveillance Project was initiated in 2009 to fill this critical gap and develop a national surveillance system for occupational hearing loss.

Methods: NIOSH partnered with 21 audiometric service providers, hospitals and others (denoted providers), who perform hearing testing for noise-exposed workers, to collect de-identified worker audiograms and related data. These workers were tested to comply with regulatory requirements due to high noise exposure (≥ 85 dB). This approach allowed NIOSH to collect millions of de-identified audiograms from thousands of workplaces across the United States while protecting the identities of workers, companies and providers. NIOSH examined these data, and other data sources with information for non-noise-exposed workers (e.g., Centers for Disease Control and Prevention population surveys). Hearing loss incidence, prevalence, adjusted risk (prevalence ratios [PRs]), years of healthy life lost (disability-adjusted life years [DALYs]) and severity were examined by industry, and when data was available, by occupation. Thirty-year trends in hearing loss prevalence, and 25-year trends in incidence and adjusted risk were also examined.

Results: The overall prevalence of hearing loss among U.S. noise exposed workers slightly decreased from 20% in the 1981-1985 time period to 19% in the 2005-2010 time period. The incidence in the 1986-1990 and 2005-2010 time periods decreased from 9% to 7%, respectively. The overall adjusted risk of incident hearing loss decreased 46% over the same time period. Dramatic differences in the prevalences of hearing difficulty and tinnitus were observed between noise-exposed and non-noise-exposed workers (23% and 15% vs. 7% and 5%, respectively). The Mining, Construction and Manufacturing sectors consistently had the highest prevalences (25%, 25% and 20%, respectively) and adjusted risks for hearing loss, and the most healthy years lost due to hearing impairment.

Conclusions: The prevalence of hearing loss among noise-exposed workers has remained steady over 30 years. The incidence and risk of incident hearing loss has decreased over time, indicating some progress in OHL prevention efforts in the United States, although other factors may have contributed to this reduction (e.g., reduction in smoking, better treatment of ear disorders). Noise-exposed workers within the Mining, Construction, and Manufacturing industry sectors, in particular, need additional prevention efforts. Reducing workplace noise remains critical to prevent worker hearing loss and preserve worker quality of life.

EPIDEMIOLOGY, HEARING AND AGING

DIFFERENT VIEWS OF AGING OF THE HUMAN AUDITORY PERIPHERY

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Results from approximately 1000 human participants suggest an onset of age-related peripheral auditory decline as early as the third decade of life with the most rapid phase of this decline occurring before the sixth decade of life. Using newly-developed test hardware and calibration techniques that allow accurate estimation of thresholds and otoacoustic emissions up to 20 kHz, we document important differences in the trajectories of aging when viewed through different physiological measures.

Hearing thresholds show a pattern of decline which follows a "two-speed" trajectory with slower changes in early life but much more rapid decline later. This transition between slow and fast change appears to happen at earlier ages as frequency of measurement is increased. Distortion product otoacoustic emissions (DPOAEs) appear to be sensitive markers of these age-related changes, leading the decline in hearing thresholds by approximately five years. Interestingly, the profile of peripheral auditory aging captured by stimulus frequency otoacoustic emissions (SFOAEs) is very different from that observed using DPOAEs and hearing thresholds. SFOAEs appear to be less sensitive to age-related changes. SFOAE levels decline in the third and fourth decades of life, before plateauing. Difference may also point to interactions between pathophysiology of auditory peripheral aging and the processes that generate DPOAEs and SFOAEs. Our results suggest that aging of the auditory periphery is a combined outcome of various changes activated at different points in the lifespan of an individual that progress at different rates and may even counteract each other in the case of some measures.

RELATION OF PURE-TONE AUDIOMETRY AND COGNITIVE FUNCTIONS WITH HEARING IN NOISE PERFORMANCE IN THE RHINELAND STUDY

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Age-related hearing loss (ARHL) is a common disabling condition and a major health concern in the aging populations. It is characterized by loss of hearing sensitivity, reduced speech understanding, slowed central processing of acoustic information, and impaired sound localization. ARHL can be caused by deficits in the peripheral auditory system (pARHL), e.g. pathology in the middle and inner ear, or by central deficits (cARHL), predominantly impairments within neural auditory pathways. Typically, ARHL results of degeneration in both the peripheral and central components of the auditory system, yet it is difficult to assess the relative contribution of the age-related changes within the ear and in the auditory brain. Cognitive decline, cARHL, and pARHL are common comorbidities in aging adults still the relations and interdependencies between these three disorders are largely unknown. Moreover, the concept of cARHL is not well understood and it is still a matter of debate to what extent cARHL is indeed a distinct entity. We aimed to assess to what extent peripheral hearing ability and different cognitive functions influence central hearing ability across the life span.

This study is based on the first participants of the Rhineland Study, which is a single center community-based cohort study of persons aged 30 years and over. We measured central hearing with a hearing in noise test (50%-speech reception threshold [50%-SRT]) and peripheral hearing with pure-tone audiometry (pure-tone average [PTA] of frequencies 0.5k, 1k, 2k, 4k Hz in the better ear). For both measures higher values reflect worse performance. Tympanometry was used to assess inner ear functions. We measured the following cognitive domains: executive functioning (Trail Making Test [TMT] B-A), working memory (Digit Span Forward), long-term memory (Verbal Learning and Memory Test [VLMT]; delayed recall), and crystallized intelligence (multiple choice vocabulary test [MWTB]). We log transformed TMT B-A and 50%-SRT. We further inverted TMT B-A so that higher values in all cognitive

measures represent better test performances. We examined the association between peripheral hearing and cognitive functions with central hearing with a multivariable linear regression model. We used hearing in noise performance as outcome and PTA and the different cognitive scores (all z standardized) as determinant variables. We adjusted all models for age, sex, and income. We performed additional analyses for which we excluded hearing aid users and participants with impaired tympanometric function. Our preliminary results are based on the data of the first 1306 participants (56.2% women) with a mean age of 55.28 (± 13.95 standard deviation) years. We excluded participants that were non-native speakers of German ($n=74$) and had missing data in the hearing in noise test ($n=53$), which left 1179 participants to be included in our analyses. Increasing age was associated with worse hearing in noise ($\beta=0.004$ per year increase in age; 95%CI 0.004,0.005; $p<.001$). Increasing PTA was associated with worse hearing in noise ($\beta=0.006$; 95%CI 0.005,0.006; $p<.001$), with the effect of an increase of 5dB in PTA being comparable to the effect of a 7.5 years age difference. Better verbal intelligence was associated with better hearing in noise ($\beta=-0.008$; 95%CI -0.014,-0.002; $p=.01$). Working memory and executive function were also associated with hearing in noise with effect sizes comparable to a 1 to 2 year increase in age, but these associations did not reach statistical significance in our preliminary dataset ($\beta=-0.005$; 95%CI -0.012,0; $p=.078$ and $\beta=-0.006$; 95%CI -0.012,0; $p=.057$). We observed no effect of long-term memory ($\beta=-0.004$; 95%CI -0.011,0.003; $p=.258$). Excluding participants with impaired tympanometric function and hearing aid users did not substantially change any of those results.

We found that worse peripheral hearing was associated with worse central hearing performance, regardless of age, sex, and socioeconomic status. Moreover, our data suggest that verbal intelligence, working memory, and executive functions, but not long-term-memory, are associated with hearing in noise performance.

THE EFFECT OF REMEDIATION OF HEARING LOSS ON COGNITIVE FUNCTION IN OLDER HEARING AID RECIPIENTS: PRELIMINARY PROSPECTIVE LONGITUDINAL STUDY RESULTS

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Introduction Hearing loss has been found to be independently associated with the rate of cognitive decline in older adults, with an accelerated rate of cognitive decline for those with hearing loss. Although there are successful treatments for hearing loss such as hearing aids, there is no successful treatment for the cognitive decline that often occurs with ageing. It is therefore important to investigate whether remediation of hearing loss could delay the onset of cognitive impairment.

This new longitudinal study is investigating the relationships between:

1. Degree of hearing loss and rate/extent of cognitive decline
2. Success with hearing aids and post-fitting cognitive change
3. Hearing aid outcomes and change in quality of life across a variety of measures

Methods Participants are being recruited over the first 3.5 years of the study and are assessed pre- and every 18 months post hearing aid fitting, and cognitive and other measures are compared with those of a control group from a comparable cohort study of older adults with normal hearing. Pre- and post-fitting assessments include cognitive function, hearing, speech perception, quality of life, activity, diet, loneliness and isolation, anxiety, depression, medical health and biomarkers.

Results Initial results for 69 adults, aged 60-92 years with mean better ear PTA 30dB are presented. Executive function was significantly negatively correlated with increased hearing loss (-0.25 , $p=0.041$) and increased age when controlling for education level (-0.34 , $p=0.004$).

Controlling for age, gender, cardiovascular conditions, education, and whether participants were working or retired, multiple linear regression showed PTA was a significant predictor of executive function ($p = 0.029$), contributing 14% to the overall variance. Marginal effects analysis showed an additional 10dB of hearing loss predicted a reduced mean executive function score by 0.26, or 40% of the SD on this measure.

Participants reporting higher levels of physical activity had a significantly higher average group psychomotor function score ($p=0.038$). Females with one or more cardiovascular conditions also had a

significantly lower average group executive function score ($p=0.025$).

Conclusions Despite the small initial sample size, hearing loss, age, physical activity and cardiovascular disease were correlated with significantly poorer cognitive function at baseline. Follow up over 5 years will reveal the effects of intervention with hearing aids on all outcomes, and whether this intervention can delay or slow the onset of cognitive decline. Updated results will be presented.

A QUALITATIVE EXPLORATION OF THE HEARING AND COMMUNICATION NEEDS OF OLDER ADULTS WITH DEMENTIA AND HEARING IMPAIRMENT LIVING IN RESIDENTIAL AGED CARE FACILITIES

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BACKGROUND: For older adults with dementia, the co-occurrence of hearing impairment (HI) results in additional communication challenges, a phenomenon referred to as excess disability (1). In addition to its negative consequences on communication, untreated HI in adults who have dementia is also associated with lower rates of engagement in social activities (2) and faster rates of cognitive decline (3). Hearing rehabilitation potentially plays a pivotal role in reducing the negative consequences that occur in adults who have dementia and untreated HI. However, within aged care facilities, HI is often under detected and poorly managed (4, 5). To date, however, no research group has directly explored the hearing and communication needs of adults who have dementia and HI who reside in residential aged care facilities. In view of this, the purpose of this study was to: 1) understand the hearing and communication needs of adults living in aged care with dementia and HI; and 2) to explore how current hearing services meet these needs.

METHODS: Participants were recruited from two regions in South West Queensland Australia between July 2017 and April 2018. A qualitative methodology was employed. A sample of 5 to 15 people from each participant group was interviewed: 1) audiologists, 2) aged care staff and 3) individuals with dementia and HI and 4) family members of people with HI and dementia. Interviews were transcribed via a professional transcription service and were analysed using thematic analysis (6).

RESULTS: Preliminary analyses for research question one have identified that audiologists, aged care staff and families find it difficult to determine the hearing and communication needs of people with dementia and HI. Audiologists reported it was challenging to assess hearing and to provide hearing rehabilitation to this group as rehabilitation success relied on the involvement of aged care staff and families. Aged care staff and families reported it was difficult to distinguish between cognitive-communication breakdowns and communication breakdowns resulting from HI.

Preliminary analyses for research question two have identified that hearing services do not currently meet the needs of this population. Aged care staff reported that they often do not refer residents with more severe dementia to hearing services due to poor outcomes they had observed with hearing aids. Similarly, families reported that as dementia progressed, hearing aids were no longer a practical solution. A key theme of increasing education and training in hearing and communication strategies beyond hearing aids for this population was identified.

CONCLUSIONS: As identified in this study, identifying the hearing and communication needs of adults with dementia and HI who live in aged care is complex. Findings indicate that current hearing service delivery models do not meet the hearing and communication needs of older adults living with dementia and HI in aged care homes. More research is needed to develop and evaluate a hearing services delivery model that is patient-centred and overcomes the barriers identified by this research study.

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CONTRIBUTING FACTORS TO THE HIGH PREVALENCE OF HEARING IMPAIRMENT IN A RURAL AREA IN A SOUTH AFRICA

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The global prevalence of hearing impairment is on the increase despite the fact that 50% of the causes are preventable. There is evidence that the factors contributing to the prevalence and etiology of hearing impairment vary widely from country to country. In South Africa, as in other low-income and middle-income countries, more context-specific information on the estimated prevalence of hearing impairment and the factors that contribute to its onset is required. This will assist with the development and implementation of targeted prevention programmes to reduce the burden of hearing impairment on the individual, family and the society.

The aim of this study was to determine the prevalence of and factors associated with hearing impairment and auditory pathology in the Elias Motsoaledi Local Municipal area of the Limpopo Province, South Africa to guide the development of a context-specific and targeted prevention programme.

A cross-sectional population survey was conducted using the World Health Organisation (WHO) Ear and Hearing Disorders Survey (WHO, 1999). A random multi-stage cluster sampling strategy, two-stage sampling, was utilised to select the seven municipal wards and 357 households through the probability proportional to size (PPS) method. A total of 850 participants were included in the study.

The overall prevalence of hearing impairment was 19.88% (95% CI: 0.15-0.2) and 8.94 (95% CI: 0.08-0.12) for disabling hearing impairment. The prevalence of ear disease was 13.19% (95% CI: 0.10 -0.15) with impacted cerumen and otitis media reported most often. The majority of participants with disabling hearing impairment (66%) indicated that the cause of their hearing impairment was 'undetermined'. Age, gender and hypertension were associated with hearing impairment. A significant number of participants required referrals to their nearest health facility for further audiological management to confirm the presence of hearing impairment.

Factors contributing to the high prevalence of hearing impairment and ear disease in this rural area will be highlighted and strategies outlined to reduce the burden of disease in this community.

10-YEAR FOLLOW-UP RESULTS OF THE NETHERLANDS LONGITUDINAL STUDY ON HEARING: TRENDS IN HEARING DECLINE

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Objectives Previous findings of longitudinal cohort studies indicate that acceleration in age-related hearing decline may occur. Five-year follow-up data of the Netherlands Longitudinal Study on Hearing (NL-SH), showed that around the age of 50 years, the decline in speech recognition in noise accelerates compared to the change in hearing in younger participants. Other longitudinal studies confirm an accelerated loss in speech recognition in noise, but use older age groups as a reference.

The present study aims to determine the change in speech recognition in noise over a period of 10 years in participants aged 18 to 70 years at baseline. Our study additionally investigated the effects of age, sex, educational level, smoking and alcohol use on the decline of hearing ability over time.

Methods Baseline, 5-year and 10-year follow-up data of participants of the NL-SH, collected until May 2017, were included. The NL-SH is a web-based prospective cohort study which started in 2006. It uses the National Hearing Test (NHT), which is an online digit-triplet speech in noise test to assess hearing ability. Speech-Reception-Thresholds in noise (SRTs), corresponding to 50% speech recognition, were calculated. Online questionnaires on various aspects of life were filled in by participants. A linear mixed model was used for analysis of longitudinal changes in SRT.

Results Data of in total 1349 participants were included. At the start of the study, the mean age of the participants was 45 years (SD 13 years) and 61% of the participants were categorized as having good hearing ability in noise. SRTs significantly decreased over a decade ($p < 0.001$), thereby adjusting for the confounding effects of age, sex, and having a history of smoking. The mean deterioration was 0.9 dB signal-to-noise ratio over 10 years. The rate of the progression of hearing loss accelerated significantly in age groups of 51-60 and 61-70 years compared to younger age groups (18-30, 31-40, and 41-50 years) ($p < 0.001$). Hearing in participants with a history of smoking deteriorated significantly faster during the follow-up of 10 years ($p = 0.004$). We did not find any difference in the progression of hearing loss with regard to sex, educational level, and alcohol use.

Conclusion Our study is the first longitudinal study, with a 10-year follow-up, to reveal that the accelerated rate of deterioration in speech recognition ability in noise is already apparent in groups aged 51-60 and 61-70 years at baseline, compared to younger age groups. The association between hearing loss, a history of smoking and age is complex. Further research on hearing loss and smoking, with respect to health conditions/ diseases associated with smoking and its treatment, are recommended. Identifying and understanding factors that contribute to hearing loss is imperative for prevention and timely intervention to avert hearing loss and its consequences.

THE ASSOCIATION OF HEARING LOSS WITH DEVELOPMENTAL OUTCOMES AT AGES 5 AND 7 YEARS IN CHILDREN WITH NON-SYNDROMIC UNILATERAL CLEFT LIP AND PALATE: THE CLEFT CARE UK STUDY

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PURPOSE: To examine the association between otitis media with effusion (OME), hearing loss and developmental outcomes at 5 and 7 years.

METHOD: Two hundred and sixty-eight 5-year-old British children with non-syndromic unilateral cleft lip and palate (UCLP) were recruited to the Cleft Care UK cohort study. Children had air and bone conduction audiometry at age 5. Information on grommet and hearing aid treatment was obtained from parental questionnaire and medical notes. Hearing loss at age 5 was defined as >20 dB in the better ear and history of OME and hearing loss was determined from past treatment. Children with sensorineural hearing loss were excluded. Associations were examined with speech, behaviour and self-confidence at age 5 and educational attainment at age 7. Associations between hearing variables and developmental outcomes were examined using logistic regression.

RESULTS: A history of OME and hearing loss was associated with poor intelligibility of speech (adjusted odds ratio=2.87, 95% CI 1.42-5.77) and aspects of educational attainment.

CONCLUSIONS: Hearing loss is an important determinant of poor speech in children with cleft palate.

AUDITORY PERCEPTION, PROCESSING AND COGNITION (1)

INFORMATIONAL MASKING DURING WORKING MEMORY TASK

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INTRODUCTION: Several studies have shown that speech perception in noise involves multiple cognitive resources, particularly the working memory. Rönnerberg et al. (2008) propose the Ease of Language Understanding (ELU) model which explains how the presence of a competing signal causes the speech to be processed in a sluggish and effortful manner. Often, this competing signal happens to be speech and it is now a well-established fact that speech maskers cause greater masking effects (called as informational masking; IM) than non-speech maskers such as noises (which cause only energetic masking). We hypothesise that the one of the main reasons 'informational masking' is caused is due to a breakdown in working memory. An informational masker competes with the target signals at the phonological loop and the episodic buffers of the WM construct and causes a breakdown in the overall listening situation. While there are studies which show non-steady irrelevant signals such as speech causing greater deteriorations in WM performance than steady-state signals such as noise, none of them have explored this from the point of view of informational masking.

METHOD: In our study, we observed how systematically varying the amount of linguistic information (IM is directly related to the amount of linguistic information) in the masker changes the WM performances. We measured backward digit (BD) spans in the six background conditions; 2- and 8-speaker babbles (2SB and 8SB respectively), their time-reversed versions (2RB and 8RB respectively), speech-spectrum noise (SSN) and quiet backgrounds. The choice of these maskers was based on the fact that there appears to be a neat continuum in the range of IM caused by these maskers (2SB>8SB>2RB>8RB>SSN). The babbles have the both semantic as well as phonetic information and thus the greatest IM. The RBs only have phonetic information and thus cause lesser IM than SBs, whereas the SSN causes the least masking as it is purely energetic. We measured BD spans for disyllabic Kannada digits on 20 native Kannada speakers in each condition. The stimuli were presented at an SNR of +5 which ensured clear audibility of both target and background stimuli. An adaptive procedure with six reversals was used and BD span was calculated as the mean of the last four reversals.

RESULTS: Bayesian Repeated-Measures ANOVA (with default Cauchy priors) on all masker conditions indicated that there is substantial evidence ($BF_{10}=6.208$) of effect of the masker on the WM performances against the null model. Post-hoc within group comparisons showed that there was a strong evidence of the effect of the masker against the null model only for the 2SB vs quiet ($BF_{10}=45.436$) and SSN ($BF_{10}=17.397$) comparisons. Overall, the 2SB caused the greatest deterioration in the working memory scores, while the SSN caused no deterioration compared to the quiet background. For all other comparisons, there were merely anecdotal evidences ($BF_{10}<3$) for any such masker effects, albeit the mean scores for both the RBs and SBs were poorer than the quiet and SSN maskers. The results, thus, seem to indicate that the concept of informational masking could be related to the linguistic, particularly the semantic level, confusion that is observed in the 2SB.

DISCUSSION: We explain such linguistic confusions based on three extrapolations of the different working memory models. Firstly, the presence of any competing sound distorts the input phonological salience, thus causing greater taxing of the WM to perform with the same efficiency as in quiet. This accounts for the energetic masking that is observed in any type of masking situation. Secondly, the concept of 'changing-state irrelevant stimulus' accounts for the mean scores of the RBs and SBs being poorer than the quiet and SSN backgrounds. Lastly, the strong semantic information still present in the 2SB leads to a 'pseudo' increase in the number of to-be-repeated items by entering into the episodic buffer along with the target stimuli. Such increases in the number of to-be-repeated items have been shown to reduce performance in WM tasks and have been further supported by Broadbent's Decay theory (Broadbent, 1957). As the number of items entering the phonological store increases, greater is the

potential for disruption. Additionally, our results are in agreement with that of Ellermeier & Zimmer (2014), who also supported the presence of a continuum of masking effects.

THE EFFECT OF HEARING AID USE IN OLDER ADULTS ON AUDITORY PROCESSING, COGNITION AND GAIT

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Background and aims: Degraded hearing in older adults has been associated with reduced postural control and higher risk of falls (Agmon, Lavie & Doumas, 2017). Many falls happen when older adults are engaged in multiple tasks while walking. Gait requires a delicate equilibrium between automatic and executive control. While in young healthy adults, walking is mostly automatic, 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.

The use of hearing aids may induce plastic changes in the auditory system of older adults, which can be measured in unaided conditions (Lavie, Banai, Karni & Attias, 2015).

We now ask the following questions:

1. Will these effects be apparent in aided conditions as well?
2. Can these improvements (in aided and unaided conditions) be manifested in more ecological situations such as dual tasks with walking?
3. Can hearing rehabilitation improve attention, walking and activities of daily living?

Method: 25 older individuals (mean age 70.4 ± 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 during 1 minute), 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 recalling details from stories) and questionnaires (activity of daily life [ADL], 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 the auditory tasks and in the majority of the cognitive tasks. Improvements in performance were observed in single and in dual tasks, and were apparent in aided and in unaided conditions. While walking speed did not improve, a significant improvement was observed in ADL.

Discussion: Both auditory and cognitive functions can improve after relatively short use of hearing aids, and this improvement can effect performance in ecological situations. 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.

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AUDITORY PROCESSING DISORDER OR COGNITIVE IMPAIRMENT? PARSING THE AUDITORY BEHAVIOR OF OLDER ADULTS

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Definitions of Auditory Processing Disorders (APD) across the age range suggest it is unique to the auditory modality and represents poor bottom-up sensory processing. However, behavioral characteristics of APD show great overlap with characteristics of cognitive impairment, and elements of APD test batteries are similar to elements of cognitive test batteries. Research in pediatric APD questions whether APD can be considered a clinical disorder distinct from disorders of language, cognition, and attention (Ahmmed et al., 2014; Brenneman et al., 2017). A recent review of 48 studies in the area of pediatric APD indicates that, among children, APD is not a distinct clinical disorder and is more likely due to top-down issues related to cognition and attention (de Wit et al., 2016).

Studies among older adults suggest that declines in hearing, auditory processing, and cognition are related and that older adults with mild cognitive impairment or dementia have poorer than expected hearing and auditory processing (Gates, Anderson, McCurry, Feeney, & Larson, 2011; Harrison Bush, Lister, Edwards, Lin, & Betz, 2015; Lin, 2011); however, the mechanisms remain murky. Cognitive impairment is conceived as a continuum that progresses from normal cognition, to mild cognitive impairment, and lastly to dementias such as Alzheimer's disease. Mild cognitive impairment is defined as cognitive impairment greater than expected for a person's age (Golob, Irimajiri, & Starr, 2007; Petersen, 2004). The National Institute on Aging and the Alzheimer's Association describe the clinical criteria for MCI as the following: (1) there must be a general concern regarding the person's change in cognitive function, (2) there must be an impairment in one or more cognitive domains, (3) everyday functional abilities must be maintained with only minimal assistance, and (4) the decline must not be considered dementia.

The purpose of the present study was to determine if auditory processing is distinct from cognition in a population of older adults with and without mild cognitive impairment. A sample of 228 community-dwelling older adults (mean age 71.64 years; range 56-92 years) completed a standard audiometric battery as well as a battery of auditory processing and cognitive assessments over two test visits. The sample was 57% female and 93% Caucasian with an average of 16 years of education, and 53% had MCI.

Auditory processing assessments included tests of binaural processing (Dichotic Sentence Identification, DSI; Dichotic Digits Test, DDT), speech in noise (Synthetic Sentence Identification, SSI; Words in Noise test, WIN), and temporal processing (Time-Compressed Speech, TCS; Adaptive Tests of Temporal Resolution, ATTR). Cognitive assessments included tests of memory (Auditory Verbal Learning Test Immediate Recall, AVLT-IR; AVLT Delayed Recall, AVLT-DR; Digit Span Test, DST; Spatial Span Test, SST), visual speed of processing (Useful Field of View, UFOV; Trail Making Test Part A), and executive function (Trail Making Test Part B). Pure-tone hearing thresholds were indicative of mild high frequency sensorineural hearing loss with three-frequency pure-tone averages falling in the normal hearing range.

A factor analysis of the test results identified five factors that explained 71.5% of the total variance for the entire set of tests: (1) Executive Function and Visual Speed of Processing (Trail Making Test Part A and Part B, UFOV, Spatial Span Test), (2) General Auditory Processing (DSI, SSI, TCS, WIN), (3) Memory (AVLT-IR, AVLT-DR), (4) Auditory Attention (DDT, DST) and (5) Auditory Temporal Processing (ATTR). Interestingly, the APD measures were distinguished by stimulus type: the speech measures in factor 2, the digit measure in factor 4, and the non-speech measure in factor 5.

These results indicate that, among older adults with and without mild cognitive impairment, auditory processing is a distinct clinical entity separate from domains of cognition, suggesting that APDs may, indeed, be functionally different from other disorders of cognition.

THE ROLE OF PHONOLOGY IN NOVEL WORD LEARNING IN ADULTS WITH CI

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Several studies have provided evidence that prolonged hearing loss can cause degeneration of long-term phonological representations. Profoundly hearing impaired adults were subjected to degraded auditory input, which resulted in underspecified phonological representations. This may have led to phonological working memory problems, which in turn could have resulted in slower language processing.

Therefore, we assessed the vocabulary of adults with cochlear implants and investigated the relation with speech perception and phonological processing abilities.

In this study 36 adults with at least 5 years experience with CI participated. Their average age was 57 years. Receptive vocabulary was assessed with the Peabody Picture Vocabulary Test. Auditory speech perception was measured with the Dutch Monosyllabic CVC word-test. The Bree non-word repetition task was used to assess the phonological processing abilities. Statistical analyses were carried out for pre- and postlingually deaf adults, separately. Linear regression analyses were performed to assess the relationship among speech perception, phonological processing abilities and vocabulary for both groups.

As expected, 75% of the prelingually deaf adults obtained vocabulary scores below -1 sd. Even 33% of the postlingually deaf adults obtained a score below -1sd. Remarkably, none of the postlingually deaf adults obtained a score of >1 sd. This shows that novel word learning is disrupted in both groups.

Linear regression analyses show different underlying mechanisms for pre- and postlingually deaf adults. In prelingually deaf adults speech perception is the main predictor of vocabulary. However, in postlingually deaf subjects vocabulary is mostly predicted by their phonological abilities.

COGNITIVE STATUS AND HEARING IMPAIRMENT IN THE ELDERLY: A PROSPECTIVE STUDY ON COCHLEAR IMPLANTED PATIENTS

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Objective. Recent literature has shown growing interest for the relationship between presbycusis and cognitive decline; however, a significant evidence about the long term benefit of a correct rehabilitative intervention on cognitive functions has been not reported yet. The aim of the present study is to analyse the relationship between audiological and neuropsychological performances in patients with cochlear implantation over time.

Materials and methods. 25 patients aged more than 60 years (without established neurological pathologies) affected by severe bilateral hearing loss with cochlear implantation candidacy were enrolled. Each patient was subjected to a complete audiological evaluation, to a battery of neuropsychological tests (MMSE, Rey's Auditory Verbal Learning test-RAVLT, Rey's figure copy, Digit span forward and digit span backward Stroop Test, Multiple Features Targets Cancellation-MFTC, Trail Making test, Phonological word fluency, Semantic word fluency) and to a quality of life assessment through questionnaires (SF-36, GBI) at the time of CI activation and after prolonged follow-up (6-12 months).

Results. Significantly better performance was recorded after 6 months of follow-up at MMSE and RAVLT (immediate and delayed recall), while almost significant was the Rey's figure copy, suggesting the global involvement of memory. Results in memory tests remained unchanged between the first and second follow-up (12 months after activation) and further statistically significant improvement was also reported in tests investigating executive functions (Stroop Test, Phonological word fluency and Trail Making Test), as well as a significant increase in subjective benefit, in terms of quality of life. The analysis performed showed some statistically significant correlations, in particular between MMSE and RAVLT-delayed recall and speech-noise scores with SNR0dB and SNR+ 10dB, respectively.

Conclusions. Results obtained in cochlear implanted patients suggest that hearing loss represents a truly modifiable risk factor for cognitive decline, which can and must be correctly addressed. From our data it has been possible to observe prospectively, in addition to the well-known CI benefit on quality of

life and language perception in quiet and noise, a significant improvement in the whole cognitive status and in short and long-term memory performances after a 6-month-follow-up; in addition, an increase in executive and attentive functions has been detected after a 12-month-follow-up, while cognitive mnesic levels acquired during the previous follow-up period remained stable. 1 year after the rehabilitative intervention, the recovery of superior functions and the allocation of neuronal resources for the original purpose would appear to be firmly established, with a process exactly inverse to that which determines the shift of attentional resources towards the auditory processes in the progression of hearing loss.

THE "DICHOTIC DIGIT TEST" AS A PREDICTOR OF DEMENTIA: SYSTEMATIC REVIEW

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The "Dichotic digit test" as a predictor of dementia: Systematic review

Background: This is a focused systematic review of dichotic digit test (DDT) as a prognostic factor for dementia. Cognitive impaired patients usually have problem processing competing speech such as in background noise or in dichotic presentation. This difficulty was present from very early stage of dementia. Dichotic digit test has a possibility to predict "trivial" cognitive difficulty that cans many years preceding the diagnosis of dementia and cognitive impairment.

Objectives: To investigate whether abnormal findings in the dichotic digit test are predictors of cognitive decline.

Method: Data sources: Pubmed, Medline via pubmed

Search strategy: Keyword: "(dichotic digit) AND dementia[MeSH Terms] " on 13/12/17

Study eligibility criteria: Participants=cognitive impaired/dementia adult (>18 years) and elderly; Interventions/prognostic test=dichotic digit test (double and/or triple digit pairs); Controls=normal cognition, mild cognitive impaired; Outcome= dichotic digit score percentage and ear advantage

Study appraisal and synthesis methods: All the data regarding dichotic digit score for left ear, right ear, ear advantage and overall score among each groups were analyzed and summarized.

Results: Eight studies were retrieved from the literature search with abovementioned keywords on Pubmed.(Bouma and Gootjes, 2011, Duchek and Balota, 2005) Two papers were excluded due to review paper =1, no controls=1. Total of 6 papers were included in the systematic review.

All studies showed decrease in dichotic digit score and/or increase ear advantage score among dementia/cognitive impaired compared with controls.

Overall mean dichotic digit score for each paper was ranging from 55.2 to 67.75 among dementia group (calculated only with available data reported). The mean score increased among mild cognitive impaired group to be ranging from 61.4 to 72.6. In normal controls, the overall mean scores were ranging from 73.9 to 95.2 which were statistical significant different from dementia population.

The mean difference overall DDT score for dementia and normal was 18.55 [95%CI 15.76,21.34]. Moreover, the DDT score among dementia population was significant different from mild cognitive impaired by -12.60 score [95%CI -22.68, -2.52]. No significant difference was found in mean scores between mild cognitive impaired and controls with different score of 8.13 [-5.55,21.82].

A mean score ear advantage index for dichotic digit test in each paper was ranging from 0.14 to 0.22 among dementia population. Among mild cognitive impaired population, the score in each paper was ranging from 0.02-0.05. On the other hand, among normal controls, this score was ranging from 0.008-0.01

Abnormal in dichotic digit test (<80%) had the highest sensitivity of 84% in detecting dementia among other tests eg Synthetic Sentence Identification (SSI)78.5% ,Dichotic Sentence Identification (DSI) 83.8 % (Gates et al., 2008)

One longitudinal study with follow up time of up to 4 years showed failure of dichotic digit test (cut point score <80%) can predict future dementia with adjusted hazard ratio 7.0 (1.6- 31.0)(Gates et al., 2011)

Limitations: Limited number of prospective research to shown causal temporal relationship between impairment of dichotic digit test and predictive value of early dementia

Conclusion: Dichotic digit test scores among cognitive impaired patients are likely to be lower than normal participants. Moreover, the score of cognitively impaired patients show an increased ear advantage than in the normal participants. These findings are also more prominent when the degree of cognitive impairment increases. Further study is needed to emphasize the use of ear advantage as an indicator for cognitive impairment.

Implication of key findings: Overall, the dichotic digit test could be a predictor for cognitive decline. As this test has good test-retest repeatability even among dementia participants it could be implemented as a screening tool for dementia in the clinic. Further longitudinal cohort study is needed to further investigate its potential as a screening tool.

AUDITORY PERCEPTION, PROCESSING AND COGNITION (2)

NEUROCOGNITIVE FUNCTIONS AND SPEECH RECOGNITION IN ADULTS WITH COCHLEAR IMPLANTS

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To understand degraded speech, such as through a cochlear implant (CI) or when spectrally degraded by noise-vocoding, the listener must utilize language knowledge and cognitive abilities to interpret the incoming signal. This presentation will review work in our lab that has examined the contributions of neurocognitive functions (working memory, information-processing speed and inhibitory control, speed of lexical access, perceptual closure, and fluid intelligence) to recognition of degraded speech recognition in older CI users and normal-hearing (NH) age-matched peers.

Eighty adults (40 CI and 40 NH) between 50 and 83 years of age underwent testing of working memory (digit span), processing speed and inhibitory control (Stroop), speed of lexical access (Test of Word Reading Efficiency), perceptual closure (Fragmented Sentences test), and fluid intelligence (Raven's Progressive Matrices). Two measures of auditory-only sentence recognition (in the clear for CI users and 8-channel noise-vocoded for NH controls) were assessed using IEEE and PRESTO sentences.

Results demonstrated that in both groups separately (CI and NH), Raven's scores of fluid intelligence significantly predicted speech recognition scores ($r = 0.3$ to 0.6). However, scores of more basic cognitive functions differentially predicted speech recognition between groups: speech recognition was primarily predicted by information-processing speed in CI users, and primarily by inhibitory control in NH peers.

In conclusion, fluid intelligence as assessed using a visual task predicted the ability to understand degraded speech in older CI users and NH peers. Moreover, findings suggest that non-auditory measures of cognition may possess utility as prognosticators of speech recognition abilities during the preoperative evaluation of patients considering cochlear implantation.

AUDITORY PROCESSING AFTER COCHLEAR IMPLANT: A P300 STUDY USING LORETA (LOW RESOLUTION ELECTROMAGNETIC TOMOGRAPHY)

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Background. The proper functioning of the auditory processing needs an integration of many types of information, and a synchronised action between auditory cortex and other cortical and subcortical centres. The normal development of connectivity between the auditory system and the high neurocognitive functions depends on sensory experience, and is made impossible by a congenital-prelingual deafness. Cochlear implant (CI) adds a new auditory modality in deaf patients. The aim of this work is to analyse cortical activations in a population of patients with cochlear implant, during the auditory process.

Material and Methods. Twenty-five implanted patients (mean age: $34,5 \pm 18,2$) were included in the study. Nineteen of them were prelingual patients and they were divided into three groups, according to the age at time of CI surgery and to the duration of CI use: first group (early implanted and lengthy CI use); second group (late implanted and lengthy CI use); third group (late implanted and short CI use). The remaining six patients were affected by postlingual deafness (hearing loss occurred after they have

learned listening and language skills). Each patient group was compared with a normal hearing age matched control group. Auditory event-related potentials (Erps) were recorded from all subjects. Two different analyses were performed: a study of N200 and P300 latencies and waves, and a cortical source estimation, performed by using Loreta (Low Resolution Electromagnetic Tomography) software.

Results. P300 latencies were greater in prelingual patients than in controls, while no differences were found among this patient group. There were no significant differences in latencies between postlingual patient and the relative control group. Concerning the cortical activity of prelingual patients during Erps elicitation, a comparable activation between patients and controls was only found in the first patient group (early implanted-long CI use), and to a lesser extent in the second group (late implanted-long CI use), while patients belonging to the third group (late implanted-short CI use) showed a very low cortical activation. Even in this analysis, postlingual patients showed no difference in activation compared to controls.

Conclusions. Cochlear implant adds a new auditory modality in prelingual patients, allowing the creation of a functional network. This involves the areas implicated in sensory and cognitive modalities, and needs some time to form. In this sense, our results showed a great importance of a long use of the device in addition to an early time of implant. Instead, in the case of patients with postlingual hearing loss, cochlear implant restores and reinforces a cortical network that has already been formed, before the onset of the hearing impaired.

THE PREDICTIVE VALUE OF NEURAL TEMPORAL PROCESSING FOR SPEECH PERCEPTION PERFORMANCE ACROSS THE ADULT LIFESPAN

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Peripheral hearing impairment cannot fully explain difficulties in speech perception with advancing age. Changes in central auditory processing, and temporal processing in particular, are thought to underlie these difficulties as well. Since the speech envelope plays a key role in speech perception, it has been hypothesized that aging – with and without hearing impairment – goes with changes in temporal envelope processing, which, in turn, could relate to changes in speech perception performance.

In previous studies, we identified significant age- and hearing-related changes in neural envelope encoding. The aim of the present study was to verify whether these changes in neural envelope encoding contribute to impaired speech perception. Therefore, we investigated correlations between neural temporal processing and speech perception performance among young, middle-aged, and older adults who were either normal-hearing or hearing-impaired. We, indeed, identify significant correlations between neural envelope encoding and speech perception performance in both the normal-hearing and hearing-impaired participant population. These neural-behavioral correspondences yield promising directions for the development of advanced rehabilitation strategies aiming to remediate age- and hearing-related difficulties in speech perception.

USING STIMULUS RECONSTRUCTION TO DECODE SPATIAL AUDITORY ATTENTION IN A FOUR SPEAKER FREE FIELD ENVIRONMENT

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Attention can be defined as the cognitive process which enables to selectively focus perceivable information while ignoring other aspects of a subject's tangible environment. Here we want to look at Spatial Auditory Attention (SAA), which could be described as the auditory systems ability to solve the cocktail party problem.

It is not known how the auditory system is able to solve the task. However, recently it has been shown that there is a cortical representation of a listener's attended soundstream and stimulus reconstruction enables the decoding of SAA. It has been shown that it is possible to decode SAA from single trials of electroencephalography (EEG) data recorded during a dichotic listening test using stimulus reconstruction.

The aim of this study was to evaluate stimulus reconstruction from single EEG trials in a realistic acoustic environment and to investigate its limitations. Within a pseudo-acoustic free field environment consisting out of four loudspeakers, ten participants had to alternately focus their SAA on one out of four loudspeakers while ignoring the remaining streams. Four different audiobooks served as acoustic stimulation material and each was played by one of the four active loudspeakers. Please note that two audiobooks were spoken by man and two by a woman. The four speakers were equidistantly arranged in a half circle - one speaker at -90° , one at -30° , one at $+30^\circ$ and one $+90^\circ$ (LS1, LS2, LS3 and LS4 respectively) - at the height of the imagined ear. On eye level, at 0° , a computer monitor was used to present visual feedback and relevant instructions. To check whether the participants were able to solve the listening task, they had to answer content related multiple choice questions at the end of each of the 24 experimental trials. The neural activity was recorded from 128 EEG channels. On the basis of the acquired EEG data, decoders were computed which were used to reconstruct speech envelopes. The basic idea behind the approach is that the cortex acts like a linear time invariant system mapping input, i.e., acoustic stimuli, to a certain output, i.e., the EEG activity. Following that idea, the ongoing EEG activity resulting from ongoing stimulation - like real speech - can be interpreted as a linear convolution. According to this, the instantaneous neural activity is the result of a convolution of the acoustic stimulation, i.e., the speech envelope, with an unknown, channel-specific temporal response function (TRF). The TRF can be seen as a filter describing the transformation of the ongoing stimulus to the ongoing EEG activity. To us, it is even more interesting that the described can be used the other way around. It can be used as a backward model to reconstruct the stimulus from the recorded neural activity. For each participant and trial we reconstructed the speech envelope from the recorded neural activity. Then we used Pearson's correlation coefficient to compare the reconstructed speech envelope to the four actual speech envelopes. The speech envelope showing the highest correlation was determined as the attended one. If the predicted attended speech envelope matched the actual attended speech envelope, the spatial auditory attention decoding was counted as correctly predicted by the algorithm.

The amount of correct answered questions ranges between 50.0% and 94.4% with an average of 76.8 +/- 13.1%. We were able to correctly predict the attended loudspeaker with up to 84% prediction accuracy. Regarding the fact that simple guessing should result in 25% (four loudspeakers) prediction accuracy, the achieved accuracy is remarkably high.

The results suggest that it is possible to use the approach to decode the orientation of SAA in this multi-talker environment. The hypothesis is, that the recorded EEG is mostly driven by the attended speaker compared to the unattended ones, in other words, the EEG is mostly driven by the rhythm of speech a listener is attended to. However, we also discuss that it is necessary to include exogenous data, i.e., the characteristics of the used acoustic stimulation, into the analysis which makes it difficult to transfer the approach out of laboratory into real life listening situations.

SPATIAL AUDITORY ATTENTION DECODING FROM ONGOING EEG ACTIVITY ONLY

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In 1953 E. C. Chery introduced the term cocktail party problem in order to describe a listener's ability to easily focus on one out of several competing talkers in a multi-talker environment. Beside other factors, it is the ability to spatially direct auditory attention, that plays a major role in solving the cocktail party problem.

While the cognitive processes on which spatial auditory attention (SAA) relies are not well understood, current research investigates effects of auditory attention on ongoing electroencephalographic (EEG)

activity caused by ongoing stimulation, i.e., real speech. It has been demonstrated that it is possible to reconstruct characteristics of auditory stimulation from recorded neural activity and it has been shown that stimulus reconstruction is sensitive to selective auditory attention and can be used to decode auditory attention. The disadvantage of using the stimulus reconstruction approach is the necessity to know some elementary characteristics of the external auditory scene itself. In other words, using this approach, it is not possible to decode auditory attention directly from neural activity - endogenous, i.e., recorded neural activity, as well as exogenous data, i.e., physical characteristics of the acoustic environment, are necessary.

Here, the authors would like to present a new way to decode the orientation of SAA that is based exclusively on ongoing EEG data. The proposed method is based on Granger causality (GC). It is best known for expressing the functional directivity between different processes. Using GC, it can be determined if the past information of a second process Y contains useful information to predict the future of process X higher than of using only the past information of X. In other words, the inclusion of past information of Y and X yield a better prediction of X, than not using Y. GC offers a tool to quantify the degree of dependency and allows a statement on the direction of that dependency.

In total, 17 subjects with no known health problems - especially no known hearing loss (proofed by a current pure tone audiogram) or neurophysiological diseases / impairments - took part in this study.

Those 17 participants had to alternately focus one out of two competing loud speakers. To do so, the participants sat in a comfortable chair, facing a monitor (0°) in the middle of an acoustically controlled environment between two active loudspeakers (-90° and +90°). The acoustic stimulation, i.e., several different podcasts, was played via those loudspeakers. The two speakers were equidistantly arranged at the height of the imagined ear, one meter away from the participant.

The acquired and pre-processed (referencing against Cz, bandpass filtering 1-45Hz using a zero phase shift finite impulse response filter based on a Hamming window, filter order 1000) EEG data was used to compute GC coefficients between different electrodes of relevance (FC5, FC1, FC2, FC6, C5, C1, C2, C6, TP7 CP5, CP1, CP2, CP6, TP8, TP9, TP10, 97 and 104; the electrodes were selected in the way that they cover the area of the primary auditory cortex, as well as the Wernicke's area which is associated with the comprehension and the understanding of speech and the structures of the "dorsal stream" which are responsible for audiomotor processing). The resulting GC coefficients show patterns on how dependencies between electrodes are orientated during the two listening conditions. Those patterns were used to classify between the different directions of SAA. As classifier we used a support vector machine (SVM) algorithm with a linear kernel function.

The proposed classification method was used individually as well as over the total set of participants. In both cases the results show that the proposed approach is able to reliably detect the orientation of SAA, i.e., 84 +/- 2.6% and 70.45 +/- 0.74% respectively. The achieved decoding accuracy is comparable to related works. For example, a study by O'Sullivan et al. from 2015 using a speech reconstruction approach in a dichotic paradigm achieved a decoding accuracy between 82% and 89%. Therefore it is concluded that it is possible to decode SAA exclusively from ongoing EEG activity. In addition, the results indicate that there could exist a general pattern within the recorded EEG data that allows decoding the orientation of SAA which the authors wish to investigate in future studies.

SPEECH INDUCED BINAURAL BEATS

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Objective evaluation of binaural interaction is valuable in the diagnosis of central auditory processing disorders (CAPDs). The most commonly used electrophysiological correlates of binaural interaction is the β -wave of the auditory brainstem response. However, analysis of the β -wave contains no information of neural processes above the level of the brainstem. Binaural beats (BB) are an auditory illusion created by presenting to the ears two sinusoids signals with a slightly different frequency and are closely related to binaural interaction as they cannot be perceived monaurally. Based on the principles of BB, we designed a scheme to change speech signals in the time frequency domain in such a way, that dichotic

presentation leads to a transient auditory perception, including late auditory evoked potentials (LAEPs), while diotic presentation elicits neither. In this study, we modified sentences used to determine speech intelligibility to generate beats which we call speech induced binaural beats (SBB). Twelve normal hearing adults entered the study. LAEPs were recorded using passive electrodes on the left and right mastoids with reference to Cz. During the measurements, subjects were instructed to keep their eyes closed and press a button every time they heard a "color" word. For maximum reproducibility, the SBB were always contained in the same word. Dichotic presentation of the altered speech signals reliably evoked late potentials, while diotic stimulation did not. We can therefore assume that the recorded LAEPs are indeed a correlate of binaural interaction. In this way, we can simultaneously test the subject's speech intelligibility and record SBB evoked LAEPs. Thus speech intelligibility and binaural processing at cortical levels can be assessed at once.

EXTENDED HIGH FREQUENCY HEARING CONTRIBUTES TO SPEECH PERCEPTION IN NOISE

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Human hearing in healthy young people can extend to at least 20 kHz, but clinical audiometry, on which a diagnosis of hearing loss is typically made, is limited at the high frequency end to 8 kHz. Within the range tested, hearing loss is typically greatest at higher frequencies. Long standing, unresolved questions are whether frequencies above 8 kHz contribute to functionally important hearing, and whether audiometric testing should extend to frequencies above 8 kHz. Previously, we found that a remotely-deliverable, digits-in-noise (DIN) test may be sensitized for detection of high frequency hearing loss by low-pass filtering the speech-shaped masking noise at around 1.5 kHz (Vlaming et al., Ear Hear, 2014). In this study, we used successively higher cut-off frequencies to investigate roles of high frequency hearing.

Participants were 18-30 year olds with tone thresholds ≤ 20 dB HL at 0.25-8kHz bilaterally. Extended high frequency (EHF) audiometry was also performed (10, 12.5, 14, 16 kHz). DIN masking noise was the sum of the 10 digits, and was presented 'broadband' (40dB down at 14 kHz) or with three different low-pass filters at 2, 4 or 8 kHz.

As expected, the lower the frequency of noise filtering, the greater the benefit for speech detection in terms of speech reception threshold (SRT). However, two surprising results were found. First, 8/20 participants had an EHF hearing loss, mostly bilaterally and at 14-16 kHz. Second, even with the broadest filtered noise (<8 kHz), DIN SRTs were significantly more sensitive ($n=10$, $p<0.03$) than those obtained using broadband noise. This finding suggested that extended high frequency hearing contributes to performance of the normal DIN task and, presumably, to everyday speech perception in a variety of listening environments. People complain of difficulty hearing in challenging environments, despite having normal audiograms. Our results suggest that one contribution to this difficulty, even for young adults, is an EHF hearing loss.

IS THE DIFFERENCE BETWEEN SPEECH AUDIOMETRIC RESULTS IN INFORMATIONAL NOISE AND ENERGY NOISE AN INDICATOR OF CONCENTRATION AND WORKING MEMORY?

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When assessing candidates for hearing aid fitting in a professional hearing care protocol, we need much more information than tonal and speech in quiet audiometric data. The Acceptable Noise Level (ANL) test and Speech Audiometry in Noise, prove to give good added value in a realistic clinical protocol. Working memory assessed by the Reading Span Test, would be a very important complement to the test battery, since multiple studies show the impact of working memory in understanding in noise and how selecting

different compression schemes for subjects with poor and good working memory, has significant impact in the performance. Unfortunately, the Reading Span Test turns out to be perceived very negative by candidates for hearing aids and is therefore rejected by professionals in clinical practice.

Aimoni et al (2014), published a very interesting study, where they demonstrate that older subjects with mild cognitive decline, perform much poorer in speech audiometry in noise when using informational noise (competing speech) than older control subjects. This difference is much smaller for speech audiometry in noise when using energy noise (speech weighted constant noise).

In our study, we assessed the difference in speech audiometric results between energy and informational noise and compared this with results on the reading span test (working memory) and questionnaires (SSQ and CRS questionnaire) on 100 subjects in different age and educational level groups.

The preliminary results indicate that the difference between speech audiometric results in energy noise and informational noise is related to the reading span results and the topics in the questionnaire related to concentration, listening in dynamic or complex environments.

This procedure is both very time-efficient and is perceived as a realistic and logical test procedure.

At the time of the conference, we will have the final results of this study available.

EXPLORING THE SELF-REGULATORY BEHAVIORS OF ELEMENTARY STUDENTS WITH HEARING LOSS IN INCLUSIVE CLASSROOMS

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Self-regulation describes how individuals, including children, respond to environmental demands and control cognition and behavior to meet goals. Educational psychologists hold the belief that individuals who are effectively self-regulating utilize executive functions (EF; i.e., working memory, cognitive flexibility and inhibition control), as well as higher order processes such as metacognition, motivation, and strategic action to regulate emotions, learning, and social interactions. This presentation will present the results of an exploratory, mixed-method and multi-level research study which was conducted to examine relationships among students' hearing loss, academic achievement and self-regulation, classroom background noise levels, teachers' perceptions of inclusion of students who are hard of hearing and features of classroom instruction that support self-regulation. Data consisted of 10 elementary teachers' perceptions of the inclusion, and ratings of 131 students, of whom 8 were hard of hearing, self-regulation and academic achievement scores. Classroom observations were conducted to obtain background noise levels and to examine whether and how teachers implement the features of classroom contexts to support self-regulation within their classroom. Results indicated that a) hearing status predicted self-regulation, b) self-regulation predicted academic achievement for children without hearing loss and hard of hearing students, c) hard of hearing students received lower self-regulation ratings than 'normal' hearing peers, and d) classroom background noise levels were negatively related to the use of features of instruction to support self-regulation and to teachers' knowledge and understanding of hearing loss. The implications of these results will be discussed.

E-HEALTH (1)

BARRIERS AND FACILITATORS TO TELEPRACTICE IN EARLY INTERVENTION SERVICES FOR CHILDREN WITH HEARING LOSS

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Telepractice has been identified as a means of ensuring improved access to services for families living in rural/regional locales. Research to date has indicated that telepractice is a cost-effective model for providing early intervention for children with hearing loss and their families. In addition to providing access to specialised services, telepractice has the potential to promote family-centred care through increased parent engagement and the ability to provide intervention within naturalistic environments. However, despite the recognition of these benefits, its uptake within Australian early intervention services for children with hearing loss has been inconsistent. While previous studies have investigated barriers and facilitators to the uptake of telepractice in other healthcare fields and in general speech pathology practice, to date no studies have specifically explored this issue in early intervention services for children with hearing loss. This study aimed to identify the major barriers and facilitators to the successful uptake of telepractice services in early intervention for children with hearing loss and their families.

A qualitative study design was utilised to provide in-depth exploration of service providers' perceptions of telepractice as a service delivery model for children with hearing loss. A purposive sampling strategy was used to recruit a maximal variety of professionals from five not-for-profit hearing services and one public hospital-based hearing service across Australia. There were a total of 16 participants including speech pathologists (n=5), teachers (n=5), audiologists (n=3), financial services manager (n=1), social worker (n=1), and speech pathologist/audiologist (n=1). Participants took part in one semi-structured in depth interview, with questions focussed on perceived benefits, challenges, facilitators and barriers associated with the delivery of telepractice. Transcripts were first coded according to the six components of the COM-B model of behaviour: Physical Capability, Psychological Capability, Social Opportunity, Reflective Motivation, and Automatic Motivation, and then major barriers and/or facilitators under each component were identified.

A total of 21 specific barriers and/or facilitators were identified under all COM-B themes. The major barriers were Psychological Capability (clinical skills), Physical Opportunity (technology and Internet connection; physical absence), Social Opportunity (training, education and clinical support), and Reflective Motivation (preference for in-person services). It will be important to address these barriers with specific behaviour change strategies or interventions in order to optimise the use of telepractice in paediatric hearing services.

PROCESS EVALUATION OF A CLUSTER RANDOMIZED CONTROLLED TRIAL TESTING THE EFFECTIVENESS OF AN ONLINE SUPPORT PROGRAMME (SUPR) FOR OLDER HEARING AID USERS

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Background: An online educational Support Programme, SUPR, was developed for hearing aid users (HAUs) and their communication partners (CPs) offering care beyond HA fitting in a dispensing setting. The effectiveness of SUPR is currently being evaluated via a cluster randomized controlled trial (ISRCTN77340339) that is carried out among 70 HA dispensing practices in the Netherlands. The main aim of SUPR is to establish long-term (i.e., lasting at least 1 year post-intervention) improvements on communication strategies, personal adjustment to hearing impairment, and HA handling skills among

older (50+) HAUs, and on third-party disability of their CPs. SUPR consists of: 1) a Practical Support Booklet, providing practical information on hearing aids and home exercises to match the specific needs of the participants to fitting of the appropriate hearing aid, 2) online material offered via email over a period of 6-7 months. The online material consists of three instruction videos on HA handling, five videos on communication strategies, and three peer testimonial videos, 3) appointment of a CP who is advised to be involved intensively throughout the hearing aid fitting process and the program, 4) optional noncommittal email contact with the HAD practice. The current study describes the process evaluation of the implementation of the SUPR-study. Via this we aim to obtain insight into 1) implementation circumstances, 2) (non-) compliance with the intervention and 3) the clients' and professionals' experiences with the intervention.

Methods: Data was collected and analyzed based on eight process indicators using a methodology based on the framework of Linnan & Steckler: context of the implementation, recruitment of participants, reach of the intervention, fidelity of the implementation of the intervention, intervention-dose delivered, intervention-dose received, satisfaction with the intervention, and perceived benefit of the intervention. Data collection involved HAU questionnaires, dispenser questionnaires and objective data on HAUs' online behavior delivered by the HAD headquarters.

Results: A total of 1.459 first-time HAUs and 728 experienced HAUs were invited to participate in the study. Of these, eventually 127 first-time clients and 61 experienced clients in the intervention group, and 111 first-time clients and 56 experienced clients in the control group met all inclusion criteria and were enrolled in the study. Ninety-nine new HAUs, 45 experienced HAUs and 43 dispensers completed the process evaluation questionnaire. The vast majority of the first-time (75.8%) and experienced HAUs (82.2%) indicated that they received the Practical Support Booklet, and most of them used it as it was intended (i.e., to obtain information and tips and to write down their goals and experiences with the HAs). Of the emails that were delivered, around one third of the videos were actually viewed. The instruction videos were viewed most often, followed by the videos on communication strategies and peer testimonials. The dispensers mostly followed the study protocol, although only half of the dispensers told their clients about the goals of the online materials or encouraged them to watch the videos. Seventy-six percent of the first-time clients and 63.3% of the experienced clients indicated that they had invited a CP to participate in the program. First-time HAUs (mean = 3.2 ; standard deviation (SD)=1.13) were significantly more satisfied with SUPR ($p = 0.039$) than experienced users (mean = 2.9, SD = 1). The perceived benefit of SUPR in terms of improvement in communication, personal adjustment and HA use was rated as good.

Conclusion: The process evaluation indicators showed that the use of the Practical Support Booklet and views of the educational videos were suboptimal. Nonetheless, the participants indicated that they were satisfied with the different elements of the intervention and the overall benefit they perceived was good. The results indicate that SUPR is somewhat more satisfactory for first-time HAUs than for experienced HAUs. The information on useful and suboptimal elements that were collected in the current study will also be used to explain future (positive and negative) trial outcomes.

EMPOWERING SENIOR COCHLEAR IMPLANT USERS AT HOME VIA A TABLET-COMPUTER APPLICATION

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Objective The introduction of connectivity technologies in hearing implants allows new ways to support cochlear implant (CI) users remotely. Some functionalities and services that are traditionally only available in an in-clinic care model, can now also be accessed at home. This study explores the feasibility of a prototype of a tablet computer application in a group of senior experienced CI users at home, evaluating usability and user motivation.

Materials and Methods Based on user feedback, a tablet computer application (MyHearingApp, MHA) was designed implementing 6 different functionalities: (1) My Hearing tests, (2) My Environment, (3) My Hearing Journey, (4) Tip of the Day, (5) Recipient Portal, and (6) Program use and Events. The clinical

evaluation design was a prospective study of the MHA in 16 senior experienced CI users. During 4 weeks, participants could freely explore the functionalities. At the end usability and their motivation for uptake and adherence were measured using questionnaires.

Results Based on the System Usability Score, a good level of usability was indicated (75.6). The ability to perform hearing tests at home is ranked as the most relevant functionality within the MyHearingApp. According to the Intrinsic Motivation Inventory questionnaire, participants reported high levels of interest and enjoyment, found themselves competent, and did not experience pressure while working with the app.

Conclusions The user feedback from this small scale study with a research prototype suggests that at least part of the adult CI users are open to take more responsibility for and to become a more active actor in their own hearing care, if only this is facilitated with the right tools. This may speed up the evolution from a clinic-led to a more patient-centered care model, where CI users feel more empowered.

WHAT IS THE FUTURE OF EAR CARE AND HEARING SCREENING IN THE COMMUNITY? – CAN WE BE MOBILE?

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Background: There are half a billion people in the world with disabling hearing loss and one of the most common causes hearing loss is simple ear wax!

Last year in the NHS our of the 80 million outpatient procedures performed ear wax removal was in the top 10 and each time costing the GP a significant amount in referral costs. With developing technology we developed a solution, which aimed to take the service to the patient.

Method: CEEK, a community ear examination kit. It's a smartphone clip on which captures an image of the tympanic membrane, performs ear microsuction, allows for remote consultation with specialists and can be linked to hearing screening. All components have been developed with the non-specialist in mind and provides the opportunity to up-skill our allied health professionals such as Audiologists, Nurses and Health Care Assistants.

We have performed opportunistic hearing screening in various environments such as high street ear care stores, GP practices, hospital outpatient departments and nursing homes. The CEEK device will be trialed alongside our allied health professionals and assessed on its potential to be used in the community.

Results: Opportunistic screening in these various environments identified the need for a service to be delivered in the community. The number of individuals found to have undiagnosed hearing loss were:

1. Hospital inpatients – 33%
2. Nursing Homes - 62%
3. Hospital Outpatients – 30%
4. GP waiting room – 60%

The device is in the final stages of development and initial feedback has shown the potential for use in the community.

Conclusion: Hearing screening and ear care can be delivered in the community with emerging technology. The aim will be to reduce the burden on secondary care facilities and also enhance the skills of allied health professionals.

LIVING WELL WITH HEARING LOSS: APPLYING A PERSON-CENTRED APPROACH IN AUDIOLOGICAL REHABILITATION USING AN EHEALTH TOOL

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Background: The provision of individualised, goal-oriented hearing health care aligns with a person-centred approach to audiological rehabilitation and can be used to adopt the perspective of living well with hearing loss. Taking this approach ensures that we move beyond a deficit model in rehabilitation and include other aspects of living well with hearing loss, including social engagement and communicative functioning. The Ida Institute's Living Well Online tool utilises eHealth to assist clients in preparing for their audiology appointment by focusing on the communication situations which are most relevant and

important to them and uses an active problem solving approach to assist clients in identifying solutions to their everyday communication difficulties. In this way, Living Well Online also assists audiologists in identifying client goals. This study aimed to explore how Living Well Online facilitated the provision of person-centred care in audiological rehabilitation, and specifically how it influenced the way in which audiologists communicated with clients in audiological appointments.

Methodology: Two audiologists and twenty-four clients with hearing loss participated in this study. Audiologists working across two private clinics invited clients to complete Living Well Online prior to their appointment. Audiology appointments were subsequently video-recorded to observe how the Living Well tool was utilised during the appointment, and clients and audiologists participated in an individual qualitative interview to investigate their perspective of Living Well Online and its use in appointments. Appointments were transcribed verbatim and analysed using conversational analysis. Interviews were transcribed and analysed using template analysis.

Results: Four participants completed Living Well Online prior to their appointment; the remaining 20 participants completing it within their appointment with the audiologist's assistance. Two of the twenty-four clients brought a family member with them to their appointment who also participated in completing the Living Well tool. Audiologists typically communicated to the client that the purpose of the tool was to focus the conversation on the client as a person, and to assist them in better understanding the client's individual hearing situations. Duration of discussion relating to Living Well Online ranged from 1:40 minutes to 16:16 minutes. Analysis of appointments suggested that clients who completed Living Well Online prior to their appointment typically had longer discussions and more active involvement in conversations than clients who completed the tool during the appointment. In addition, audiologists' use of open versus restrictive questions influenced the person-centredness of the communicative interaction, with the use of open questions providing clients with the opportunity to identify their own communication situations to discuss. Analysis of the client interviews revealed four themes of importance: client characteristics influenced tool use (e.g., the therapeutic relationship and experience with technology); client satisfaction with tool design (e.g., ease of use, presentation and workings of the website); process of using tool (e.g., belief that the tool should be used in session and helps the audiologist); and helpfulness of tool content (e.g., relatability to the client and social/emotional aspects of using the tool). Clinicians reported that the Living Well tool provided a framework to streamline goal setting and provided an important context to client communication difficulties.

Conclusions: Feedback from both clients and clinicians showed support for the use of Living Well Online within hearing health care appointments. Importantly, Living Well Online provided a context for clients and clinicians, focusing on communication and clients' participation in everyday life. Communication patterns of clinicians influenced the extent to which person-centred care was implemented in using the tool. Using the tool has implications for training audiologists, highlighting the importance of open-ended questions and the value of completing the tool prior to appointment attendance.

SELF-FITTING HEARING AIDS

FACTORS THAT INFLUENCE CLINICIAN ADOPTION OF REMOTE HEARING AID FITTING SUPPORT

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Background: Tele-audiology services include the application of telecommunication technology to deliver audiology professional services at a distance. The literature suggests that most audiologists display a positive attitude towards tele-audiology and that level of willingness to engage in the provision of remote clinical services may partly depend on the patient/client's age, as well as the task being performed by the audiologist (Eikelboom & Swanepoel, 2016; Singh et al., 2014). Services related to remote hearing aid fitting support are starting to become clinically available. These have involved synchronous service delivery models to facilitate distance communication between the hearing instrument fitter and the end hearing aid wearer, using videoconferencing or telephone communication, in addition to an information pathway to exchange data between clinician-driven fitting software and the hearing aid wearer's device. Recent research efforts suggest that remote hearing aid support as a clinically feasible option for most adult participants (Angley et al., 2017). Further research is needed in the areas of pediatrics and clinical implementation.

Purpose: This study, involving a diverse group of stakeholders, explored the factors that influence the adoption of tele-audiology practices related to one specific application: The provision of follow-up remote hearing-aid support. The end goal was to represent a domain of ideas in a conceptual framework to be utilized in the development and planning around clinical implantation of such application.

Methods: Concept mapping research methods (Kane & Trochim, 2007) were used to facilitate a collaborative and participatory study involving 42 clinical audiologists reporting diverse practice contexts, patient/client populations and clinical/technological skills. Practicing audiologists located across Ontario, Canada and were divided into groups according to the patient/client population they reported to most commonly serve in clinical practice (i.e., adults versus children). Data collection involved structured group processes in face-to-face group brainstorming sessions. Researchers and study participants were directly involved in all aspects of the study, including the sorting of ideas, importance rating tasks and interpretation of results.

Results: Group brainstorming resulted in the generation of over 100 succinct statements describing the factors felt to influence clinical adoption of this tele-audiology application. Multidimensional scaling and hierarchical cluster analyses were used to articulate and graphically depict concept map(s). Results will be presented depicting the major ideas generated and how they are interrelated.

Conclusions: Findings include knowledge around the barriers and facilitators felt to influence clinical uptake of follow-up remote hearing aid fitting support in Ontario, Canada. In addition, results directly inform the need for specific planning and development efforts within the field of audiology, including structured training efforts, the creation and dissemination of protocol/guidance documents, greater dissemination of tele-audiology research, and regulatory revisions, to support effective clinical implementation of tele-audiology initiatives.

EXAMINING POTENTIAL APPLICATIONS FOR PEDIATRIC TELEHEALTH AND REMOTE FINE TUNING

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The World Health Organization describes telehealth as the "use of telecommunications and virtual technology to deliver healthcare outside the traditional health-care facilities. Telehealth, which requires access only to telecommunications, is the most basic element of eHealth, which uses a wider range of information and communication technologies (ICTs)".¹ Today, Pediatric audiologists can use telehealth

for an extensive range of applications including audiological screening, diagnosis, intervention and educational services. Satisfaction with telehealth has been shown to be high among adult patients, and evidence for higher satisfaction within hearing healthcare is also emerging. As the area grows, it is of interest to explore how teleaudiology may affect benefit and satisfaction in a pediatric population. Technological improvements have driven the advancement of tele-audiology that enables hearing instrument remote fine tunings. These improvements may mitigate the issues in access, scheduling and wait times; that limit our capability in resolving pediatric hearing instrument and programming issues. The intention of this qualitative study was to explore the perceptions of teens, audiologists and caregivers on tele-audiology as well as examine how a commercially available hearing aid fine-tuning service based on asynchronous teleaudiology could be optimized. Barriers to remote provision of fine-tuning services, suggestions for remote service protocols and improvements in tele-audiology are also explored.

Methods Subjects were fit with ReSound LiNX 3D or ReSound ENZO 3D hearing aids. These products are compatible with the ReSound Assist, which is a cloud-based remote fine-tuning service that the user accesses via a smartphone. Teens, audiologists and caregivers were invited to participate in semi-structured questionnaires to gauge their insight and engagement in remote tele-audiology options. Surveys are analyzed to ascertain key themes.

Preliminary Results Analysis is ongoing over a period of 7 months. Preliminary trends suggest the following outcomes with ReSound Assist: 1) provides a cost effective solutions for families and audiologists; 2) facilitates faster response times to patient fitting requests; 3) results in increased family satisfaction due to reduction in family travel expense, less absence from work or school to attend appointments, and less family separation.

1. World Health Organization. Telehealth. Available at: <http://www.who.int/sustainable-development/health-sector/strategies/telehealth/en/>

OUTCOMES WITH A SELF-FITTING, APP CONTROLLED BLUETOOTH HEARING AID

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The Companion by SoundWorld Solution is a Bluetooth receiver-in-the-canal (RIC) hearing aid that can be manipulated from an app downloaded to a smartphone, tablet, or computer. The app will enable the user to perform a self-administered pure tone test, the result of which will determine the initial setting of the hearing aid parameters according to a proprietary fitting formula. After the initial setup of the device, the user can use the app to perform further fine-tuning of the settings in real-life environments. Due to the integrated battery pack to enable Bluetooth transmission, the Companion is heavier and about twice the size of traditional RIC devices. The question addressed in this presentation is if taking control of the setup of the hearing aid will influence outcomes. Sixty hearing-impaired adults of whom half were experienced and half were new to hearing aids were invited to self-fit the Companion while having access to knowledgeable support via a help-line, and to evaluate it in the field for 12 weeks. Following the field trial, outcomes were measured in form of coupler gain; speech reception threshold in noise; hearing aid handling and management skills; and self-reported benefit and satisfaction. The same outcomes were measured for conventionally fitted devices owned by experienced hearing aid users. Fifty-two participants, of whom 38 achieved successful user-driven fittings and 14 failed the self-fitting process and then obtained clinician-driven fittings, completed the field trial. Irrespective of hearing aid experience, the type of fitting (user- or clinician-driven) had no significant effect on outcomes. Compared to conventionally fitted hearing aids, users selected higher low-frequency gain in the Companion, showed more difficulty handling and managing the Companion, and gave the device lower benefit and satisfaction ratings on a few subscales. The lower ratings of management skills, benefit and satisfaction were not influenced by who drove the fitting process, but could be explained by the physical design and implementation of the Companion; such as the size of the hearing aid body, choice of instant-fit tips, battery life, and inability to adjust the maximum power output level. Overall, findings suggest that with the right design and support, self-fitting hearing aids may be a viable option to improve the affordability and accessibility of hearing health care.

REMOTE FINE TUNING

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Introduction: Fine tuning of hearing aids has always required a patient to see an audiologist, however tele audiology is changing this. Because tele audiology can reduce the need to travel to the clinic it is particularly valuable for patients who are very busy or have difficulty getting to the clinic. There are disproportionately many elderly people who have difficulty getting to the clinic due to transportation and/or mobility limitations. This is relevant because many hearing-impaired people are elderly. One example of tele audiology is remote fine tuning, which allows a patient to make a request, the audiologist sends an update to the hearing aid users phone, and the user downloads this update to the hearing aids. This allows a patient to have hearing aids adjusted without needing to come to the clinic and it allows feedback to be sent live from the situation they are struggling with.

Method: A survey was sent to hearing aid users who had used remote fine tuning and audiologists who signed up for remote fine tuning. Hearing aid users received an invitation to fill out a questionnaire via their hearing aid app. Audiologists received an email survey asking about to use of the service.

Results Twenty audiologists who used the remote fine-tuning app responded. Their answers give insight into what works well using remote fine tuning and what could be improved

Seventy patients answered the survey. Their responses provide information about patient experience using remote fine tuning (the technical solution) and if the changes were useful to hear better.

Discussion Remote fine tune fine tuning cannot solve all problems, but it can solve some problems and users appreciate the convenience of being able to solve problems without needing to visit the clinic. Also, feeling some control over problem solving is important for users. We should consider how these solutions can be made as useful as possible for elderly people who have difficulty visiting the clinic.

E-HEALTH (2)

CHARACTERISTICS AND BEHAVIORS OF PERSONS SEEKING HEARING HEALTHCARE ONLINE

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Objective: This study describes characteristics and behaviors of people who are interested in seeking hearing healthcare (HHC) online.

Design: A non-profit clinic was established from which services through a virtual clinic are offered. Most of the patient-audiologist interactions are conducted online. We used online means to invite individuals to take a free online digit-in-noise (DIN) test. Upon failing the test, individuals reported their readiness to seek HHC by using two tools; the Line and the Staging algorithm. Study sample: Individuals ≥ 18 years of age, within the greater Durban area, South Africa were eligible to participate in the study.

Results: A total of 462 individuals completed the online DIN test during the first 3 months. Of those, 58.66% (271/462) failed the test and 11.04% (51/462) submitted their details for further contact from the clinic audiologist. Five individuals proceeded to a comprehensive hearing evaluation and hearing aid trial: all those individuals showed readiness to seek further HHC on the measurement tools. These individuals have reported knowing of their hearing challenges prior to taking the test and have waited for a period of between 5 to 16 years before seeking HHC. A significant association between age and DIN test result was found.

Conclusion: This explorative study is the first clinic to utilize digital tools across the entire patient journey in combination with face-to-face interactions in providing HHC. Internet-connected devices provide an opportunity for individuals to seek HHC and for providers to offer initial services to detect, counsel and support persons through the initial engagement process of seeking HHC. This may open up new audiology patient pathways through online hearing screening, assessment of readiness to seek further HHC and enhancement of service delivery using hybrid services by combining online and face-to-face modes of synchronous and asynchronous communication.

A SMARTPHONE NATIONAL HEARING TEST -PERFORMANCE AND CHARACTERISTICS

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Hearing screening programs have a critical role in monitoring hearing and early detection of hearing difficulty. However, implementation and success of these programs are reliant on specific human and technological resources like trained screening personnel, audiological equipment, and optimal quiet test environments. Digits-in-Noise (DIN) tests are becoming increasingly popular since they are less sensitive to ambient noise and do not require calibrated equipment. The DIN test measures the speech reception threshold (SRT in dB signal-to-noise ratio) where a listener can correctly identify 50% of digit triplets (e.g., 3-2-7) presented in speech noise. The first smartphone national hearing test, called hearZATM was launched in 2016 in South Africa. The test can be completed within 3 minutes, correlates highly with pure tone average thresholds (0.5,1,2,4 kHz) and has sufficient sensitivity and specificity for population-based screening. This study determined the characteristics of individuals that have tested themselves with the hearZATM national hearing test App and test performance.

Method: A retrospective analysis of 30321 persons who completed a test between March 2016 and August 2017 was conducted. User characteristics, including age, English-speaking competence and self-reported hearing difficulty were analyzed. Regression analyses were conducted to determine predictors of the SRT.

Results: Overall referral rate of the hearZATM test was 27%, and 37% of these had self-reported hearing difficulty. Age distributions showed that 32% of listeners were 30 years and younger, 40% were

between 31 and 50 years, and 28% were older than 50 years. Age, self-reported English-speaking competence and self-reported hearing difficulty were significant predictors of the SRT.

Conclusion: High test uptake, particularly among younger users and high overall referral rate indicates that the hearZATM App addresses an important public health need. The test also reaches target audiences including those with self-reported hearing difficulty and those with normal hearing who may benefit from monitoring their hearing ability.

APPLYING ITEM RESPONSE THEORY TO SCREEN HEARING USING AN ADAPTIVE MANDARIN WORD RECOGNITION TEST

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According to a 2008 report by the World Health Organization, hearing loss has become one of the most prevalent chronic disabilities worldwide. If rehabilitation for people affected by hearing loss is not started early on, the associated decreased productivity and increased social costs are a great burden to society. Thus, expanding hearing-care-related consolation services and hearing screenings into primary health care is crucial for improving public awareness about hearing health care. Developing rapid and easily administered hearing screening techniques and equipment is a means to achieve this purpose.

With the development of technology and telecommunications, smartphone-based hearing screenings have emerged rapidly. Pure tones have been used as stimuli in hearing screening; however, some researchers have suggested that applying speech as a test material may be closer to real life and has higher face validity. To reduce test times, audiologists usually administer from 25 to 50 items to estimate the examinee's speech recognition ability; valid and reliable outcomes are difficult to obtain using fewer test items. Therefore, on the premise of not sacrificing test reliability and validity by using fewer items, developing an adaptive speech recognition test is a suitable approach.

Item response theory (IRT) is a statistical model for estimating the probability of correctly answering based on the estimated latent trait of the test taker and item parameters. The major idea behind the IRT-based adaptive test is based on the performance on a prior item to select items with maximum information at the current trait or ability level. The sequence of items, numbers of items approached, and items administered all differ among examinees, which are benefits that traditional tests cannot obtain. In the present study, an IRT-based adaptive Mandarin monosyllable recognition test (MMRT) was proposed for hearing screening. Subjects with and without hearing loss were recruited to evaluate the feasibility of the developed adaptive test. Correlations among PTA, traditional test scores, and adaptive test results were estimated. Finally, the percentage of item reductions in the developed adaptive test compared with the traditional test was calculated.

A total of 96 ears without hearing loss (average PTA: 9.05 dB HL) and 18 ears with hearing loss (average PTA: 33.01 dB HL) were recruited. Through the generation of the adaptive version of the MMRT, the difficulties of the items (50 items) were first calculated by 1-parameter IRT for 48 ears without hearing loss. Subsequently, the items were ordered according to their difficulties and divided into six levels (level 1 was the easiest and level 6 was hardest). In the adaptive MMRT, subjects were first tested with one of the items from level 3. If the item was correctly answered, an item from level 4 was administered. By contrast, if the level 3 item was answered incorrectly, an item from level 2 was administered. The test was terminated when three consecutive items were answered incorrectly or when the level of items was finished being tested.

No statistically significant difference in the number of items in the adaptive MMRT was observed between subjects with (mean = 12 items) and without (mean = 14 items) hearing loss ($t = -1.18$, $p = .25$). A positive correlation between the scores of the traditional MMRT and level stop of the adaptive version was found ($r = .90$, $p = .00$), indicating that subjects with adaptive MMRT stopping at a higher level tended to score higher in the traditional MMRT. The higher the average PTA was, the lower the obtained level of the adaptive MMRT test became ($r = -.81$, $p = .00$). Furthermore, level 2 was the highest level that subjects with hearing loss could reach in the adaptive MMRT, showing that the adaptive test can discriminate subjects with and without hearing loss efficiently. Compared with the traditional test, the adaptive MMRT can efficiently screen subjects with hearing loss reducing the items by 42.20%–51.50%.

ESTABLISHMENT OF THE CHARACTERIZATION OF AN ADULT DIGITS-IN-NOISE TEST BASED ON INTERNET

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Objective: To establish the characterization of the Chinese version of digits-in-noise test (DIN test) based on internet.

Method: Fifty participants were recruited which consists of 34 people with normal hearing (NH) and 16 people with sensorineural hearing loss (SNHL). Pure-tone audiometry, Acoustic Immittance and DIN test were tested respectively. Pearson correlation coefficient between the groups of NH and SNHL, receiver operating characteristic curve, the area under the curve as well as the sensitivity and specificity was analyzed by SPSS 19.0.

Results:

1. The correlation between the speech recognition threshold (SRTn) and pure-tone audiometry thresholds (average of 0.5, 1, 2 and 4kHz) was 0.85 ($p < 0.001$).
2. The optimal cut-off point was -9.5dB, which means any results over this value could lead to a conclusion of underlying hearing loss.
3. The sensitivity and specificity was 0.938 and 0.941 respectively with -0.95dB as the best cut-off point.

Conclusion: This DIN test based on Internet has well-done performance as a hearing screening method with good sensitivity and specificity. It could be a worthy tool for the large population adult hearing screening.

COMPARISON OF THE FREQUENCY OF POSITIVE HEARING SCREENING OUTCOMES IN SCHOOL-AGE CHILDREN FROM DIFFERENT COUNTRIES IN ASIA

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Introduction Hearing screening have an extremely important preventive task, being the primary means of secondary prevention. They allow for an early detection of hearing disorders, thus enabling treatment and eliminating or minimizing the negative consequences associated with this type of dysfunction. Hearing-impaired children often experience delayed development of speech, language and cognitive skills, which may result in slow learning and difficulty progressing in school. For many years the Institute of Physiology and Pathology of Hearing has undertaken a variety of initiatives in countries across continents, which include screening for hearing.

The primary goal of the program is early detection of hearing impairment, especially in children who start school and at raising awareness among parents and the school environment about hearing problems. These efforts are aimed at improving the state of medicine abroad, especially in Asian countries, enabling access to health care and promoting healthy lifestyle.

Material Hearing screening was performed in group of 1.421 children in 7 Asian countries: Armenia – 200 children, Azerbaijan – 200 children, Kazakhstan – 212 children, Kirgizstan – 300 children, Siberian (Russia) – 166 children, Tajikistan – 143 children, Uzbekistan – 200 children.

Method Screening was performed using the Sensory Organs Platform; based on an audiometric hearing threshold measurement procedure. A modern platform developed by the Institute of Sensory Organs is essential for the affordable and universal study of a large population of children. The threshold values for air conduction were determined in the frequency range of 0.5 - 8 kHz. The abnormal test result was the threshold value for air conduction of 25dB HL and more for at least one frequency in at least one ear. Moreover, a subjective assessment was conducted on the basis of questionnaires for parents.

Results A positive result of hearing screening was found in 15.9% to 24.1% of the children tested. Most

of the hearing loss was benign or moderate, most often among all ears with abnormal hearing screening in children with high frequency hearing loss. In addition, there was a large number of unilateral hearing loss. In most cases, parents were not aware that their children had hearing problems. Studies have shown that the scale of hearing impairment among school children is significant in all countries participating in the program.

Conclusion Pilot hearing screening has shown that the organizational model of screening developed in Poland and the methods, devices and information systems used in the studies can be successfully implemented not only in European countries, but also in Asian countries. It should be emphasized that hearing screening performed outside of Poland was the first hearing screening test conducted in schools in the surveyed countries.

The results confirm the high incidence of hearing problems in school children. Based on the results, it is strongly recommended to implement hearing screening in the countries concerned as a routine procedure in medical care.

RISK FACTORS

RISK FACTOR ANALYSIS IN UNILATERAL AND BILATERAL HEARING LOSS IDENTIFIED THROUGH UNIVERSAL NEWBORN HEARING SCREENING IN THE COMMONWEALTH OF VIRGINIA.

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Objective: To compare the incidence of Joint Committee on Infant Hearing (JCIH) risk factors in children with unilateral hearing loss (UHL) to bilateral hearing loss (BHL).

Methods: Retrospective review of children with confirmed hearing loss identified through universal newborn hearing screening (UNHS) in Virginia from 2010–2014.

Summary of Results: Over the 5-year study period, 1,004 children (0.20% of all births) developed a confirmed hearing loss, with 544 children (51%) having at least one JCIH risk factor. Overall, 18% of children with confirmed hearing loss initially passed UNHS. Of all children with risk factors, 226 (42%) demonstrated UHL and 318 (58%) had BHL. The most common risk factors for UHL were neonatal indicators (69%), craniofacial anomalies (30%), stigmata of HL syndromes and family history (14% each). The most common risk factors in BHL were neonatal indicators (49%), family history (27%), stigmata of HL syndromes (19%), and craniofacial anomalies (16%). Children with the risk factor of positive family history were more likely to have BHL, while those with craniofacial anomalies were more likely to have UHL ($p < 0.001$).

Conclusion: Neonatal indicators were the most common identified risk factor in both UHL and BHL populations. Children with UHL were significantly more likely to have craniofacial anomalies, while children with BHL were more likely to have a family history of hearing loss. Further studies assessing the etiology underlying the hearing loss and risk factor associations are warranted.

PLASMA GENTAMICIN CONCENTRATIONS IN NEONATES COOLED FOR SUSPECTED HYPOXIC-ISCHAEMIC ENCEPHALOPATHY AND RELATIONSHIP WITH LATER PERMANENT CHILDHOOD HEARING IMPAIRMENT

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BACKGROUND & AIM: Perinatal asphyxia and aminoglycoside antibiotic therapy are recognised risk factors for permanent childhood hearing impairment (PCHI). Therapeutic hypothermia (TH) improves neurological outcomes in asphyxiated newborns, but it is unclear whether TH affects the risk of ototoxicity from aminoglycoside therapy. Our aim was to review early gentamicin concentrations in a large cohort of neonates who had undergone TH for suspected hypoxic-ischaemic encephalopathy (HIE) and to examine whether raised gentamicin concentrations during TH were associated with a later diagnosis of PCHI.

METHODS: We reviewed first trough gentamicin concentrations and results of newborn hearing screening and any later audiological test results in neonates who received moderate whole-body TH (core temperature maintained at 33.0–34.0°C for ≥ 72 hours) for suspected HIE in our tertiary-level neonatal unit during the 10-year period 2007 to 2017. We compared first trough gentamicin concentrations and proportions who had a raised first gentamicin concentration (> 2 mg/L) according to whether they had a later diagnosis of PCHI or a 'normal' hearing outcome (no PCHI).

RESULTS: Of 218 babies who received TH for suspected HIE during the study period, 34 were excluded (21 died; 13 alive but no gentamicin concentration available). Of the 184 who underwent hearing screening, audiological outcomes were available for 182 infants. 12 (6.6%) had PCHI and 170 (93.4%) did not have PCHI. There was no significant difference in first trough gentamicin concentrations between

infants with later PCHI and those with no PCHI (median [inter-quartile range] PCHI 2.3 mg/L [2.0-3.0 mg/L] vs. no PCHI 1.9 mg/L [1.5-2.6 mg/L], p value=0.16, Mann-Whitney test), and no difference in proportions of infants with a raised first gentamicin concentration of >2 mg/L (PCHI: 8/12 [67%] vs. 78/170 [46%], p value=0.18, Fisher's exact test).

CONCLUSION: This is the largest study to date to report early gentamicin concentrations and hearing outcomes in neonates treated with TH for suspected HIE. In our cohort neither first trough gentamicin concentration nor a raised concentration of >2 mg/L was significantly associated with an increased risk of later PCHI. We speculate that reception of TH may reduce the risk of aminoglycoside ototoxicity in neonates with HIE.

INFLAMMATION AND HEARING STATUS IN MID-CHILDHOOD AND MID-LIFE: POPULATION-BASED CROSS-SECTIONAL STUDY

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Background: Age-related hearing loss is a prevalent and progressive condition whose insidious early beginnings culminate in substantial late-life population disease burden. Its causes are unknown. Lifelong inflammation - known to contribute to many non-communicable diseases - has not been thoroughly studied regarding hearing. We aimed to determine if glycoprotein A (GlycA), a novel biomarker of chronic inflammation, is associated with hearing acuity in mid-childhood and mid-life.

Methods: Design: Population-based cross-sectional CheckPoint study nested within the Longitudinal Study of Australian Children, comprising child-parent dyads at child age 11-12 years. Measures: Plasma GlycA from semi-fasting venous blood. Pure-tone air-conduction audiometry in sound-proof conditions at 1, 2, 4, 8 kHz and tympanometry in each ear separately. We calculated high Fletcher index (mean of 1, 2, 4 kHz, the frequencies most relevant to speech perception) and defined hearing loss as threshold >15 decibels hearing level (dB HL) in the better ear. Analysis: Associations of GlycA with hearing threshold and loss via linear and logistic regression adjusted for age, sex, neighbourhood disadvantage, type of tympanogram (A, B, C), and (for children) birth weight and gestation in weeks.

Results: 1169 children (mean age 11.4 years, 48.8% boys) and 1318 adults (mean age 43.9 years; 13.4% men) were included in analyses. The mean disadvantage index was around 1027, indicating a slight skew towards less disadvantaged people compared with the general Australian population (mean 1000). Mean (standard deviation) for high Fletcher index were 8.0 (5.7) for children and 13.1 (7.0) for adults, with 8.7% of children and 26.3% of adults showing hearing loss >15dB HL on the high Fletcher index. In adults, GlycA predicted hearing thresholds for every individual frequency and for high Fletcher index, especially acuity at 2 kHz (β =7.9, 95% CI 4.3 to 11.4, p <0.001). In children, GlycA predicted hearing thresholds only for the lower frequencies (β =7.0, 95% CI 3.0 to 11.1, p <0.001 for 1 and 2 kHz) and high Fletcher index (β =6.2, 95% CI 2.8 to 9.5, p <0.001). This translated into GlycA predicting adult hearing loss (OR=6.6, 95% CI 2.4 to 18.2, p <0.001) with attenuated patterns in children (OR=4.2, 95% CI 0.8 to 23.6, p =0.10) on the high Fletcher index.

Conclusions: GlycA is already associated with poorer hearing, particularly in the lower audiometric frequencies, by mid-childhood. This potentially reframes age-related hearing loss as a polygenic lifecourse condition sharing inflammatory underpinnings with other non-communicable diseases. This could have profound implications for future prevention efforts beginning in childhood.

RISK FACTORS ASSOCIATED WITH HEARING LOSS IN INFANTS: AN ANALYSIS OF 600 REFERRED NEONATES

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OBJECTIVE: The aim of our study was to evaluate the frequency of risk factors and their influence on the distribution and manifestation of hearing loss in infants. The study was conducted at the Department of Otolaryngology in Centro Hospitalar de Vila Nova de Gaia (Portugal), as part of the national universal

neonatal hearing screening, conducted from 2012 to 2017.

MATERIALS AND METHODS: The selected population included every newborn that twice tested positive on the transient evoked otoacoustic emission (TEOAE) screening test, as well as all neonates with one or more risk factors as defined by the Joint Committee of Infant Hearing in 2000 (JCIH). The following procedures were used with each neonate: otolaryngological examination (with otoscopy), tympanometry, automated otoacoustic emission (AOAE), and auditory brainstem response (ABR). A total of 600 infants were examined. Subjects were categorized into two groups: the first group consisted of 489 (81.5%) neonates with risk factors of hearing loss, while the second group included 111 (18.5%) neonates without any known risk factors, but who twice tested positive on the TEOAE screening. A statistical analysis was performed using SPSS Statistics v25.0.

RESULTS: Among all infants examined (600), sensorineural hearing loss (SNHL) was identified in 45 cases (7.5%), and conductive hearing loss (CHL) in 17 cases (2.83%), while normal hearing (NH) appeared in 538 cases (89.7%). The largest percentage of SNHL appeared in children with identified or suspected syndromes associated with hearing loss. The next highest frequency of SNHL was comprised of children subjected to mechanical ventilation for a period in excess of 5 days. Only a small percentage (2.86%) of SNHL appeared to be due to the use of ototoxic medications, despite the fact that this factor is the most prevalent (41.1%) of all analyzed risk factors of hearing impairment. After ototoxic medications, the frequencies of risk factors are as follows: premature birth (27.5%); familial hearing loss (24.2%), low birth weight (19.0%); Apgar scores of 0-4 at 1 min and of 0-6 at 5 min (13.6%). Furthermore, as the number of coexisting risk factors increases, the probability of SNHL in infants is seen to also increase. For children with one to four coexisting risk factors, the probability of SNHL nearly doubles.

CONCLUSION: Our results indicate that syndromes associated with hearing loss, mechanical ventilation and maternal infections were statistically significant risk factors in the occurrence of hearing loss (p value <0.05). The most common risk factors are ototoxic medications, premature birth, familial hearing loss, low birth weight, and Apgar scores of 0-4 at 1 min and of 0-6 at 5 min. As the number of risk factors an infant is exposed to grows, the probability of hearing impairment increases. The high percentage of children with sensorineural hearing loss in the absence of any known risk factors demonstrates the necessity of hearing screening in all neonates.

RISK FACTORS FOR HEARING LOSS IN YOUNG ADULTS

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For the most part, young adults attending a university have normal hearing. These young adults most likely exhibit risk factors, such as recreational noise exposure, alcohol and marijuana use, for hearing loss. The purpose of the research lab is to evaluate how these risk factors affect cochlear function, with the primary focus being on recreational noise exposure. Both inner and outer hair cells within the cochlea are vulnerable, especially to noise exposure. The measurement of otoacoustic emissions (OAEs) reflect outer hair cell function while neural potentials that exit the cochlea primarily from inner hair cells can also be measured. Along with questionnaire data that included personal music system use, alcohol and marijuana use, distortion product OAEs (DPOAEs) and electrocochleography (ECoChG) were measured. DPOAEs ($2f_1-f_2$) were collected in 187 participants at 1, 1.5, 2, 3, 4, and 5 kHz. The frequency (f_2/f_1 ; $f_2 > f_1$) was fixed at 1.22 with stimulus levels fixed at $L_1, L_2=55, 40$ dB SPL. ECoChG were obtained in 19 participants using clicks presented at 90 dB HL and at a rate of 7.1/sec and summing potential (SP)/action potential (AP) ratios, AP latency, and AP amplitude were determined. Participants listened to one hour of music through earphones with a probe tube placed in the ear canal to measure equivalent continuous sound level (LAeq). Participants that reported heavy drinking (defined as more than 15 drinks per month) had significantly lower 1, 1.5, and 2 kHz DPOAEs than less risky drinkers (15 or fewer drinks per month) and non-drinkers. Those participants who reported using marijuana more than twice a month also had significantly lower 1, 1.5, and 2 kHz DPOAEs. All ECoChG measures were similar for both drinking and marijuana categories. Participants who reported listening to a personal music system with earphones at loud or very loud volume had lower DPOAEs for all frequencies tested compared to those who reported listening at low or medium/comfortable volume, but this difference was not statistically

significant. Mean LAeq was 72.9 dBA (SD=10.9 dB) and young adult men listened at a significantly higher level (mean=76.5 dBA; SD=10.7 dB) compared to young adult women (mean=71.7 dBA; SD=10.8 dB). Those participants that listened at 85 dBA or higher had poorer 1, 1.5, 2, 3, and 4 kHz DPOAEs compared to those listening at less than 85 dBA; these differences were not statistically significant. Lastly, those participants who were self-reported heavy drinkers, used marijuana more than twice a month, and listened to music through earphones greater than 85 dBA had significantly poorer 1, 1.5, 2, 3, and 4 kHz DPOAEs compared to those who reported being non-drinkers, non-marijuana users, and listen to music through earphones less than 85 dBA. In these preliminary data, young adults who report certain risk factors have poorer DPOAEs than those who do not report those risk factors. What is not known currently is what were the background noise conditions during those risk factors. It is likely that young adult, undergraduate students, while engaging in drinking and marijuana smoking settings will be in loud environments (i.e., house parties, bars, or clubs). Objective noise and alcohol data are to be collected and then analyzed with the hearing protocol to further evaluate the association of risk factors for hearing loss in young adults.

IMPROVING HEARING CARE (1)

PRIORITISING RESEARCH TO SUPPORT PEOPLE WITH HEARING PROBLEMS THROUGH NHS SERVICE IMPROVEMENT AND INNOVATION

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Context: The NHS England Action Plan on Hearing Loss (APoHL) sets out a clear vision for improving quality of life and outcomes for people with hearing problems emphasising the importance of research in achieving that vision. It also highlights the need for reliable quality data to discover unwarranted variation in access and quality of services, and to increase awareness and understanding of the social, emotional, and personal health advantages of maintaining good hearing health across the whole life course. These essential considerations underpin the financial costs of health and social care and so have wider implications for society. The APoHL Research and Innovation (R&I) group has been working towards achieving this vision.

In the UK, the funding of research to support hearing care is limited and declining whilst the burden of hearing loss is increasing. There is no clear strategic research agenda; noticeably the culture needed to achieve the multi-disciplinary patient centred research that is needed is not evident.

The R&I group aimed to analyse gaps and propose strategic priorities in hearing research that are not currently being done or commissioned, but would benefit patients and the NHS; with particular focus on research and innovations in hearing loss and tinnitus that can make the largest impact in the next 10 years.

Approach: The James Lind Alliance priority setting group published their top ten research priorities for people with mild-moderate hearing loss in September 2015, EVIDENT and Cochrane & NICE (2017) reviews were also included.

Rather than focusing on a single economic criterion such as return on investment, the team used a Multi-Criteria Decision Analysis (MCDA) prioritisation model to examine the potential for return on investment of research in hearing and tinnitus. A Delphi questionnaire methodology was used along with key stakeholder focus groups. The work entailed four-phases:

1. Hearing research gap analysis
2. Delphi exercise
3. Face-to-face stakeholder meetings
4. Final reporting

Results & Conclusions:

As expected this work echos previous work, however it is more statistically robust providing strategic direction in not just the technical elements of patient pathways, but across the entire life course. The work revealed three areas with high priority and consensus scores:

1. Patient pathway research (e.g. impact of telehealth or e-health methods, introduction of genomics etc.)
2. Long term outcomes for children young people with congenital hearing loss
3. Early intervention in the 40-60 year age group to reduce and offset dementia incidence.

The pipeline of novel hearing therapies, drugs, gene & cellular therapies is rapidly approaching the clinical domain. Testing these therapies will require research capacity, for which hearing specialties need to prepare. Hence to make the MCDA more robust there is a clear need for further exploration with expert groups (with overseas input) to identify rationale for variation in priorities.

NHS England recently published a board paper on Supporting and Applying Research in the NHS with an action to set out research priorities for national NHS programmes. Our work is therefore very timely

aligning with overall direction of travel. Consequentially a set of recommendations have been made to NHS England with an aim for outputs from this and further work to lead to more efficiency in hearing pathways and thus savings for these treatments. This current works reinforces the need for prioritising research on early identification and intervention leading to better outcomes.

Conflict of interest: Please note that this work was supported and commissioned by NHS England through a research agreement between The Ear Foundation and AD CAVE SOLUTIONS Limited (Professor Adrian Davis).

PROFESSIONAL PREPARATION IN THE U.S. FOR SPEECH LANGUAGE PATHOLOGISTS AND AUDIOLOGISTS WORKING WITH CHILDREN WHO ARE DEAF OR HARD-OF HEARING

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Rationale: Advances in early identification of hearing loss, access to language through amplification and cochlear implants, and the provision of early intervention have all had a profound impact on children with hearing loss. As a result, over 87% of students identified as having hearing loss are receiving some aspects of their education in main stream schools, with over 2/3 of these students spending over 80% of their educational time in mainstream classrooms (Digest of Ed. Stats., 2015).

In recent years, there has been increasing awareness that the knowledge and skills of providers who serve children who are Deaf or Hard-of-Hearing (DHH) is a factor that influences child outcomes (Eisenberg et al., 2007; Harrison et al., 2016). While best practice outlines high expectations for highly qualified providers (Joint Committee of Infant Hearing (JCIH), 2007), there is a noted discrepancy in skills and knowledge base of those who specialize in working with children who are DHH and those who see children who are DHH as part of a more diverse caseload. To date there is limited research on the attributes, preparation, and comfort of these two groups of professionals who provide speech and hearing services to children who are DHH.

Aims: This paper is a report of a recent survey conducted by the authors through the auspices of the American Speech-Language Hearing Association (ASHA) Special Interest Group on Hearing and Hearing loss in Childhood (SIG 9). SIG 9 is comprised of professionals who specialize in serving children with hearing loss. The specific aim of the survey was to describe and compare attributes, professional preparation, and comfort level of two groups of Speech Language Pathologist and Audiologists in the United States who self-report that they are involved in providing speech and language services to children with hearing loss. One group was comprised of clinicians whose primary area of expertise is working with children who are DHH. The second group represents a group who see a more diverse caseload, but who work to some extent with this population.

Methods: An 18-question survey was sent to two groups of speech and hearing professionals. The first group was comprised of all SIG 9 members (n=695) and is considered a Specialized group whose clinical focus children with hearing loss. The second group was comprised of a sampling of speech and hearing professionals (n=2158) who are members of other SIGs whose focus is other than childhood hearing and hearing loss (e.g. childhood language disorders). This was considered the Non-specialized group. The resultant response rate was 30.7% (213 respondents) for the Specialized group and 11.6% (246 respondents) for the for the Non-specialized group.

Results: Not surprisingly, the Specialized group was primarily involved with serving children who are DHH, with 63.5% reporting that over half of their case load was comprised of children who are DHH. Notably fewer (15%) of the Non-specialized group reported that over half their caseload was comprised of children who are DHH. However, nearly 1 in 4 clinicians in this group reported that more than 25% of their caseload was comprised of children with hearing loss.

While both groups reported that their primary setting was school-based (pre-school through High School), 58% more of the Non-specialized respondents reported providing services primarily in school settings than did the Specialized group. As a group the Specialized group was more comfortable working

with children who were DHH. Both groups appeared less comfortable working with middle school and high school children.

81.9% of the Specialized group reported receiving some degree of training for working with children who are DHH while only 59.3% of the Non-specialized group reported such training. Group differences were also found in the source of this training (graduate school, certificate programs, continuing education, etc.).

Conclusion: The findings suggest that a sizable number of clinicians are providing services to children who are DHH while also serving a range of clients with other communication issues. The majority of those reporting that they are providing these services also report that they are employed in school settings. The Non-specialized group appeared less comfortable and less well prepared to work with this population than the Specialized group. The implications for graduate and professional training will be explored.

DEVELOPMENT AND IMPLEMENTATION OF AN ICF BASED E-INTAKE TOOL IN DUTCH CLINICAL OTO-AUDIOLOGY PRACTICE

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Background/Objective: Ear and hearing health care should focus on enhancing a patients' total functioning to facilitate optimal, patient-centered care. The Brief International Classification of Functioning, Disability and Health (ICF) Core Set for Hearing Loss (CSHL) provides a minimal standard for what aspects need to be measured in clinical encounters in adults with hearing loss. We developed an intake tool based on the ICF CSHL, by operationalizing its categories into a Patient Reported Outcome Measure (PROM). Besides careful development, strategies for the implementation of the ICF based intake tool in clinical practice are key for successful implementation of care innovations. These were investigated. Therefore, development and implementation plan of the ICF based e-intake tool in Dutch clinical oto-audiology practice will be outlined.

Method: For the development of the e-intake tool potential items that corresponded to the ICF categories of the CSHL were selected from existing PROMs. Via various consensus and feedback-rounds in the research team, the most suitable items were included and adapted in the first version of the intake tool. This version was reviewed by an expertpanel via a digital survey. Next, the intake tool was pilot-tested in patients using the three step test interview. For the implementation, the Behavioral Change Wheel guide was used for the development of an implementation plan. Firstly, barriers and enablers to use the intake tool from the perspectives of health care professionals (i.e., audiologists and otologists) and patients were identified via interviews. Based on this, implementation strategies for the successful adoption of the intake tool in clinical routine practice were developed.

Results: An intake tool containing 62 items was developed covering nine domains: general- and health information; location of the ear/hearing problem; medical background; physical and mental problems; hearing problems; ear problems; activities and participation; environmental factors; and personal factors. Professionals recognized the potential value of the intake tool but raised important concerns as well. Professionals' barriers to the implementation of the intake tool were: lack of time and the need to address all functioning topics that would arise from the tool. Enablers included integration into the electronic patient record system; a better preparation by the patient for the intake consult by using the tool; and providing a complete picture of the patient's functioning. Patients were generally positive and willing to use the intake tool, and raised little concerns. Patients' barriers related to fear of losing personal attention/contact with the professional. Enablers included knowledge on the aim and relevance of the intake tool; expectation of better preparation; and a more focused intake process. Implementation strategies to overcome barriers included enhancing professionals' knowledge, skills and motivation regarding the intake tool's relevance, and its clinical usefulness. To reinforce patients' motivation, providing clear and specific information on the purpose of the intake tool was recommended.

Conclusion: A digital ICF based intake tool has the potential to contribute to complete and efficient intake and a transparent care process for the oto/audiology patient. By making the outcomes on the

patient's functioning profile available to both the professional and the patient prior to the intake consultation, the patient can be better involved in the choices made about his/her rehabilitation plan. The findings of the present work have implications for the further design of the e-intake tool and its implementation in the oto-audiology clinical practice and to make this a standard part of the (intake) care process.

INCREASING THE FAMILY-CENTREDNESS OF AUDIOLOGICAL REHABILITATION: HOW DOES IT IMPACT CLIENTS AND FAMILY MEMBERS?

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Background: Family-centred care is an extension of patient-centred care and considered the gold standard in modern healthcare. Despite increasing interest in the application of family-centred care to adult audiological rehabilitation, its implementation varies widely, with audiological rehabilitation typically involves the fitting of hearing aids, with less of a focus on the needs of the entire family unit. This study measured the impact of a family-centred care intervention program for audiologists, aimed at increasing family member involvement in audiological rehabilitation.

Methodology. A mixed methodology design was utilised for this single sample pre-post discovery oriented project. A total of 16 clinicians participated in a two-part intervention outlining the implementation of family-centred practices, including use of the Goal Sharing for Partners – Mini (GPS-Mini) to capture both client and family goals for rehabilitation. Following the audiologist-targeted intervention sessions, 60 hearing care clients and 65 family members were recruited to participate in this study, with a sample of appointments being videotaped to directly observe audiologists' use of family-centred practices. In addition, both clients and family members participated in qualitative individual semi-structured interviews about their perceptions of the family-centred approach to audiological rehabilitation.

Results: Observational analysis of the family-centred audiological appointments revealed that, in general, clients and family members were physically positioned equally in the clinical rooms, which facilitated the implementation of family-centred practices. Family members were engaged in the appointments, able to contribute information to the case history and discussion of communication difficulties, which in some cases resulted in the development of both client and family goals. Throughout the appointments, family members were observed to spontaneously contribute to the discussion, however these discussions often focused more on the client with hearing loss rather than on the needs of the family unit. When interviewed, both clients and family members reported that they valued the engagement of family members in the rehabilitation process. Implications for the provision of family-centred adult audiological rehabilitation will be discussed, including strategies to engage clients and families in goal setting and rehabilitation processes.

Conclusions: Following an audiologist-targeted intervention to increase family-centred care practices, clinicians engaged in family-centred care behaviours during audiological rehabilitation which were positively perceived by clients and families. The GPS-Mini provided a framework for audiologists to consider the needs of both clients and family members. However, full implementation of family-centred care remained variable.

PUBLIC HEALTH AND AUDIOLOGY: THE MISSING LINK IN ATTAINING HEARING HEALTH ACROSS THE LIFESPAN

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Many health professions have successfully leveraged public health principles to prevent disease. However, audiology as a profession has focused almost exclusively on identification, treatment, and rehabilitation of existing hearing loss. Audiology should be viewed from a population health perspective as well. Many principles of public health and its associated frameworks – epidemiology, health determinants, evidence-based practice, health promotion, communication, and wellness – are highly

relevant to the scope of audiological practice but have been historically almost completely overlooked. The World Health Organization estimates that half the cases of hearing impairment worldwide are preventable. As most hearing losses are permanent, prevention efforts could have a significant impact on reducing the global burden of hearing loss. A paradigm shift is needed in order to expand the focus of the profession from a solely patient-centered perspective to a population health perspective.

For too long, hearing loss prevention has been viewed as a small, specialized area of audiology practice relegated to a few professionals who manage occupational hearing conservation programs. However, hearing loss prevention should really be part of every audiologist's practice. Audiologists have the tools, opportunity, and strategic position to advocate and facilitate hearing loss surveillance and prevention.

This presentation will focus on public health as it relates to audiology practice. It will provide an overview of the goals and principles of public health, differences between public health and clinical practice, and key public health tools which can be used to facilitate hearing loss prevention efforts. These tools include:

- a) Epidemiology – how “big data” underpins audiology practice and how audiologists can harness “big data” principles in a smaller way;
- b) Risk factor evaluation – how to counsel patients/clients about possible hearing risks before they lead to hearing loss;
- c) Preventive measures – how to help patients/clients to avoid or protect themselves from hearing risks
- d) Special populations – how to identify groups who may be particularly at risk of developing hearing loss and design and target interventions specifically suited to their needs; and
- e) Public health intervention for the promotion of hearing health – what you can do locally and globally to promote hearing loss prevention among the general public.

Achieving this expansion of the scope of practice of audiology to include a public health perspective will require interventions at many different levels across the field. Raising awareness among audiologists about the need to incorporate public health principles in their day-to-day practice is an important first step.

THE DEVELOPMENT OF THE TINNITUS DECISION AID

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Shared decision making in tinnitus care – what is happening now? What do patients want? And how can we present the options?

This presentation describes three linked studies investigating the potential for shared decision making in tinnitus care.

We present findings from a qualitative interview study of patient preferences for care in tinnitus and the perception of current decision making. This involved in depth interviews with a sample of 41 people who had sought help for tinnitus. They were sampled to provide contrast in age, sex, stage of help-seeking, hearing levels and access to clinical services. In depth interview data were transcribed and analysed using grounded theory approaches to constant comparison. The themes that are presented describe the preferences for clinical care.

Secondly we present findings from ethnographic observations of current decision making in tinnitus care and the interactions that occur between clinicians and patients. Thirteen clinical encounters were video-recorded across three contrasting clinical sites in England. Videos were watched and transcribed and were analysed using grounded theory methods. We present a description of the consistent and variable features in the interactions and the contrasting decision making approaches.

Finally we will describe the development of the decision aid for tinnitus. The decision aid was developed through a process of combining data on patient preferences in phase 1 with a review of the literature in approaches to tinnitus care. The decision aid was developed through iterative engagement with people with tinnitus through a sequence of development meetings and focus groups. The decision aid was tested through use in clinical settings and refined through readability testing. We describe the process and explain the decision aid for tinnitus care.

These projects were funded by the British Tinnitus Association.

CREATING AND VALIDATING A NEW PATIENT-CENTRED OUTCOME MEASURE FOR AUDIOLOGY: THE "INDIVIDUAL MANAGEMENT PLAN - OUTCOME SCORE"

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Background: Useable and meaningful outcome measures are a key part of any clinical practice, both for monitoring the patient's own progress and for measuring and reporting service level quality and improvement. Clinicians and researchers have called for improved measures that are patient-centred and that are focussed on more than just hearing aids (Tysome et al., 2015; British Society of Audiology, 2016).

Driven by audiology clinicians' reports of poor experience with available outcome measures for audiology rehabilitation both locally and nationally, their being too device specific, not useable in practice according to their validated design, and providing little sensitivity to change, research was commenced to either identify or develop an outcome measure for audiology rehabilitation that would meet patient, clinician and service needs.

Methods: Following a review of existing measures, the "Individual Management Plan Outcome Score" (IMP-OS) was developed with audiology clinicians and piloted with adults attending audiology for hearing assessment and rehabilitation in North Wales, UK. The review and the methodology of the new outcome score development will be detailed, along with the initial validation completed.

As the IMP-OS questionnaire items are co-produced by clinician and patient for each pathway and therefore different for each individual, the team also piloted a method of categorisation, in order to measure and evaluate the patient outcomes at a service level or by patient group. This was again developed with clinicians and the pilot research completed with adults accessing the North Wales service for hearing rehabilitation.

Results: The results of the initial validation of the IMP-OS showed high patient participation rates, high clinical completion rate, good clinician satisfaction, strong correlation to a commonly used outcome measure and good test-retest reliability. Implications of these results will be discussed, along with detail on use in clinical practice and results of the service evaluation pilot.

Conclusions: Pilot and initial evaluation in North Wales has demonstrated the IMP-OS to be a clinically useable tool for measuring outcomes in a patient-centred approach, in a format which is not limited to hearing aid rehabilitation, co-produced with the patient and yet relevant at a service level for quality assurance and service development.

KNOWLEDGE TRANSLATION AND IMPLEMENTATION SCIENCE: FACILITATING BEST PRACTICE IN PAEDIATRIC AUDIOLOGY

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Audiology, like most of the health sciences professions, has been working on integrating evidence-based practice principles since the mid-1990's. However, adoption of best practice has been varied. Knowledge and Implementation in Paediatric Audiology (KIPA), are a group of clinicians, researchers and members of industry who identify gaps in clinical practice and look to develop feasible solutions to manage them. Current paediatric audiology clinical practice gaps will be reviewed, and KIPA's projects to address these gaps will be discussed.

EFFECTIVE TINNITUS TREATMENTS FROM THE TINNITUS RETRAINING THERAPY TRIAL

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Background: Tinnitus, the perception of sound in the absence of external sound, is a distressing condition that may affect individuals of all ages, and like hearing loss, its prevalence increases with age. In fact, tinnitus is often associated with hearing loss. No medical interventions are currently known to alleviate tinnitus; current treatment options are typically based on reducing the perception of and reaction to tinnitus to improve quality of life. Tinnitus Retraining Therapy (TRT) was among the first of current therapies that aimed to reduce the tinnitus impact and improve quality of life, but studies evaluating efficacy were typically small and not controlled. We conducted the Tinnitus Retraining Therapy Trial to evaluate the definitive efficacy of TRT and its components, tinnitus-specific counseling (TC) and sound therapy (ST) versus the standard of care (SOC) on the quality of life.

Methods: The TRTT is the first phase III randomized controlled trial sponsored by the National Institute of Deafness and Other Communication Disorders. The trial is a double-blind, placebo-controlled, multi-center trial for individuals with debilitating tinnitus at 6 US military hospitals. The landmark trial compared TRT, Partial TRT, and SOC. The TRT group used conventional sound generators and the Partial TRT group used placebo sound generators to implement ST, both in combination with tinnitus-specific counseling. The counseling component in TRT is theory-driven, didactic, directive, and 'top-down'. The SOC counseling, based on military audiologists' usual practice and preferred practice guidelines from the American Speech-Language-Hearing Association, was a scripted patient-centered care approach that was patient-driven, interactive, facilitative, and horizontal rather than 'top-down'. All groups were encouraged to use environmental sound enrichment whenever possible. The primary outcome was change in score on the Tinnitus Questionnaire (TQ), a tinnitus-specific health-related quality of life instrument, assessed longitudinally between treatment and follow-up (3, 6, 12 and 18 months). Secondary outcomes included change in the TQ subscales, global and subscale scores on two other tinnitus-specific quality of life instruments, the Tinnitus Functional Index (TFI), and the Tinnitus Handicap Inventory (THI), and change in ranking of their tinnitus problem using a visual analog scale.

Results: 151 study participants were randomized in the TRTT, 51 each to TRT and Partial TRT and 49 to SOC. Mean (SD) total baseline scores on the TQ were 54.6 (11.2), 54.4 (11.5) and 56.4 (11.9) for the TRT, Partial TRT and SOC groups, respectively, representing a moderately severe impact of the tinnitus among study participants. All participants improved significantly over the 18 months of the trial on TQ scores; respective scores (SD) on the TQ for TRT, Partial TRT and SOC were 39.0 (19.2), 35.9 (15.3), and 37.3 (16.8) at 18 months. The majority of participants improved, with 69% (77/111) of study participants improving by 10 points or more on the TQ at 18 months; there was no difference across treatment groups (65% (22/34) in the TRT group; 72.5% (29/40) in the Partial TRT group, and 70% (26/37) in the SOC group). The same pattern of improvement was seen for TQ subscales and total and subscale scores on the TFI and THI. When asked to rank their tinnitus as a problem on a 10 point visual analog scale, all groups showed that it was less of a problem at 18 months (median change (IQR): TRT, -1 (-4 to 0); Partial TRT, -2 (-4 to 0); SOC, -1 (-5 to 0)).

Conclusion: The quality of life for participants in all three treatment groups – TRT, Partial TRT and SOC – improved as measured by decreases in three tinnitus-specific quality of life instrument scores from baseline to 18 months and change in the ranking of tinnitus as a problem. Counseling, whether as a didactic session or as an interactive patient-driven session, proved efficacious in alleviating the distress caused by tinnitus for most participants. Accompanying environmental sound appeared to be sufficient for facilitating habituation for the two treatment groups without sound generators (Partial TRT and SOC). In practice, we would recommend that clinicians consider the patient when choosing the counseling approach to be used to treat severe tinnitus.

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COGNITIVE DECLINE

LONGITUDINAL RELATIONSHIPS BETWEEN DECLINE IN SPEECH-IN-NOISE RECOGNITION AND COGNITION - THE LONGITUDINAL AGING STUDY AMSTERDAM

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Background: Decline in hearing and cognitive functioning are both known to be strongly associated with aging. Various hypotheses about the causal relationships between hearing, cognition, and age have been proposed: 1) hearing loss causes immediate cognitive impairment (information degradation hypothesis – via a) an audibility mechanism or b) a resource allocation mechanism); 2) prolonged hearing loss causes time-lagged cognitive decline (sensory deprivation hypothesis); 3) cognitive decline causes hearing loss (cognitive load on perception hypothesis), or 4) a common aging factor causes decline in both cognition and hearing (common cause hypothesis). Supporting evidence for all five hypotheses has been reported but no studies modelled all five causal pathways into one single model. Only this way, it could be evidenced that multiple causal pathways would apply simultaneously.

Aims: The current study aims to identify the causal pathways between decline in hearing, cognition, and age. The study extends on previous work through: 1) application of sophisticated statistical methods, 2) using a speech-in-noise-recognition measure for hearing, and 3) analyzing various cognitive outcomes.

Methods: Data of 1029 respondents of the Longitudinal Aging Study Amsterdam were used spanning a total follow-up period of 7 years. All respondents were non-hearing aid users. Hearing was measured using a digit triplet speech-in-noise test. Cognition measures included: global cognitive functioning (Mini Mental State Examination), fluid intelligence (Raven Coloured Progressive Matrices), information processing speed (adapted Coding Task); and episodic memory – immediate recall and retention (15-Words Test). Bivariate dual change score modeling was used to model the causal pathways between hearing, cognition, and age. All pathways (i.e., corresponding to all five hypotheses) were firstly modeled in a base model. Subsequently, parameters belonging to one causal pathway were turned off, creating models nested within the base model. The difference between the two models was tested via a chi-square test. Parameters (i.e., causal pathways) were turned off until the simplest model was reached in which all causal pathways had to be turned on and model fit was acceptable. This model was then adjusted for significant confounding by gender, crystallized intelligence, cardiovascular conditions, or alcohol use.

Results: All final models showed acceptable to good model fit. For information processing speed, global cognitive functioning, fluid intelligence, and verbal memory-immediate recall, all pathways except for the sensory deprivation hypothesis pathway were supported by the data. For verbal memory-retention, the information degradation and the cognitive load on perception hypothesis pathways were not supported by the data, but the common cause hypothesis and the sensory deprivation hypothesis pathways were.

Conclusion: The results show that causal pathways corresponding to all five causal hypotheses were supported. Support for the common cause hypothesis, the information degradation hypothesis, and the cognitive load on perception hypotheses-pathways were found in almost all (i.e., 4 out of 5) cognitive measures. It should be noted that this was unexpected in some cases (e.g., support for the information degradation pathway for cognitive measures that do not rely on auditory stimuli, such as information processing speed). These findings deserve further study. Nonetheless, in summary, the results show that the links between hearing, cognition, and age are far more complex in real life than can be captured by one pathway and corresponding hypothesis. Implications will be discussed.

AUDITORY EVOKED POTENTIALS IN OLDER ADULTS: THE CONSEQUENCES OF MILD COGNITIVE IMPAIRMENTJennifer Lister*^[1], Ana Buján Mera^[2], Jerri Edwards^[1]^[1]University of South Florida ~ Tampa ~ United States of America, ^[2]University of A Coruña – INIBIC ~ A Coruña ~ Spain

Pure-tone hearing thresholds and performance on tests of auditory processing have been documented as risk factors for cognitive impairment among older adults; however, a consistent and strong indicator of cognitive decline has not emerged from these behavioral test batteries. In contrast, studies of auditory evoked potentials (AEPs) have shown promising evidence of an auditory neurophysiological indicator of early-stage cognitive impairment, particularly mild cognitive impairment (MCI). MCI is defined as cognitive impairment greater than expected for a person's age (Petersen, 2004) and is conceived as part of a continuum that progresses from normal cognition, to MCI, and lastly to dementias such as Alzheimer's disease. The National Institute on Aging and the Alzheimer's Association describe the clinical criteria for MCI as the following: (1) there must be a general concern regarding the person's change in cognitive function, (2) there must be an impairment in one or more cognitive domains, (3) everyday functional abilities must be maintained with only minimal assistance, and (4) the decline must not be considered dementia.

The purpose of this study was to examine the auditory P1–N1–P2 complex among older adults with and without MCI for biomarkers of cognitive impairment. Participants were 42 older adults (mean age = 72.34 years, SD = 5.71 years; 52% female). Based on scores on the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), the participants were placed in one of two groups: cognitively normal older adults (CNOAs; n = 21) with MoCA scores greater than 25 and older adults with mild cognitive impairment (MCI; n = 21) who had MoCA scores between 20 and 25. In addition to the AEP measures, a standard, comprehensive audiometric evaluation as well as a battery of auditory processing and cognitive measures were completed by each participant. Average pure-tone hearing thresholds were indicative of mild-to-moderate high frequency sensorineural hearing loss, consistent with presbycusis.

To elicit the P1–N1–P2, a passive paradigm was used in which two blocks with 300 stimuli in each were presented: a block of 1000 Hz pure tones or a block of the speech syllable /ba/. Order of the two blocks was counterbalanced across participants. Stimuli were presented binaurally via insert earphones. Stimulus duration was 100 ms (5 ms rise/fall), the interstimulus interval was 2.5 s, and the presentation level was 85 dB SPL. A 64-channel Neuroscan system was used to record responses.

AEP data were analyzed in two stages. First, the latency and amplitude of each peak was measured at a single electrode (FCZ) and analyzed relative to group and stimulus condition. Second, a temporal-spatial principal component analysis (tsPCA) was used to examine the data across multiple time windows and spatial locations.

The single-electrode analyses indicated significantly smaller P2 amplitudes ($p = .006$) for those with MCI compared to CNOA across stimulus conditions. None of the other potential group effects were significant ($ps > .05$). Stimulus effects were found for P1 and P2 latency. The tsPCA indicated no differences between the groups for any of the factors extracted in the N1 time interval (including N1b and Ta component of the T-complex), nor for P1. Consistent with the single-electrode analyses, the tsPCA revealed that the MCI group showed a significant amplitude decrease around the P2 response time interval.

These results suggest that P2 amplitude may be a useful biomarker of early-stage cognitive impairment and may be a signal of cholinergic hypoactivation. As effective treatments become available, early identification of cognitive impairment can facilitate the prescription of treatment at the earliest juncture. AEPs have the potential to serve as efficient, non-invasive, cost-effective indicators of future cognitive decline and impairment.

AGE-RELATED HEARING LOSS AND COGNITIVE DECLINE AMONG AN ELDERLY POPULATION: THE ROTTERDAM STUDY

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Background: Age-related hearing impairment (ARHI) is highly prevalent above the age of 60. Recent epidemiological studies have suggested that ARHI is a risk factor for cognitive decline and dementia, and that for example use of hearing aids may alter the pathways of hearing loss towards cognitive decline. Along with its high prevalence among the elderly, this opens a huge preventive potential for this global health concern. However, the mechanistic pathways through which hearing loss causes cognitive decline remain unknown. As such, we assessed the relation between hearing abilities and cognitive decline in a large population based study.

Methods: From the population-based Rotterdam Study, we included 2148 participants (57% female; mean age = 66.6 years, SD: 10.9) whom underwent pure-tone audiometry (PTA) hearing assessment (2009-2015) and had cognitive assessment at baseline and cognitive assessment at follow-up (2014-2018). Hearing thresholds were determined in low frequencies (the average of 0.25, 0.50, and 1 kHz) and high frequencies (the average of 2, 4, and 8 kHz). Cognitive assessment consisted of Mini Mental State Examination (MMSE), Stroop test, Letter Digit Substitution Test (LDST), Word Fluency Test (WFT), Word Learning Test (WLT) and a manual dexterity test: Purdue Pegboard Test (PPB). We assessed the relationship between hearing loss and cognitive decline, using linear mixed models for both global cognition (using principal component analysis) and by examining the relationship for all individual tests separately. All models were adjusted for age, sex, education and other relevant confounders.

Results: We found that poorer hearing at high frequencies was associated with a lower global cognition (difference = -0.26; CI: -0.51, -0.01). Worse hearing ability at high frequencies is associated with changes on the LDST (difference = -0.30; CI: -0.54, 0.05), the PPB both hands (difference = -0.46; CI: 0.77, -0.15) and on the PPB sum (difference = -0.39; CI: -0.68, -0.11). Hearing loss across all frequencies leads to a decline on the PPB both (difference = -0.38; CI: -0.71, 0.05) and on the PPB sum (difference = -0.31; CI: -0.62, -0.00).

Conclusion: Hearing loss at high frequencies was associated with global cognitive decline, especially in the executive function domains and manual dexterity and bimanual coordination functions. These results suggest that the presence and degree of hearing loss may accelerate cognitive decline in the elderly, although the presence of a common underlying cause for both decline in hearing and cognition cannot be excluded.

AGING AND MULTI-TALKER LISTENING: FOCUSING, DIVIDING AND SWITCHING ATTENTION

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Many communication situations in daily life call for different forms of attention. Typically, it is required to focus on one talker while ignoring competing voices from the background. However, communication in a multi-talker setting is usually dynamic, hence dividing or switching attention may also be important.

Multi-talker situations usually pose large problems, especially to older listeners. This might be due to sensory degradation since even a slight hearing loss can have detrimental effects on speech understanding. Moreover, cognitive functions such as storing and updating relevant information and inhibiting irrelevant information are crucial. Unfortunately, these functions may decline with age consequently increasing communication problems in demanding multi-talker settings.

This talk gives an overview of different forms of attention relevant with typical listening and communication situations. It presents data from several experiments addressing focusing, dividing and switching attention and discusses consequences for speech understanding and verbal communication in older age.

LISTENING EFFORT

THE PUPIL DILATION RESPONSE TO AUDITORY STIMULI: CURRENT STATE OF KNOWLEDGE

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Background and aim: Measuring the allocation of cognitive resources during listening provides valuable insight in the factors influencing auditory processing and listening effort. One way to quantify cognitive resource allocation is by the application of pupillometry. In recent years, the number of studies inside and outside the field of hearing science addressing the pupil response evoked by auditory stimuli has increased considerably. We will present the results of a review that aimed to provide an exhaustive overview of the existing research describing the pupil response to auditory stimuli.

Results: In total, 141 studies were included and discussed in this review. These originated from multiple domains, including hearing science and linguistics. Furthermore, the review covers pupillometry research into motivation, memory, and emotional processing. We will present a unique overview of these studies, organized according to the components of the Framework of Understanding Effortful Listening (FUEL). The results show that the pupil response is sensitive to various task manipulations (e.g. intelligibility level, linguistic complexity, emotional valence) as well as interindividual differences such as age and hearing status. Many of the findings have been replicated. Frequent interactions between the independent factors affecting the pupil response (like degradation level, sample characteristics, reward level, event probability) have been reported, which suggests that multiple processes compete for resources when listening to sound. The interplay between these processes should be taken into account in future studies. Also, research could focus more on interindividual differences, for example by including middle-aged and older participants. The present review facilitates careful design of future studies by indicating what factors should be controlled for. Besides presenting the main findings of the literature, we will also highlight several studies performed outside the field of hearing science that have interesting implications for the application of pupillometry in the assessment of listening effort.

In conclusion, measuring the pupil dilation response to auditory stimuli has been demonstrated to be a sensitive method applicable to numerous research questions. The sensitivity of the measure calls for carefully designed stimuli.

THE EFFECT OF REWARD ON LISTENING EFFORT AS REFLECTED BY THE PUPIL DILATION RESPONSE

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Listening to speech in noise can be effortful but when motivated we seem to be more persevering. According to the Framework for Understanding Effortful Listening (FUEL), the amount of effort we spend in a conversation depends on our motivation to achieve goals and attain rewards. Previous research showed effects of monetary reward on autonomic responses like cardiovascular reactivity and pupil dilation, while participants processed auditory information. The current study examined the effect of monetary reward on speech processing in noise and related listening effort as reflected by the pupil dilation response. We expected listening effort to be sensitive to reward when performing a sufficiently difficult task.

Twenty-four students (median age 21 yrs., range 18-52 yrs.) performed a speech reception threshold (SRT) task in which they listened to and repeated sentences uttered by a female talker. The sentences

were masked by a single male talker, at two difficulty levels (easy or hard), or were presented in quiet. These conditions were presented in a blocked fashion. Importantly, participants were unaware that, for the 'easy' and 'hard' conditions, intelligibility was fixed such that 85% or 50% of the sentences could be repeated correctly. At the start of each block, participants were informed about the condition (heard, easy, or in quiet), and were told that they could earn a high (5 euros) or low (0.50 euro) reward when repeating 70% or more of the sentences correctly. A within-subject design with six blocks was applied: condition (heard, easy, or in quiet) x reward (high or low). Each block contained 25 trials (sentences) and during each trial, pupil diameter was recorded. At the end of each blocks, participants rated their effort, performance, and motivation level. Additionally, participants performed a working memory capacity task (SICspan) and filled in a need for recovery questionnaire.

The results for the three conditions showed no effect of reward on the SRT. However, the peak pupil dilation showed a significantly larger response for high compared to low reward, for both the easy and hard condition. In quiet, reward had no effect on the peak pupil dilation. These results suggest that a higher reward made participants spend more effort on a task (when sufficiently difficult), even without a benefit on performance. Correlation analysis showed the SICspan score to correlate negatively with self-rated effort and positively with performance in the 'quiet' low-reward condition. For this group of participants, higher working memory capacity related to less self-rated effort and better self-rated performance in the easiest and least effortful listening condition. The outcomes of the need for recovery questionnaire showed a negative correlation with self-rated motivation, in both the 'hard' high-reward and 'quiet' high-reward conditions. This suggested that low need for recovery as experienced in daily life relates to higher motivation in high-reward situations.

In line with FUEL we conclude that listening effort as reflected by the pupil dilation response is sensitive to the amount of monetary reward. People with a low need for recovery report a higher motivation (less urge to give up) in high reward conditions than people with a high need for recovery.

A POTENTIAL PROTOTYPE FOR A CLINICAL BEHAVIOURAL TEST OF LISTENING EFFORT IN COCHLEAR IMPLANT USERS

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Currently, there is no clinical assessment of listening effort (LE) that can be used within the cochlear implant (CI) population. This is particularly worrying in light of the growing evidence that the cognitive load caused by excessive LE can lead to long-term physical and mental ill health. This toll on health and wellbeing is potentially caused by the cognitive load becoming a stressor, increasing the likelihood of over-activation of the hypothalamus-pituitary-adrenal gland (HPA) axis. Since increased LE is a common complaint amongst the hearing impaired (especially CI users), it is all the more paramount to find a sensitive and robust method of measuring LE in everyday life. This is because ongoing monitoring of LE could potentially enable the control of LE levels and, therefore, prevent excessive LE (and the resultant physical and mental health toll) from occurring.

This paper explores the feasibility of using the dual-task paradigm for a prototype clinical test of LE in CI users. This is achieved with 5 pilot studies systematically modifying and refining the dual-task paradigm and 3 larger-scale studies testing efficacy of LE measurement with 3 different participant cohorts: 1) 30 normal hearing adults in normal listening conditions; 2) 30 normal hearing adults listening to CI simulations; and 3) 25 actual CI users.

The dual-task paradigm is typically a lab-based behavioural measurement, where two tasks are performed simultaneously. It is assumed that the brain possesses only a finite pool of cognitive resources, which has to be shared across all the tasks it is required to perform. If the primary task (i.e. the task that is prioritised) increases in level of difficulty, more cognitive resources will be allocated to the primary task at the cost of the other concurrent cognitive tasks. If the primary task is a listening task, this theoretically means that the performance level in the secondary task could be used as an index for measuring LE (where decreases in secondary task performance indicate increases in LE).

In this prototype LE test, the primary task is listening to English sentences spoken by a male talker. The secondary task involves a rapidly flashing visual sequence of digits, in which participants count the

appearances of a target digit. Secondary task performance is compared across a series of progressively more difficult listening conditions. These involve sentences presented in quiet (i.e. no background noise) and then masked by background noise levels where signal-to-noise ratios are individually tailored to the participant's speech discrimination ability (achieved using adaptive tracking prior to testing).

In all three of the larger-scale studies, significant differences in secondary task performance (i.e. the index of LE) are detected across different listening conditions. What is particularly striking is that, within the study involving the CI user cohort, the dual-task paradigm reveals substantial LE being experienced even in quiet (i.e. when there is no background noise). This suggests the possibility that CI users could potentially experience health-threatening levels of LE even when listening conditions are optimal. This, therefore, appears to warrant the need for close monitoring of LE in clinical practice, in order to identify any potentially detrimental consequences.

Overall, it appears that, with more refinement and standardisation, this lab-based measurement of the dual-task paradigm shows promise in being translated into a real-life setting as a clinical test of LE. A particular strength of this prototype design is that the secondary task could (theoretically) be paired with the majority of speech intelligibility test materials, meaning that the issue of LE could be identified in tandem with routine sentence intelligibility testing. This then could ultimately promote better rehabilitation outcomes in both speech comprehension and physical wellbeing, because the actual cognitive cost of understanding the CI input would be taken into account.

SUBJECTIVE LISTENING EFFORT IN CI USERS

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The usage of hearing devices can result in a relief of listening effort. This study evaluated whether the adaptive categorical listening effort scaling (ACALES, Krueger et al, 2017), a method to assess subjective listening effort (LE) in the laboratory, could be conducted with CI users to investigate for example, the benefit of bilateral versus unilateral hearing device provision in bimodal or bilateral cochlear implant (CI) listeners.

In the ACALES method, the signal-to-noise ratio (SNR) is varied adaptively to adjust the SNR range to the individual ratings using a 14-step scale from "effortless" to "extreme effort", including the additional category "only noise". The resulting listening effort rating functions for different conditions – e.g., one hearing device vs two - can be compared to assess possible release from LE for one of the conditions. The ACALES results were obtained for quiet and two different maskers (the stationary Olnoise and the fluctuating IFFM noise) with either 1) only the CI or one CI (better ear) active, in bimodal or bilateral CI-listeners, respectively, or with 2) both devices active. Additionally, free field audiograms with and without hearing devices were determined as well as speech intelligibility (SI) functions for quiet, Olnoise and IFFM noise with the Oldenburg sentence test in noise (OLSA). Further, questionnaires inquiring sound preferences and hearing habits (SP-HHQ, German translation) and subjective LE were used.

The results show that SI increases with increasing SNR whereas LE is decreasing. LE ratings as well as SI scores depended on the masker. Results for the different provision conditions for the two maskers indicate a benefit of a provision with two devices (CI+HA or two CIs) in comparison to only the/one CI. It can be concluded that the ACALES indicates a benefit in LE for a bilateral and a bimodal provision compared to unilateral provision.

Krueger, M., Schulte, M., Zokoll, M.A., Wagener, H.C., Meis, M., Brand, T., Holube, I. (2017). Relation between listening effort and speech intelligibility in noise. *American Journal of Audiology*, Vol. 26, 378-392.

LISTENING EFFORT IN NORMAL-HEARING YOUNG ADULTS SUFFERING FROM CHRONIC TINNITUS

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Aim. Chronic tinnitus can result in comorbid distressing symptoms, one of which is related to impaired concentration attributable to difficulties with speech understanding in various listening conditions.

Previous research stated that non-auditory central aspects, such as working memory and selective attention, may influence hearing and speech understanding in several listening situations. Therefore, speech intelligibility may become more effortful for persons with tinnitus because their cognitive reserve is reduced by it. As a result, the question was raised whether listening effort may be increased in tinnitus patients when performing several tasks simultaneously. Since, to the best of our knowledge, no research exists pertaining to the effects of tinnitus on listening effort, this study aimed to investigate the connection between both.

Material and Method. Thirteen normal-hearing young adults with chronic tinnitus were matched with control participants for age, gender, hearing thresholds and educational level. A dual-task paradigm was used to evaluate listening effort in different listening conditions. A primary speech-recognition task and a secondary visual memory task were performed both separately and simultaneously. In addition, subjective listening effort was rated in various listening situations. The Tinnitus Handicap Inventory was used to evaluate the influence tinnitus handicap on the amount of listening effort.

Results. Listening effort was significantly higher in the tinnitus group across listening conditions. There was no significant difference in listening effort between listening conditions, nor was there an interaction between groups and listening conditions. In addition, subjective listening effort did not significantly differ between both groups.

Conclusions. This study is a first exploration of listening effort in normal-hearing subjects with chronic tinnitus showing that listening effort is increased as compared to a control group. As dual-task paradigms assume a limited capacity of the brain to process information, it may be suggested that listening effort is increased in subjects with chronic tinnitus compared to subjects without tinnitus because the capabilities of the higher-level cognitive systems are taxed more by the presence of tinnitus. Including a test for listening effort in clinical practice may therefore be useful to better understand the complaints about concentration related to speech recognition often indicated by tinnitus patients. However, there is a need to further investigate the cognitive functions important for speech understanding and their possible relation with tinnitus and listening effort.

SPEECH PERCEPTION

SPEECH PERCEPTION OUTCOMES OF 5-YEAR-OLD CHILDREN USING HEARING AIDS OR COCHLEAR IMPLANTS: FINDINGS OF THE LOCHI STUDY

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Aims: The aims of this study were to report on the speech perception in noise of 5-year-old children with hearing loss; and to determine the factors associated with the speech perception outcomes, separately for children using hearing aids (HAs) or cochlear implants (CIs).

Methods: Participants were 224 children enrolled in the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study. All children received their first HAs or CIs before 3 years of age. Speech reception thresholds (SRTs) for 50% correct perception of words or sentences were measured in two conditions. In one condition, speech and babble were presented from a loudspeaker positioned at 0° azimuth (S0N0). In a second condition, speech was presented from the front, and babble noise was presented from two loudspeakers positioned on both sides (S0N±90). The difference in SRTs between the two test conditions gives a measure of spatial release from masking (SRM).

Results: On average, the mean SRTs in the S0N0 and S0N±90 conditions were 6.9 dB (SD 3.8) and 3.6 dB (SD 4.2) respectively for children using CIs; and 4.0 dB (SD 3.2) and 1.4 dB (SD 3.8) respectively for children using HAs. Compared to normal-hearing children, children with hearing loss required a higher signal-to-noise ratio to achieve a similar level of performance, but the SRM was comparable. Regression analyses showed that better speech perception performance was associated with better language ability for both groups. In children using CIs, earlier age at implantation was associated with better outcomes.

Conclusions: Early intervention was effective in improving speech perception for children using CIs.

A CROSS-SECTIONAL INVESTIGATION OF AUDITORY FUNCTION AND SPEECH PERCEPTION IN NOISE PERFORMANCE

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Objectives: Difficulty with speech perception in noise (SPIN) is one of the most common complaints expressed by patients in audiology clinics. Traditionally, elevated hearing thresholds are considered to be the main contributors to difficulty in SPIN; yet, patients will often report difficulties with SPIN despite having clinically normal hearing thresholds. The purpose of this cross-sectional study was to critically evaluate the relationship of various metrics of auditory function (behavioral thresholds and otoacoustic emissions) and self-rating of hearing ability on SPIN performance in a large sample of clinically normal-hearing individuals.

Design: Behavioral hearing thresholds, otoacoustic emissions (OAEs, stimulus-frequency and distortion product), and self-reported ratings of hearing ability were recorded from 921 clinically normal-hearing individuals between 10 and 68 years of age. The Quick Speech-In-Noise (QuickSIN) test outcome, quantified as the Signal-to-noise ratio (SNR) loss, was used as the metric of SPIN ability. Principle component analysis (PCA) and linear regression modeling were used to evaluate the relationship between the measures of auditory function and performance on the QuickSIN. Additionally, the differences in auditory functions between those with and without clinically significant SNR loss was evaluated using analyses of variance.

Results: Overall, SNR loss was invariant with age. However, more than 25% of participants exhibited

mild or worse SNR loss, even in this clinically normal-hearing population. SNR loss was not related to self-ratings for either hearing trouble in quiet or in noise. PCA revealed that DPOAE levels at 12,500 - 16,000 Hz were significantly correlated with the variation in QuickSIN scores, although correlations were weak ($R^2 = 0.017$). Intriguingly, we found that self-generated physiological noise levels, measured indirectly as the noise floor during OAE recordings, were associated with poorer QuickSIN performance. Furthermore, noise floor levels at 750 to 4,000 Hz were significantly correlated with the variation in QuickSIN scores ($R^2 = 0.077$).

Conclusions: Overall, age, self-report, and extended high frequency auditory function did not predict SPIN performance in this subject group. Higher ear-canal noise floor levels were associated with worse QuickSIN performance in listeners with normal hearing sensitivity. We propose that elevated noise floors in poorer SPIN performers could affect effective SNR, thereby negatively impacting SPIN performance as seen by poorer QuickSIN scores.

THE EFFECTS OF MILD BILATERAL AND UNILATERAL HEARING LOSS ON CHILDREN IN THE EARLY SCHOOL YEARS

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Permanent hearing loss is one of the most common childhood disorders. Population-based studies have shown that a large proportion (40-50%) of hearing-impaired children have a permanent mild bilateral or unilateral hearing loss (MUHL). In Canada, in jurisdictions where better than moderate permanent hearing loss is targeted in newborn hearing screening programs, children with MUHL are being identified in infancy. A new population of children has therefore emerged from early screening; however, little is known about the outcomes following early identification of milder forms of hearing loss. Objective: This project was conducted in the context of the Universal Newborn Hearing Screening publicly funded Infant Hearing Program of Ontario (Canada) and as part of the Mild and Unilateral Hearing Loss in Children Program. The purpose of this work was to quantify the impact of MUHL on auditory, communication, early literacy, academic, social, and behavioral skills in early school-aged children and to compare their results to norms from children with typical hearing. Methods: This project consisted of cross-sectional and retrospective components. Firstly, thirty-two children with MUHL (16 unilateral, 16 bilateral), 5 to 9 years of age and from three regions in Ontario were assessed. They underwent a battery of tests comprised of speech (GFTA) and language (PPVT, WIAT, CTOPP, CELF) measures administered by speech-language pathologists. Parents and teachers also completed questionnaires to evaluate functional auditory (PEACH, TEACH), social (SSIS), and behavioral (BASC) skills. Secondly, we conducted a retrospective chart review of all children identified at a Canadian pediatric center with MUHL and born between 2003 and 2011. Hearing loss characteristics and scores on speech-language (PLS, GFTA, PPVT) measures near time of discharge from the clinic at school age were extracted from the medical records for 258 children. Amplification recommendations and uses, as well as therapy sessions were documented. Results: Direct Child Assessments: Mean scores for each outcome measure fell within the average range of test norms. The CTOPP-2 phonological memory composite score yielded the lowest mean at 87.3 and almost half of the children (46.4%) scored below the average range from the normed sample on this subtest. Also, parent- and teacher-reported auditory function were lower than average when compared to children with typical hearing. Chart Review: Mean scores for each outcome measure fell within the average range of test norms. However, about a quarter of children obtained standard scores below the average range expected for children with normal hearing on the language subtests and speech production. Also, 10.0% of auditory comprehension standard scores were well below 2 standard deviations of the expected norm on this subtest. Conclusion: The majority of children functioned within the expected range of children with normal hearing, however, for some more difficulty was noted on functional auditory and phonological processing skills. Findings from this research study contribute to knowledge on the effects of MUHL on various outcome measures. Building on the contributions of this study, future work on a similar population of early identified school-aged children to study the longitudinal effects of MUHL on functional auditory, speech-language, phonology/literacy, behavioral and social outcomes is warranted.

SPEECH DEVELOPMENT

LANGUAGE OUTCOMES OF CHILDREN WITH MILD-MODERATE CONGENITAL HEARING LOSS: IS EARLIER DETECTION LEADING TO IMPROVED OUTCOMES?

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Background: Internationally, universal newborn hearing screening (UNHS) is often designed to identify moderate or greater losses. However, such programs also frequently detect infants with mild loss. This results in many infants and children with mild hearing loss receiving earlier hearing aid fitting than what has historically occurred. The benefits of this earlier treatment are not yet established. In Australian children aged 5-8 years with congenital mild-moderate hearing loss, we aimed to (1) compare language outcomes between four hearing loss detection systems; (2) determine whether child age at detection predicts outcomes; and (3) compare outcomes between children identified via the present UNHS system and the general population.

Methods: Linear regression was used throughout to adjust for potential confounding factors. Using a quasi-experimental design, language outcomes were compared across four population-based systems of hearing loss detection: opportunistic detection, n=50; universal risk factor referral, n=34; newly established UNHS, n=41; and well-established UNHS, n=21. After pooling the participants, we also examined whether age of detection predicted outcomes. The language outcomes of children detected under the current UNHS system were compared to children without hearing loss.

Results: Mean age at diagnosis and hearing aid fitting fell steadily across the four systems of hearing loss detection. For children with moderate losses, mean expressive language (p for trend .05) and receptive vocabulary (p for trend .06) improved as detection systems evolved, but benefit was not obvious for mild losses. In the pooled cohort, diagnosis before age six months predicted better language outcomes for moderate losses. Children with mild-moderate losses detected under the present UNHS system exhibit expressive language scores well below children in the general population (adjusted mean difference -8.9 points, 95% CI -14.7 to -3.1).

Conclusions: Treatment arising from UNHS appears to be clearly benefiting children with moderate hearing losses, as measured by improving language outcomes. However, rigorous trials are needed to quantify benefits, versus costs and potential harms, of early aiding of children with mild losses.

THE ROLE OF DEVELOPMENTAL NEUROPLASTICITY IN THE PREVENTION OF LANGUAGE DISORDERS

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In recent years, the interest of scientists and professionals involved in language and communication is increasingly turning to the study of children with learning difficulties and language.

Often the "first signs", the first difficulties are not fully understood leaving all this to turn into pathologies that are later more difficult to overcome, especially for the child and the family or the network that must support it. Why arrive, then, at this point?

The interest and the goal of the Association "THE ART OF LANGUAGE AND COMMUNICATION ACADEMY" is to intervene even before the "evidence", beginning with the sensitization and education of new parents, (if possible already from the eighth month of pregnancy, in a phase of "preparation"), on how to face the neuro-psycho-motor development of the child in the course of the change in family dynamics since birth.

Starting from the premise that children learn to "communicate" from the first hours of life, we have thought of a "space" that accompanies the child and the new parents "step by step", assisted by basic pediatricians, through observation, follow -up and the advice to serenely follow these important evolutionary aspects related to communication and language, making the most of the neuro-plasticity. This type of approach allows us to monitor any small delays which are easily retrievable in a short time, but also to identify early problems or diseases related to late onset during early childhood and to be able to promptly start early intervention or perform a diagnosis as soon as possible , where necessary, in order to plan an educational-rehabilitative intervention and adequate family support.

ARTICULATION DEVIATIONS IN PRESCHOOL HEARING-IMPAIRED CHILDREN AND HEARING AND SPEECH REHABILITATION

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The problems with the perception of speech sounds are a direct consequence of hearing insufficiency. The auditory processing disorder leads to articulation deviations as well as the irregular speech development, which causes the difficulties in the realization of verbal communication.

The aim of this research is ascertaining articulation deviations in preschool hearing-impaired children depending on the inclusion in the process of hearing and speech rehabilitation.

A sample of 60 preschool hearing-impaired children from the preschool institutions on the territory of the Republic of Serbia is encompassed by the research. The research sample is divided into the experimental and control groups. The groups are equalized regarding the age, the degree of hearing impairment and intellectual abilities. The age of the hearing-impaired children is 4 to 7. The hearing-impaired children from the experimental group were included in the rehabilitation treatment of hearing and speech lasting two years at the least, in contrast to the hearing-impaired children from the control group.

The Triage Articulation Test (Kostić, Vladislavljević, Blagojević) was used for the research.

The research findings show that the experimental group has better sound articulation than the control group at the significance level of 0.01. Preschool hearing-impaired children pronounce vowels best and affricates most poorly. The most frequent articulation deviations are substitution, omission and distortion. The conclusion is that the timely inclusion of preschool hearing-impaired children in the process of hearing and speech rehabilitation affects the prevention and correction of articulation deviations and thereby also the development of better sound articulation, speech and language.

Key words: articulation deviations, hearing-impaired children, preschool age, hearing and speech rehabilitation.

C.I. OUTCOMES

ANALYSIS AND TREATMENT OF RELATIVE CLAUSES IN COCHLEAR-IMPLANTED CHILDREN

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Cochlear implant (CI) is considered 'gold-standard' for hearing loss, in fact it allows better hearing than conventional hearing aids (HA). In case of preverbal bilateral severe to profound hearing loss, early cochlear implantation enables proper language acquisition (Gantz et al., 2000). However, individuals with CI can show several impairments in the major language domains, such as syntax and morphology (for Italian, Guasti et al. 2012; Volpato, 2010). To a large extent, syntactic deficits mostly concern sentences in which the typical word order (in Italian: Subject-Verb-Object) is violated. While subject relative clauses (SR: *il bambino che segue i cani* 'the child that follows the dogs') present a canonical order of constituents, object relative clauses can show two types of non-canonical word order: either with a pre-verbal subject (OR: *il bambino che i cani inseguono* 'the child that the dogs follow') or with a post-verbal subject (ORp: *il bambino che inseguono i cani* 'the child that follow the dogs'). The processing of these structures is characterized by clear asymmetries: SRs are easier than ORs and ORps; and ORs are easier than ORps. Relative clauses are derived by wh-movement, which consists in transferring the subject or the object of a sentence to a new position in the left periphery of the sentence.

This study aims at presenting some data about the comprehension and the production of Italian RCs in three CI-children. In addition to this, we would like to suggest an original treatment of syntactically complex sentences based on the explicit teaching of syntactic rules addressed to them.

The participants are three Italian speaking CI-children aged 8;5-10;5, two girls and a boy. They were born from hearing parents and they were diagnosed with bilateral profound sensorineural hearing loss between the age of 0;5 and 2;0. Because they gained only a little benefit from the conventional HA, they received the CI between the age of 2;7 and 8;4, therefore their hearing experience with a CI is comprised in a period between 2;1 and 7;0 years. The participants underwent cochlear implantation at the ENT Clinic of the Padua University Hospital and follow speech therapy sessions at least once a week. Every child was tested on production and comprehension of RCs using two Italian tests by Volpato (2010). Production was investigated through an elicitation task, and comprehension resorting to an agent selection task. Two children showed RCs production and comprehension below age appropriate range, the boy showed an impaired production of ORs, while one of the girls showed an impaired comprehension of SRs and ORps. The second girl demonstrated age appropriate language, but her parents asked for her to be involved in the treatment experiment, so as to benefit of language improvements.

Since RCs are among the most difficult and impaired structures, they were chosen to be the target of the rehabilitation through explicit teaching activities.

Our study was inspired by Levy and Friedmann (2009), who described a treatment focused on the explicit teaching of syntactic rules addressed to a Hebrew speaking boy with syntactic SLI.

The interventions had different purposes: The intervention on the boy tested the efficacy of the explicit teaching of syntactic rules and the duration over time of its effects. The intervention on the two girls examined generalization effects to untrained sentences derived from the same type of syntactic movement, such as wh-questions, and to narrative skills. The interventions comprised seven sessions distributed in three stages. The aim of the first stage was to turn the participant's implicit knowledge of the verb structure into explicit knowledge, which could be used as a support during the explanation of wh-movement. The second stage of the treatment aimed at teaching the wh-movement through a card game, which enabled the children to see and touch the movement took into consideration. The third session comprised the review of the topics taught during the previous sessions

The improvement in both production and comprehension of relative clauses was evident at the end of treatment and was maintained several months after the end of treatment.

To the best of our knowledge, this is the first study in which the treatment of relative clauses based on the explicit teaching of syntactic rules was given to CI-individuals.

HEALTH-RELATED QUALITY OF LIFE IN NORWEGIAN CHILDREN WITH COCHLEAR IMPLANTS OR NORMAL HEARING

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Purpose The study investigates self-reported Health-Related Quality of Life (HR-QOL) in children with cochlear implants (CIs) compared to normal hearing peers (NH).

Method Study sample consisted of 168 children, 84 children with CIs (45 boys, 54 %) and 84 children with normal hearing (45 boys). The children were individually matched on gender and age (+/- 6 months of the chronological age of the child with CIs). The socioeconomic background was also similar in the two groups. Mean age at participation was 120,20 months (67,15 - 155,99, SD 23,36) in the CI group, and 120,33 months (73,17 - 158,29, SD 22,33) in the NH group. The children in both groups were reported by parents to not have disabilities or conditions known to affect language development or HR-QOL. All children had Norwegian as their first language.

Characteristics of the children in the CI group.

All children in the CI group had a nonverbal IQ above a standard score of 75. The mean age at cochlear implantation was 34,20 months (5,49 - 141,83, SD 27,03). The group includes both children who were born deaf and who have had a progressive or sudden hearing loss. Mean age at implantation amongst congenitally deaf was 19,35 months (5,49 - 38,77, SD 9,37).

The majority of the children in the CI group, 86 %, used spoken language with none or little sign support. The remaining children either used spoken language with much sign support, or both sign language and spoken language according to different situations. Main stream schools were the most common educational setting for the children applying to 87 %, and the remaining children were either educated in schools for the deaf (7 %) or in separate classes for children with hearing loss in main stream schools (6 %).

Measurements HR-QOL was assessed by means of self-report using the Pediatric Quality of Life Inventory 4.0 (PedsQL; Varni, Seid & Kurtin, 2001). The questionnaire exists in a Norwegian translation, and through 23 questions it gives a measure of four domains: Physical health, Emotional-, Social- and School functioning. In addition, the questionnaire provides a Total score, and a composite score of Psychosocial health. A higher score indicates a higher perceived HR-QOL. The versions of self-report for children 5-7 years and 8- 12 years were used.

Results There was a statistically significant difference between groups on the total score, psychosocial health and school functioning, with a lower mean score in the CI group. After Bonferroni correction for multiple testing, the school functioning domain was the only domain to remain statistically significantly different between groups. School functioning in the CI group (72,26) was reported to be diminished compared to the NH group (81,38), $z = -2.99$, $p = .003$. When estimating an at-risk score from how many children have a score equal to or higher than -1 SD of the normal hearing groups mean on the Total score, 86 % of the children in the NH group are within this range, while the same number in the CI group is 68 %.

Conclusions Results show similar levels of HR-QOL in the two groups on most domains. On the Total score 68 % of children in the CI group report to have a good HR-QOL. This is a positive finding as it indicates that for many children with CIs who have no known additional disabilities besides their hearing loss, the children themselves report HR-QOL that is comparable to the level of normal hearing peers. However, the domain School functioning seems to be an area of life where the children with CIs does experience more problems than their peers. This finding highlights the need for more attention to resolve problems the children who have a hearing loss might experience in school.

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NEW CLINICAL CARE MODEL IN REHABILITATION OF PATIENTS WITH COCHLEAR IMPLANTS

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Aim: Due to dramatical increase of CI patients number worldwide the new selection of tools to enable a novel model of clinical care was developed by Cochlear Ltd. It includes a wireless handheld devices for measuring Evoked Compound Action Potentials (ECAPs) intraoperatively – CR120 and CR220 remote assistants, new simplified fitting software – NFS and wireless programming POD.

The aims of this study was to confirm that new tools can replace existing bulky equipment; that less overall time and experiences required to complete the standard clinical workflow.

Material and methods: A prospective between subject comparison study was conducted with 105 test subjects measured with CR120 and 125 subject measured with CR220. ECAP threshold measurements were performed intra-operatively using both the wireless handheld device and the standard clinical system. The time required for each measurement was noted. Analyses were then performed comparing the thresholds for equivalence or difference, and the measurement time compared.

Results: ECAP thresholds were measured and found to correlate closely between the two measurement systems. The time required for the measurements was significantly less with the CR120 and CR220 remote assistant. Based on this, an analysis of the potential efficiency increase can be performed and will be presented. A prospective between subject comparison study was conducted with 65 test subjects fitted using NFS and the standard fitting software. Both fitting order and audiologists were randomised. Auditory performance was analysed by an expert speech therapist and the parents completed a performance questionnaire. This was conducted at multiple time points: at initial fitting and at the three/four months fitting appointment. Also first results with the wireless programming POD will be presented.

Conclusions: The CR120 and CR220 can be safely used to measure ECAP thresholds intraoperatively. The ECAP threshold measurements obtained were equivalent to the standard clinical system. Measurements with CR120 and CR220 take less time, require more manageable equipment and staff to make the measurements.

The NFS system also required less time for map creation and fewer audiological/cochlear implant skills for fitting the majority of patients. Performance results were on average comparable between groups. In a number of cases the map created with the NFS tablet system was the preferred solution. New clinical care model is a great tool to implement into the daily clinical workflow and can be successfully used in the clinical practice.

EARLY LISTENING SKILLS AS A PREDICTOR OF LANGUAGE OUTCOME FOR CHILDREN USING A COCHLEAR IMPLANT

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Introduction For children with severe-to-profound hearing loss the development of listening skills using cochlear implants [CI(s)] provides the framework for the subsequent development of oral language. Young children undergoing cochlear implantation at the Royal Victorian Eye and Ear Hospital, Melbourne, Australia, participate in an Early Listening Programme (ELP) in the immediate post-operative period. The ELP aims to develop caregiver's skills in optimal device use, early development of listening and spoken communication. Speech Pathologists work with the child's family to achieve the 19 ELP goals. As the ELP has been implemented since 2009, it is timely to investigate the relationship between mastery of the 19 ELP goals and each child's oral language acquisition.

The first aim of this study was to describe the time taken to master the 19 ELP goals for a large cohort of children using CI(s). The second aim was to investigate the relationship between fast versus slow mastery of ELP goals and outcomes on standardised tests of language.

Method There were 73 children identified from retrospective review of medical records who received

their first CI before three years of age and attended the clinic for the post-CI ELP. Demographic information including: age at first CI, residual hearing, gender, cognitive status, socioeconomic status, maternal education, parental hearing status, family participation rating and mode of communication was collected. Timeframe for acquisition of the 19 ELP goals was quantified in weeks and divided into three domains: parental goals e.g. use of parentese; child goals e.g. responds to name consistently; and interaction goals e.g. demonstrates turn-taking. Oral language was assessed at 12 months post-CI using the Preschool Language Scale (PLS) and standard scores for receptive, expressive and total language were used in the statistical analysis.

Results Timeframe for acquisition of the 19 ELP goals ranged from 2.8 to 68.4 weeks. Shorter timeframe for acquisition of parent goals was significantly correlated with longer timeframe of acquisition of both child and interaction goals. Attainment of child goals was not correlated with interaction goals. Better receptive language, expressive and total language scores at 12 months post-CI was related to younger age at 1st CI, higher non-verbal IQ, higher family participation rating and shorter timeframe for acquisition of parent related ELP goals. Better expressive language was also correlated with longer timeframe for acquisition of child related ELP goals. Interaction ELP goals, residual hearing and gender were not correlated with oral language outcome.

Conclusion Results of this study suggested that younger age CI, higher family participation rating, higher non-verbal IQ, shorter timeframe for acquisition of parent and child related ELP goals is associated with better oral language outcome at 12 months post implant. Of practical significance, these factors - with the exception of non-verbal IQ - can be targeted or optimized within the CI program. CI programs should strive to: provide CI/s as soon as audiological/medical criteria are met, engage families in the intervention and provide goal-based therapy that focuses on the development of early listening skills.

CAN DATA LOGS PREDICT RECEPTIVE VOCABULARY OF CHILDREN WITH COCHLEAR IMPLANT?

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The Cochlear™ Nucleus® 6 Cochlear implant (CI) sound processor collects information about the user's sound environment and daily CI use. The study investigates associations between these automatic measures and the receptive vocabulary scores of children with CI. Peabody Picture Vocabulary Test (PPVT) results and data logs were obtained from 45 children (age 1-14) who were prelingually deaf and had received a CI before age 3. The vocabulary scores were modeled as a function of CI use and exposure to speech and noise throughout the 12 months preceding the test, as well as other potential predictors of language performance (gender, chronological age, age at implantation, hearing age, implantation mode, speech understanding, etiology of deafness and educational placement). Different statistical models were compared to evaluate the predictive value of data logging measures. We found that information from the data logs predicted receptive vocabulary. More specifically, children who were exposed to more speech and had higher daily CI use had better receptive vocabulary scores. The model fit was comparable to the best models without data logging information. The study provides evidence that CI data logs capture meaningful information about a child's sound environment. This suggests that they can be used to detect and address problems in children's environment and improve their language development and auditory rehabilitation.

POST COCHLEAR IMPLANT TWIN A FEMALE CHILD DIAGNOSED WITH EPILEPSY

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Introduction: 11 years old female child patient diagnosed with bilateral congenital sensory neural hearing loss when she was 2 months of age. Patient had strong family history of hearing loss as her grandmother and parents uncles are deaf- mute. Patient had bilateral cochlear implant in two different sitting; right ear was implanted on 11th August 2008 while the left done on 3rd May 2010 as per family request to do the operation in two different years.

Patient has been regularly visiting in cochlear implant clinic for re-programming according to cochlear implant programming schedule. Patient's mother noticed that her daughter had several episodes of going in a trans-like state, stopping what she does and staring directly ahead.

Case Discussion: The episodes can last for a few seconds up to around 1 minute. There are no other clinical signs or evidence of jerky movements or any focal deficit. These episodes happened after she wakes up from sleep or when she is tired but there is no certain pattern for them. She had 1 episode which sound like complex partial seizure and 1 of these episodes happened while she was next to the swimming pool. After these episodes, on 1 or 2 occasions, she appeared confused and seemed to be doing some automatism. Physical examination revealed as normal without any evidence of neurocutaneous stigmata, abnormal neurological signs, any weakness or paralysis or any other neurological concern.

Conclusion: This case diagnosed as juvenile absence epilepsy (part of idiopathic generalized epilepsy) and showed no role of cochlear implant to trigger epilepsy. Which means if a child is diagnosed with epilepsy and severe to profound hearing loss can have cochlear implants to help him in communication by developing language and speech which will change his method of communication from sign language to spoken language.

C.I. IN ADULTS

PSYCHOSOCIAL HEALTH OF COCHLEAR IMPLANT USERS COMPARED TO THAT OF ADULTS WITH AND WITHOUT HEARING AIDS: RESULTS OF THE NETHERLANDS LONGITUDINAL STUDY ON HEARING

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Objectives This study aimed to examine the psychosocial health status of adult cochlear implant (CI) users, compared to that of hearing aid (HA) users, hearing-impaired adults without hearing aids, and normally hearing adults.

Methods Cross-sectional observational study, using both self-reported survey data and a speech-in-noise test. Data as collected within the Netherlands Longitudinal Study on Hearing (NL-SH) between September 2011 and June 2016 were used (N=1,254). Psychosocial health measures included emotional and social loneliness, anxiety, depression, distress, and somatisation. Psychosocial health, hearing status, use of hearing technology, and covariates were measured by self-report; hearing ability was assessed through an online digit-triplet speech-in-noise test.

Results After adjusting for the degree of hearing impairment, HA users (N=418) and hearing-impaired adults (N=247) had significantly worse scores on emotional loneliness than CI users (N=37). HA users had significantly worse (higher) anxiety scores than CI users in some but not all linear regression models. Differences between normally hearing (N=552) and CI users were not-significant for all psychosocial outcomes.

Conclusions Psychosocial health of CI-users was not different from that of hearing-impaired adults with or without hearing aids. CI users' level of emotional loneliness was even lower than that of their hearing impaired peers using hearing aids. A possible explanation is that CI-patients receive more professional and family support, and guidance along their audiological rehabilitation journey than adults who are fitted with hearing aids.

Funding

Data collection of the second measurement round of the NL-SH was financially supported by Sonova AG, Switzerland.

VISUAL AND AUDITORY WORD MEMORY IN OLDER ADULTS: COMPARING POSTLINGUALLY DEAF COCHLEAR IMPLANT USERS TO NORMAL HEARING CONTROLS

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Background: In recent years, the association between hearing impairments and cognitive abilities has been receiving increasing attention. Previously, we found that prelingually deaf young adults with cochlear implants (CI) showed lower auditory word memory ability relative to normal hearing (NH) group while their visual word memory was comparable.

Objective: The present study evaluated auditory and visual word learning strategies among older postlingually CI group as compared to older NH (ONH) adults.

Methods: 25 older adults (age>60 years) (CI-11, ONH-14) participated, all showed intact cognitive abilities (MOCA >26). All CI users showed good open-set speech perception results (mono-syllabic > 50%, di-syllabic >80%). Participants performed two verbal learning tasks, in which words were learned by vocal production (saying aloud) or by no-production (silent reading or listening), followed by a free recall test (a Production Effect paradigm, PE). These tasks were performed via the auditory and the visual modalities.

Results: Both groups (ONH and postlingually CI) showed a production benefit with visual and auditory presentations (higher recall rates for vocalized than silently read words). The size of the PE was larger in the visual modality in compared to the auditory modality for both groups.

Comparing these results to a previous study with prelingual young CI users revealed that while prelingual

CI users show reduced auditory word learning as compared to NH, postlingually CI users show comparable auditory strategies as NH older adults.

Conclusions: The results support the use of vocal production as a memory strategy (via the auditory and the visual modalities) in older adults. Such technique may be easily used in everyday situations, e.g. following a medication schedule, memorizing directions. The similarity between ONH and older postlingual CI may suggest that when deafness occurs after the completion of language acquisition, the participants use similar long-term word learning strategies, hinting on comparable cognitive abilities.

RESULTS FOR BILATERAL AND BIMODAL USE OF COCHLEAR IMPLANTS: EVIDENCE FOR RECOMMENDATION OF BILATERAL IMPLANTATION IN ADULTS

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Introduction: Most adult cochlear implant users in developed countries use a hearing aid in conjunction with their implant device (bimodal hearing). Significant benefit is observed in most cases when the hearing aid input is added. Benefits have also been documented for the use of bilateral cochlear implants (CIs) for speech perception in quiet, localization, and speech perception in noise. Adults with a first CI proceed with a second CI based on perceived benefit, cost/insurance issues and surgery risks, but it has been difficult to provide evidence-based recommendations regarding the potential benefit of a second CI for an individual who uses a hearing aid in the non-implanted side. This study attempted to quantify speech perception results for bimodal and bilateral CIs in adults and provide a guide for those considering a second CI.

Method: Speech perception outcomes were reviewed for 1393 adults with acquired hearing loss who received a cochlear implant at the Melbourne Cochlear Implant Clinic between 2000 and 2015. This unselected cohort included 487 who used their first CI alone, 639 who used their first CI with a hearing aid on the contralateral side, and 267 who went on to have a second CI.

Results: Bimodal advantage for speech perception averaged 13.0% for CNC word scores and 12.8% for CUNY sentences in 10dB SNR. There were significant but weak relationships between the degree of bimodal benefit and pre-implant speech perception scores in the non-implanted (better) ear. Bilateral advantage averaged 19.4% for CNC words and 19.0% for CUNY sentences in 10dB SNR. Regression analysis suggested that CI users scoring less than 20% for CNC words in the non-implanted ear were likely to perform better with a second implant.

Conclusions: This analysis of speech perception outcomes for a large unselected cohort of adult CI users indicated that the use of a hearing aid or a second cochlear implant provides significant benefit over one CI. CI users who score less than 20% on CNC words in the non-implanted ear have a good chance (>75%) of benefiting from a second implant. Consideration of many other factors including age, hearing goals, medical factors, and the risk to residual hearing also need to play a part in recommending a second CI.

EFFECT OF COCHLEAR IMPLANTATION ON LONELINESS AND SOCIAL INTERACTION OF OLDER ADULTS

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Background: Social isolation and loneliness are considered as contributing factors to the age-associated hearing loss in older adults. This cross sectional study investigated the association between the severity of speech and high frequency ARHL and depression, anxiety and stress in older adults.

Study design: Cross-sectional study of a community-derived sample of adult volunteers.

Methods: A total of 27 cochlear implant recipients (CIR; M = 61.59 + 13.95 years) and 16 implant candidates (CIC; M = 65.06 + 8.59 years) were recruited. Both participant groups completed a hearing assessment, De Jong Gierveld Loneliness Scale and Berkman-Syme Social Network Index. CIR completed

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the assessments at the baseline, post-implant 6 and 12 months and CIC completed the assessments at baseline, 6 and 12 months intervals.

Results: Nonparametric Mann-Whitney U test was carried out to compare the baseline-6 months and baseline-12 months difference in scores for emotional and social loneliness and social support and interaction scores. Results revealed a baseline-12 months significant difference in scores for emotional and total loneliness scores ($P < .05$).

Conclusion: These results suggest that cochlear implantation has a positive impact on loneliness scores of the implant recipients.

EHDI PROGRAMS (1)

WHAT MAKES A NATIONAL SCREENING PROGRAMME?

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Universal newborn hearing screen has been fully implemented in England for just over twelve years, since March 2006. The NHS Newborn Hearing Screening Programme (NHSP) is one of eleven national screening programmes in England led by Public Health England (PHE). National population screening programmes are implemented in the National Health Service (NHS) on the advice and recommendation of the UK National Screening Committee. Further information about the programme is available on <https://www.gov.uk/topic/population-screening-programmes/newborn-hearing>

The UK NSC recommends that all eligible newborn babies in England are offered screening to identify those with bilateral moderate or worse permanent childhood hearing impairment (PCHI). NHSP has responsibility for implementing this policy.

Each national screening programme within PHE is responsible for carrying the tasks that are best done once at a national level including the following:-

- setting and reviewing programme standards
- setting and reviewing Key Performance Indicators
- developing a service specification for commissioners and providers of services
- setting specifications for screening equipment, IT and data
- setting care pathways
- procurement national IT system
- evaluation and modification of changes to screening protocols
- ensuring equitable access to screening
- offer expert advice in management of a screening incident
- developing information for public and health care professionals
- ensuring training and education for all those providing screening is developed, commissioned and delivered through appropriate partner organisations

To ensure a consistent and equitable approach to screening across England a national service specification is used to govern the provision and monitoring of newborn hearing screening services.

This outlines the service and quality indicators expected by NHS England for the population for whom it is responsible and which meets the policies, recommendations and standards of the UK National Screening Committee (UK NSC).

To make sure population screening is safe and effective in England, a structured quality assurance programme exists to assess the quality of local screening programmes, monitor compliance with standards and support services with improving quality. In addition, service providers and programme teams use Key performance indicators (KPIs) to help measure the success of screening programmes. Each screening programme provider must report KPI data on a quarterly basis.

Across England, approximately 670,000 are born each year. Newborn hearing screening is offered to all eligible babies, through 110 local service providers, who have responsibility for 1,500-26,000 babies each. Screening is undertaken in the maternity hospital, out-patient setting or in the baby's home.

In 2016/17, 98.4% of eligible well-babies had screening completed by 4 -5 weeks of age and 99.2% were completed by 3 months of age. Since the programme was fully implemented across the country, almost 8 million babies have been screened with more than 15,500 babies with moderate to profound hearing loss identified.

This paper describes some of the benefits of having a national approach with specific examples and discusses some of the complex issues involved in running a national programme and elucidates the relationship between PHE, local health commissioners and local screening providers.

15 YEARS OF THE POLISH UNIVERSAL NEONATAL HEARING SCREENING PROGRAM

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The Polish Universal Neonatal Hearing Screening Program (PUNHSP) has been running in Poland for over 15 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.

The Polish Program is based on three levels: early detection of hearing loss, audiological diagnosis and intervention. By December 2017, there were 5 619 130 children registered in the Program. The database represents 96% of the newborn population in Poland. On average, 8.8% (494 455) of children who had been tested on I level were referred 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, about 75-85% of children who had been referred for further tests are recorded and diagnosed in laryngological centers. Hearing loss above 20 dB was recorded in 14 548 children. It is estimated that this occurs in about 3 per 1000 children born in Poland. Bilateral sensorineural hearing loss was diagnosed in 63.3% children, conductive in 23.9% children and mixed in 12.8% children. In contrast, single-side sensorineural hearing loss was diagnosed in 48.5% children; conductive in 38.2% children; and mixed in 13.3% children.

All children, that are diagnosed with hearing loss are referred to the III level centers in order to undergo treatment, including fitting a hearing aid - 58.8% of children, rehabilitation - 32.2% of the children or surgical treatment - 9.0% of the children.

IS BRAIN DEVELOPMENT WITH RESPECT TO AUDITORY PATHWAYS FASTER IN UTERO OR OUTSIDE UTERO?

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Objective: To investigate whether brain development with respect to auditory pathways is faster in utero or outside utero.

Study design: Included were extreme immature newborns 25-27 weeks, very preterm newborns 28-30 and newborns with a gestational age (GA) of 31 weeks, all without hearing loss. Results of the 2-stage AABR nationwide Newborn Hearing Screening Program in Dutch Neonatal Intensive Care Units and diagnostic examinations were centrally registered from 1998 to 2016. No hearing loss was defined as a bilateral pass result at the first or second stage or no hearing loss according to diagnostic examinations. AABR results were obtained up to 46 weeks postmenstrual age. As the AABR results were obtained from the nationwide screening program, we did not have test results at each week of postmenstrual age. However, we assumed that if the newborn had a pass result (for example at 31 weeks' postmenstrual age), this will stay a pass (>31 weeks' postmenstrual age). Also, we assumed that if the newborn had a refer (for example at 35 weeks' postmenstrual age), the previous results would have been a refer as well (<35 weeks' postmenstrual age). Multiple imputation was used to predict the missing data (for example with a refer at 35 weeks' postmenstrual age and a pass at 40 weeks' postmenstrual age, there is missing data between 36-39 weeks' postmenstrual age). In total, ten predictions were conducted and afterwards pooled.

Results: In total, 23,964 newborns with 28,754 AABR results were eligible. GA had a significant ($p < 0.001$) and clinically relevant effect on the time of passing the AABR after adjustment for postmenstrual age. Pass rates of approximately 80% could be obtained at 35, 33, 32, and 31 weeks' postmenstrual age in newborns born at respectively 25, 26-27, 28, and 29-31 weeks GA. Pass rates of approximately 90% could be obtained at 37, 36, 35, 34, 33, and 32 weeks' postmenstrual age in

newborns born at respectively 25, 26, 27, 28, 29, and 30-31 weeks GA.

Conclusions: After adjustment for postmenstrual age in very preterm newborns, lower GA is associated with lower pass rates in AABR hearing screening. This finding suggests that functional auditory development is increasingly delayed with decreasing GA of the newborn.

LONG-TERM IMPACT OF EHDI PROGRAM ON EDUCATIONAL OUTCOMES 5 TO 10 YEARS LATER

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EHDI programs have been implemented in the US for almost two decades. Considerable resources have been focused on implementing universal newborn hearing screening, promoting timely diagnosis, and delivering early intervention. The goal of this study is to examine the relationship between newborn hearing screening and K-5 educational outcomes. Such information would be valuable for assessing the impact of EHDI programs and for informing best practice in early childhood health screening.

As part of a demonstration project mandated by the Maine (USA) State Legislature, the authors linked data from the Maine EHDI program with educational records obtained from the Maine Department of Education's State Longitudinal Data System (SLDS). The SLDS housed comprehensive records on all children enrolled in public schools across the state. This included child-level data on standardized test scores, special education placement, and special services provided. The linkage was based on the EHDI data for children born in 2003 through 2005. These data were linked with state education records from 2010 (including special education data) and 2013 (including special education and standardized assessment data). A total of more than 30,000 records were linked from birth through 8 to 10 years of age. All linked records were then de-identified for statistical analysis.

One set of analyses compared the standardized assessment data between children whose hearing loss had been identified through EHDI and children whose hearing loss had not been identified through the EHDI newborn screening/diagnosis process. For reading proficiency, results showed a small trend in favor of children whose hearing loss had been identified through EHDI. For math proficiency, results exhibited a stronger trend in which the outcome for children whose hearing loss had been identified through EHDI showed higher levels of performance.

The second set of analyses focused on those newborns who received a refer result for their hearing screen (using ABR technology), but were found to have normal hearing. The results showed that these children were nevertheless at elevated risk for special education placement five to ten years later, including significantly higher risk for autism. This supports continued monitoring of children who failed their hearing screen -- even if they are diagnosed with normal hearing -- as they may nevertheless be at elevated risk for other significant developmental challenges.

THE COST-EFFECTIVENESS OF NEONATAL HEARING SCREENING PROGRAMS: A MICRO-SIMULATION MODELLING ANALYSIS.

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Objectives Early detection of congenital hearing loss may prevent irreversible life-long speech and language impairment. Economic growth allows developing countries to advance their health care system and to extend their prevention policies. Currently, an increasing number of middle income countries is taking the implementation of universal neonatal hearing screening into consideration. One of these countries is Albania. This study aims to predict the cost-effectiveness of various hearing screening programmes, newly introduced in Albanian regions.

Methods A stochastic micro-simulation model was developed using input parameters on demography, natural history of (congenital) hearing loss, screening characteristics and treatment. Parameter values were obtained from literature review, national data publications and expert opinion. In the model, states and transitions were designed as a Markov process. Monte Carlo simulations allowed variation in the input parameters to reflect uncertainty as observed in real life. A birth cohort was modeled and individual life events (for example diagnosis of hearing loss) were simulated. We simulated various protocols using Otoacoustic Emissions (OAE) and automatic auditory brainstem response (aABR) test devices, in various sequences. Cost-effectiveness was analysed from a health care perspective over a life time horizon, using a 3% discount rate for both costs and effects.

Results Model analyses showed that performing less tests within a sequence leads to more cases detected compared to multiple screens. However, this is accompanied by increased referral rates and false positives. The two most cost-effective strategies for well babies are OAE at the second day, followed by aABR before leaving the birth clinic, and only one test with aABR with incremental cost-effectiveness ratios (ICER) of € 7,273 and € 74,843 per QALY gained, respectively. One-way sensitivity analysis shows that increased costs for diagnostic follow-up are influencing our estimates, but two-stage OAE-aABR remains the most cost-effective of all compared programs. Increased utility values for lifetime hearing impairment do increase the cost-effectiveness ratio such that it exceeds a willingness to pay threshold.

Discussion The underlying modeling techniques suit the uncertainty of the incidence curves of hearing impairment and the random behavior of individuals related to screening attendance, treatment adherence and effectiveness of screening programs. Our model is one of the few to assess the effects of neonatal hearing screening programs over a life time horizon. Additionally, this is the first model that evaluates the cost-effectiveness of multiple screening scenarios simultaneously. Data collection from Albanian implementation will enable future refinement of our model.

EHDI PROGRAMS (2)

USE OF LARGE DATA SETS IN EVALUATING PROGRAM OUTCOME IN PEDIATRIC HEARING LOSS

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Permanent hearing loss (PHL) in childhood can have a profound impact on development, with high economic costs to children, their families and to society. Advances in hearing technology and service delivery have been implemented to improve outcomes and quality of life, and to reduce the burden associated with PHL. Other sources of burden may be related to the high incidence of co-morbidities in children with PHL and potentially higher utilization of health services. The overarching goal of our research is to examine utilization of health care services in children with PHL to better understand their health care needs and the impact of programs to address them. In the first phase, we examined the impact of the implementation of hearing screening on age of identification of hearing loss in a selected region of Ontario, Canada, where its Infant Hearing Program (IHP) was implemented in 2002.

Methods: Data were linked from two large databases. The first contained audiological and demographic data for children identified with PHL at the Children's Hospital of Eastern Ontario, the only pediatric academic health centre located in Ottawa, Ontario, Canada with a catchment area of one million people. In this setting, PHL is identified for all children in the eastern part of the province. Children diagnosed with PHL from fiscal years 1991 to 2013 were identified and their data were linked to their health administrative data. This administrative data is held at the Institute for Clinical Evaluative Sciences (ICES) for Ontario, Canada's most populous province and contains administrative and health-related data for all legal residents with a valid health card. Age of identification of PHL was compared for children born in the pre-IHP era (Jan 1 1991 to Dec 31 2002) to those born in the post-IHP era (Jan 1 2003 to Dec 31 2013). Previous research in this geographic area has demonstrated a decline in age of identification in the pre-IHP era, and some children born in the pre-IHP era were screened for hearing loss at birth due to risk factors. We therefore used Regression Discontinuity Design (RDD) to assess the interaction between age at diagnosis and era (pre- vs. post-IHP screening program), which determined whether the slope of the line of age at diagnosis changed after introduction of IHP.

Analyses and Results: RDD conducted over the eras before and after implementation of IHP indicated that there was a significant association between implementation of IHP (pre- vs post-IHP) and time: this indicated that the decline in the age of confirmation of PHL was greater in the post-IHP period compared to the pre-IHP period (β (IHP*Time) -2.09, 95%CI -0.67 to -3.51, P=0.004). This was also the case when interactions between IHP, time, and severity of hearing loss were included in the model (β (IHP*Time) - 6.05, 95%CI -2.59 to -9.51, P=0.0006). Gender, rurality and mean neighbourhood income quintile did not confound the association between age at diagnosis over time and implementation of IHP.

Comparisons of age of identification were made for those children with PHL born in the 10 year era before IHP who did not undergo high-risk screening (N=319) and those born and screened in the 10 year era after implementation of IHP (N=245). The median age at confirmation of PHL was lower after implementation of IHP (Median: 13.4 months; IQR 3.35 - 35.01) than before it (Median: 41.8 months; IQR: 22.5 - 60.2), and particularly for lesser (mild, unilateral and moderate) hearing losses.

Discussion: These results indicate the implementation of universal newborn hearing screening was associated with earlier identification of hearing loss in one jurisdiction in Ontario, Canada. While age at diagnosis was decreasing before IHP implementation in this geographic area, this decrease significantly accelerated after IHP implementation. In future research, we plan to examine health care utilization over these eras, and potentially identify co-morbidities associated with PHL which may also impact outcome

and quality of life. A better understanding of health care utilization and health outcomes in this population has the potential to improve programs and services, as well as quality of life for children with hearing loss.

THE AUDIOLOGICAL SURVEILLANCE PROGRAM IN REGIONE CAMPANIA

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Objective: The prevalence of confirmed childhood permanent hearing loss (PHI) increases with the age. To capture children with postnatal hearing loss, a form of monitoring system is needed. The goal of this study was to describe a targeted surveillance program using the Joint Committee on Infant Hearing Screening 2007 (JCHI) factor registry in conjunction with parental and professional monitoring.

Methods: During the period between January 2013 and December 2016, all children who received bilateral pass result during the newborn hearing screening, and who were identified as having at least one risk factor, were referred for targeted surveillance and included in the study.

Results: During the study period 2340 children (1.41% out of 165,416) were enrolled in targeted surveillance program. Of these, 66 children were identified with permanent hearing loss. The most frequently risk factors in children with postnatal hearing loss were: family history (35%), prematurity (25.5%), low weight (19,2%), hyperbilirubinemia (19%), prolonged ventilation (15%) and congenital infection (12,5%).

Conclusion: Targeted surveillance program is effective to identify postnatal hearing loss. However, the critical issues that emerged in the work, highlight some limitations of the audiological surveillance programs that require further investigation for an effective management of the system.

EXPRESSIVE LANGUAGE IN A POPULATION COHORT OF TWO YEAR OLDS WITH HEARING LOSS

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Background: Congenital hearing loss can negatively impact expressive language outcomes in children. To date, no published population-based studies have considered the early expressive language of children with hearing loss, both unilateral and bilateral, identified solely under a Universal Newborn Hearing Screening (UNHS) system. Language evaluation during the critical language development period may clinically inform early intervention efficacy and flag need for additional supports.

Objective: To examine early expressive language skills of two year olds with hearing loss as predicted by hearing loss severity and type, age of early intervention commencement and non-English Speaking Background (NESB).

Design/Methods: Cross-sectional study of a population-based sample of 137 2-year-olds (mean=25.60 months, SD=2.98 months) with bilateral and unilateral hearing loss. The children were identified through the Victorian Infant Hearing Screening Program (VIHSP) and enrolled in the Victorian Childhood Hearing Impairment Longitudinal Databank (VicCHILD). This was not a clinically or early intervention enrolled sample, and there were no other enrolment requirements. Expressive vocabulary and language skills were assessed using a standardized parent-reported checklist, the Sure Start Language Measure (SSLM).

Results: Among all participants, children with unilateral hearing loss as a whole demonstrated better early expressive language scores than their peers with bilateral hearing loss. For children with unilateral hearing loss, 100% (mild), 71.4% (moderate), 80% (severe) and 73.3% (profound) achieved expressive vocabulary scores within the average range for normally hearing children (standardized mean=100, SD=15). While all children with mild unilateral hearing loss demonstrated age appropriate expressive vocabulary, nearly a quarter of children with moderate-profound unilateral hearing loss attained scores that were more than 1SD below the standardized mean. In contrast, age appropriate SSLM scores were only achieved by 54.6% (mild), 47.4% (moderate), 20% (severe) and 38.5% (profound) in participants

with bilateral hearing loss. Age at early intervention commencement did not significantly predict early expressive language skills. NESB children had significantly poorer expressive language outcomes compared to other children with hearing loss, irrespective of type or degree of loss (Expressive Vocabulary: $\rho = -0.22$, $p < 0.05$; Word Combination: $\rho = 0.36$, $p < 0.001$).

Conclusion: Even at an early age of 2 years, some children with moderate-severe unilateral hearing loss are already demonstrating expressive language skills below expected for their normally hearing peers. Further research with a larger sample size is needed to monitor the language outcome trajectory of these children, examine the interplay of potential confounders and establish if additional intervention is required to prevent widening language delays.

THE AUDIOLOGIC FOLLOW-UP IN CHILDREN WITH CONGENITAL CYTOMEGALOVIRUS INFECTION

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Congenital infections are very significant issue in pediatrics nowadays. Cytomegalovirus (CMV) is a crucial risk factor associated with sensorineural hearing loss (SNHL) appearance. An absence of definite audiological follow-up algorithm hinders the early diagnostics of SNHL even in the case of timely verification of congenital CMV infection. It may lead to belated diagnostics of SNHL, delay patient's (re)habilitation and impairs prognosis of their speech and language development.

The **aim** is to develop the audiological follow-up algorithm adapted for children with congenital CMV.

Materials and methods: 60 children with verified congenital CMV have been involved into audiological follow-up. The age of children ranged from 2 months to 7 years old. The follow up duration was up to 4 years. The following SNHL risk factors were analyzed: mother's anamnesis, gestation age, birth weight, APGAR score, the bilirubin level, treatment regimen (ototoxic drugs), the lung ventilation duration, etc. The comparison group included 50 infants with SNHL appearance risk factors, excluding congenital CMV (verified by negative PCR results).

Audiological assessment included: distortion product otoacoustic emissions (DPOAE) and transient evoked otoacoustic emissions (TEOAE), impedancemetry, auditory brainstem response (ABR), auditory steady-state response (ASSR) and pure tone audiometry (visual reinforcement audiometry, play audiometry, conventional audiometry depending on child's age and development). Tests for auditory processing disorders (APD) included: gap detection test, speech audiometry in quiet and noise, dichotic digital test.

This follow-up protocol was used: audiological examination was performed every 1-3 months at the age 0-12 months; every 4-6 months at the age 12-36 months; twice a year for children from 3 to 5 years old. APD tests have been performed in children elder than 4 years old.

Results: Hearing loss was revealed in 8 children (13%). Congenital SNHL was diagnosed in 6 children (10%): 2 patients with bilateral profound SNHL, one child with moderate SNHL, slight unilateral SNHL is defined in one child, one patient was diagnosed with auditory neuropathy spectrum disorders (ANSD). Two patients (3%) developed late-onset profound hearing loss: one of them had normal hearing initially and developed SNHL till one year old, the second child had initially unilateral hearing loss and then developed bilateral profound SNHL approximately by the age of 18-22 months. 2 children (4%) of the comparison group were identified with hearing impairment, both had ANSD.

One clinical case of peripheral hearing improvement in a child with hydrocephalus, congenital CMV and unilateral moderate SNHL was presented: ABR thresholds decreased from 70 to 40 dB nHL by the age of 19 months, simultaneously with neurological improvement. Thus actual diagnosis according to the last examination is unilateral mild SNHL.

Tests for APD have been performed for 10 children with normal peripheral hearing. Five of them failed some of the APD tests. So APD may be suspected for them.

Conclusion: Number of patients with hearing impairment is significantly higher in the group of patients with CMV than in the compared one. Thus CMV infection is a crucial factor in pathogenesis of SNHL appearance. Late-onset nature of SNHL with congenital CMV infection has been shown in two infants. It requires long-term monitoring in children with CMV. The hearing function requires evaluation every 3 month during the first year, every 6 months at the second one and once a year later till 6 years old. Assessment for APD is essential and can be performed in children elder than age of 4-5 years old.

Key words: cytomegalovirus infection; sensorineural hearing loss; follow-up.

EHDI PROGRAMS (3)

SOURCING AND IMPLEMENTING AN APPROPRIATE ELECTRODE GEL TO REPLACE BABY WASH DURING NEWBORN HEARING SCREENING - CHANGING THE CULTURE OF A LIFETIME

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One of the technical requirements of newborn hearing screening using automated ABR (AABR) devices is minimising impedance levels. While AABR sensor tabs come with embedded conductive gel, impedance levels were reported by screening staff to be lower when the electrodes were moistened with undiluted baby wash. The origins of its use were unclear, and since commencement of screening in 2005 it became an entrenched state wide practice used to manage impedance levels. By using this product 'off label' and outside its intended use, screening programs inadvertently place babies at risk of an adverse reaction and raise concerns regarding potential harm and liability. This presentation will outline the process undertaken by one population-based screening program to source a suitable alternate to undiluted baby wash.

Method: Location: Victorian Infant Hearing Screening Program (VIHSP), Victoria, Australia

Setting: Statewide newborn hearing screening program, 76 maternity hospitals, approx. 80,000 births per annum

Stage 1: Analysis

In order to determine suitable substitutes VIHSP consulted with;

- other screening programs,
- hearing screening equipment manufacturers,
- electrode conductive gel manufacturers and,
- other users of electrode conductive gels; e.g. radiologists, audiologists etc.

Stage 2: Feasibility study

Three (3) alternative products were recommended to VIHSP. Their effectiveness was evaluated at a number of screening sites. The data collected included screen times, impedance measures, cost per screen and staff experience, e.g. usability. Training was provided to screening staff involved in order for comparable information to be collected. In order to maintain screening Key Performance Indicators during this period, hearing screeners were permitted to continue with their current screening practice if screening conditions deteriorated during the use of the alternate.

All three products were rejected due to their limitations in either ease of use or reducing impedance.

Stage 3: Further studies

Further searches identified another potentially suitable product, an electrode conductive gel. This product was evaluated on 200 hearing screens with the same methodology. Results from the electrode conductive gel evaluation showed a favorable comparison to baby wash with short screening times, a neutral staff experience, slightly higher impedance but a negative cost.

Stage 4: Implementation

Based on the principles of effective change management, VIHSP included time at staff professional development days to present rationale for adopting an alternate product. This allowed teams time and space to understand the change, their role during evaluation and roll out of an alternative to baby wash. Local training of Area Managers followed focusing on the use of the alternate electrode conductive gel. Implementation of the new product was then systematically rolled-out into all screening locations. This included further screener training, surveys and additional communications and feedback mechanisms to encourage staff to voice their issues and fully engage in the change process.

Results: After systematic roll out across the state, VIHSP was now using a more appropriate product, fit for purpose at all screening sites. Overall program data was monitored and evaluated with particular attention to refer rates at both first and second screens (AABR1 and AABR2).

Initially, following the rollout, a decrease in the percentage of eligible babies being referred to audiology was noted (1.0% to 0.7%). Investigations into diagnostic outcomes determined that the percentage of

referred babies diagnosed with a hearing loss had increased (37.4% to 47.7%). However, the rate of diagnoses overall had not altered. This surprising benefit of a quality improvement process suggesting an increased specificity remains unexplained and investigation continues.

Discussion: Using a product 'off label' violates government regulations regarding therapeutic goods and places both the patient and organisation at risk. VIHSP was successfully able to source and implement an alternative product for use on the sensor tabs to support low impedance during screening and manage challenges from staff to maintain the status quo. The education program surrounding the product evaluations and roll-out of the alternate product was integral to the success of practice change. Monitoring and evaluation of program refer rates, diagnosis types and rates continues to be a priority for VIHSP.

AUTOMATED AUDITORY BRAINSTEM RESPONSE VS. OTOACOUSTIC EMISSIONS IN NEWBORN HEARING SCREENING – PROSPECTIVE, PILOT SCREENING TRIAL

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Objective - Early diagnosis and treatment of congenital and acquired hearing impairment in newborns is a key element for optimal speech development. The automated auditory brainstem response (AABR) method is considered to be superior to the otoacoustic emission (OAE) method, as it detects hearing deficit not only at the level of ear but also of neural origin. Recent recommendations suggest implementation of AABR to newborn hearing screening, to identify the group of newborns at higher risk of hearing impairment.

Aim – 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 268 infants (169 – with risk factors of hearing deficit; 99 – 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 – The results of OAE were positive in 2 newborns bilaterally and in 1 unilaterally. In 2 infants OAE was not performed due to anatomical defects or respiratory support. The results of AABR were positive in 5 newborns bilaterally and in 7 unilaterally. One newborn in whom both OAE and AABR were positive was finally diagnosed with bilateral sensorineural profound hearing deficit > 90 dB; the identified risk factor was congenital cytomegalovirus infection. One newborn of control group, in whom OAE was negative and AABR was positive unilaterally, finally has not been diagnosed with hearing deficit. Other infants in whom AABR was positive do not have the final diagnosis of hearing status yet. All of them had at least one risk factor of hearing deficit – treatment in the intensive care unit and mechanical ventilation (9 patients), prematurity < 33 wga (7), ototoxic treatment and very low birth weight (6), severe hypoxia (1), congenital syndrome that might be associated with hearing deficit (1) and cytomegalovirus infection (1).

AABR exam was assessed by the staff as more difficult and time consuming to perform (mean time of the exam 7.4 min; SD 7.19) 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.

VESTIBULAR EVOKED MYOGENIC POTENTIALS AT UNIVERSAL HEARING SCREENING: FEASIBILITY STUDY

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Vestibular loss has been estimated to have a high prevalence (40-50%) in congenital sensorineural hearing loss (cSNHL). In case of bilateral vestibular failure at birth, the infant shows a typical pattern of motor development with suboptimal motor proficiency levels at older ages. Vestibular loss has been more often reported in association to meningitis, to inner ear malformations and in cytomegalovirus congenital infection.

Cochlear implant (CI) is considered the first choice for the early habilitation of severe cSNHL. The prevalence of vestibular loss in cSNHL children with CI than without. The surgical risk for vestibular impairment has been questioned since 90s and the literature is still controversial.

Given these premises a child friendly vestibular test, feasible in infants and on a large scale, is worth of consideration. Ideally introduced at the universal hearing screening (HS), it should add a vestibular dimension to the screening program, promoting for example the early detection of vestibular failures to be addressed to specific habilitation. It may also contribute to the diagnostics of cSNHL, pointing out vestibular patterns specific for different forms of cSNHL. Moreover, it may improve the CI procedural safety, revealing those cSNHL cases at higher risk to develop post operative vestibular failure (for ex. CI indicated for the only vestibular functioning ear).

This study is about the feasibility of vestibular evoked myogenic potentials (VEMP) at the HS. VEMP is a vestibular test commonly used in adults. It consists of the recording the muscle response evoked by stimulation of the vestibular organ, usually by vibratory stimuli. The most diffuse clinical application is the cervical VEMP, where the myogenic potentials are recorded by surface electromyography (EMG) at neck muscles. cVEMP is rapid and harmless and it has been reproduced in infants and preterms. Expert guidelines for cVEMP in children are available.

50 infants (age: 1,9-2,1 months) were recruited from the hearing screening program in Stockholm region between February 2016 and April 2017. VEMP was conducted on infants referred to the in deep hearing screening level, namely children refer at the first level HS (48%) and the ones belonging cSNHL risk groups (52%). VEMP was performed with the Interacoustic Eclipse EP 15 device with VEMP module. For the purpose, a factory VEMP adult protocol was adapted to infant testing by: a. using a bone conducted 500 Hz tone burst at 50 dB HL- 120 dB peSPL- delivered on the mastoid with Radiohead B71; 2. applying a stimulus delivery protocol controlled by electromyography (EMG) -optimal range within 50-150 μ Volts. In this way the two major sources of VEMP intra- and interindividual response variability (acoustic admittance and muscle activity variance), could have been controlled also in infants.

The VEMP could be completed in the 87% of the sample (ears). The completion rate was significantly affected by the EMG levels, with poorer results at higher muscle activity levels during testing. Limiting the analysis to the recording obtained strictly within the EMG optimal range, the completion rate improved significantly to 97%. Further, a VEMP response waveform could be clearly identified in 73% of the VEMP recordings. The major determinants of the response rate were the completion rate and, negatively, the presence of an hearing loss confirmed at in deep hearing screening. Correcting these factors, the response rate resulted 91%. VEMP could be retrieved in all the cases of perinatal asphyxia, prematurity, in all the cases with exudative media otitis and in the only one case of connexin 26 mutation cSNHL. VEMP could not be retrieved in a case of CMV congenital infection, in a case of auditory neuropathy (nerve hypoplasia) and in 3 patients refer at the first level but with normal hearing at the in deep HS.

Concluding, VEMP introduced at HS showed good feasibility features, potentially optimal with improved EMG control during the testing. If further validated, VEMP could be considered an ideal tool to add a vestibular dimension to the modern hearing screening protocols.

Round Table

PRE-CI (RE)HABILITATION DURING THE FIRST YEAR OF LIFE – THIS MAKES THE DIFFERENCE!

Sandro Burdo^[1], *Monika Lehnhardt Goriany*^[2], *Karen Gordon*^[3], *George Tavartkiladze*^[4], *Alessandra Galli*^[1], *Nadine Cochard*^[5], *Bodo Bertram*^[6], *Malgorzala Zgoda*^[7], *Eulalia Juan*^[8], *Jayne Ramirez Inscoe*^[9]
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Universal neonatal hearing screening programs and cochlear implants have changed completely the communicative prognosis for congenitally deaf children. Early intervention and a correct use of technology allow the activation of a near-normal hearing and development of the auditory connectome, due to the plasticity of the brain.

We hold that an important clinical issue has to date not been looked into enough, and we are referring to what to do between the identification of deafness and surgery, during the first year of life, when the brain shows the maximum plasticity.

Two strategies can be followed:

- you may only aim at confirming the diagnosis and candidacy for CI, or
- you may couple the fitting of technology with a strong and structured training programme.

What to do with a congenital deaf child in the first year of life before the CI surgery will be the topic of the round table.

The panel is divided into four chapters in order to discuss and share the authors' experiences as far as possible.

The first chapter will describe some basic issues both about organization and clinical aspects. In particular, the effects of early stimulation in a developing brain will be presented.

The second chapter will mainly focus on diagnostic tools and describe how to make a correct and complete diagnosis, i.e. getting beyond the classical click-evoked ABR.

The third chapter will be dedicated to the pre-surgery technology, and we'll try not to give just general information about hearing aids or other devices, and to describe precisely how to check their performances and measure the child's outcomes.

Finally in the last chapter, the panelists will describe how to organize and what to do during the training sessions, in a global perspective that includes how to fit technology but also how to build a communicative and cognitive rehabilitation.

IMPROVING EHDI

UPDATES FOR THE WEB-BASED NEWBORN HEARING SCREENING TRAINING CURRICULUM

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Conducting a newborn hearing screen in the first hours of a baby's life is the critical first step in the Early Hearing Detection and Intervention (EHDI) process. A quality hospital-based newborn hearing screening program involves the orchestration and coordination of a variety of critical program components to ensure successful outcomes for babies and families. For babies in need of follow-up, effective, coordinated and timely communication strategies must be in place in order to reduce loss to follow-up.

Hospitals are faced with the ongoing challenge of a high rate of staff turnover and its effect on ensuring screening staff is competently trained. In an effort to improve the quality of the newborn hearing screening process and the standard of care for babies and families, the National Center for Hearing Assessment and Management at Utah State University (NCHAM), developed a standardized, competency based, training curriculum for hospital-based screeners in 2008; Newborn Hearing Screening Training Curriculum (NHSTC). Originally developed in a DVD format its popularity led to the development of a web-based version which is currently being updated. In addition, two new modules on recertification and outpatient/midwifery screening are in development.

As part of the course requirements, built-in assessment tools have made it possible to investigate learning outcomes, specifically screener knowledge and confidence in each area. Preliminary data analysis completed in 2015 on 1,200 participants

demonstrated the positive impact of the NHSTC. Since then, the NHSTC has gained international popularity and more than 7,000 participants have completed the course.

This presentation will provide an overview of the outcome data, recent updates to the course and demonstrate how EHDI programs, hospitals, and stakeholders, can utilize the course and accompanying resources to improve the standard of care for newborn hearing screening.

TWELVE YEARS' EXPERIENCE WITH A NATIONAL INFORMATION SYSTEM FOR NEWBORN HEARING SCREENING IN ENGLAND

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The NHS Newborn Hearing Screening Programme in England is one of eleven national screening programmes under the direction of the UK National Screening Committee led by Public Health England, delivered within the National Health Service (NHS) across England.

Universal newborn hearing screen has been fully implemented in England for 12 years, since March 2006. Since then, nearly 8 million babies have been screened and approximately 15,500 babies with moderate to profound hearing loss identified.

Under the leadership of Professor Adrian Davis, at the start of the programme it was decided that a national information system was required with the capability to record screening results and outcomes, audiological follow up data and key dates for identified cases including referral to early intervention services and first amplification fitting dates.

The system was also required to identify the eligible population of the approximate 700,000 babies born each year in England, track babies as they move around the country or between different hospitals and enable national and local reporting of performance in respect of programme standards.

This paper describes some of the functions and advantages of the system and also outlines some of the solutions and structures developed to manage the challenges. The paper will also include new data from

the English screening programme to further demonstrate the capabilities of a national system and its associated benefits.

In order to meet the outlined requirements, a national system (eSP and subsequently SMart4Hearing - S4H) was developed by the IT supplier with vital contribution to its design and function provided by the NHSP programme team. The system was provided to all screening locations across England over a secure network as part of the implementation of newborn hearing screening.

The decision to implement a new national programme together with a national IT system has proved invaluable, delivering quality data to monitor and evidence the effectiveness of the screening protocols, services and interventions.

The system provides the following benefits to screening programme:

- A web based system requiring very little local installation or configuration. This enables new versions of the system for all users to be released simultaneously across the country
- A single national system enables accurate and timely reporting of programme performance at a national, regional and provider level
- Identification of the population eligible for screening to provide a failsafe to minimise missed babies and improve screening coverage
- A national store of all screening waveforms directly downloaded from the screening equipment removing the need for localised storage
- A single location for the recording of screening and diagnostic results and aetiological information providing a source of data for quality assurance and performance monitoring purposes across NHSP in England
- Ability to enable peer-review of diagnostic testing results

The provision of such a system provides huge advantages but also presents a number of challenges including issues of ownership and responsibility for the system, data and information governance, management of the contract with the IT supplier, monitoring system performance and user engagement. These will be discussed.

AN EHDI LEARNING HEALTH COMMUNITY: LESSONS LEARNED FROM US AND AUSTRALIAN STATES

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An Early Hearing Detection & Intervention (EHDI) Learning Health Community is a concept that has evolved significantly in the 20 years since the 1998 NHS meeting in Milan. EHDI Programs have shown great collaboration in contributing to and benefiting from a Learning Health Community. Indeed, it is where progress in case, culture, informatics, and science have united to generate new knowledge as a byproduct of overseeing a baby's early hearing care path.

<http://www.nationalacademies.org/hmd/Activities/Quality/LearningHealthCare.aspx>

Twenty years ago, the Joint Committee on Infant Hearing (JCIH) Chair presented Principles and Guidelines from the JCIH Year 2000 Position Statement at the 1998 NHS Meeting, discussing progress and challenges in the Texas Newborn Hearing Screening Program. For this presentation, with authors from the US States of Texas, Iowa, Maryland, North Dakota, Alaska, and Minnesota, and the Australian states of Victoria and Tasmania, we address what has worked and what needs improvement in jurisdictional newborn hearing screening programs over the past implementing EHDI Programs. Each state coordinator identified challenges faced, successes achieved, and those issues still in need of solutions from a Learning Health Community perspective.

The JCIH principles focus on a family-centric approach that serves as the foundation of a successful EHDI Program. Illustrating achievement of the first six Principles is incumbent upon robust information systems that not only allow for seamless data collection and high data integrity, but honor the privacy of the

family. Without this infrastructure, an EHDI Program is unable to measure its impact or make targeted improvements.

1. EHDI is a Point-of-Care Screen: Success requires flexibility for integration with existing workflows for both hospitals, birth centers, and midwives.
2. Child level data for quality improvement
 - a. Aggregate data do not easily provide a path to improvement
 - b. Real-time record of births provides a more accurate denominator and allows follow-up of infants not screened.
3. Electronic data captured directly from screening devices
 - a. Allow implementation of an algorithm to eliminate over-screening:
 - b. Reduce false negatives and enhance quality
 - c. Improve accuracy in results reporting
 - d. Provide real time access to results
 - d. Automation decreases staff time;
3. Allows staff to focus on babies needing follow-up, due to Refer or missed screens.
4. Continuum of Care in one Baby-centric Hearing Health Record with screening, rescreening, diagnostic audiology, and intervention outcomes
 - a. Facilitate communication from birth facility screeners to audiologists to early intervention.
 - b. State EHDI programs focus on intra-agency and inter-state partnerships
5. Integrated State EHDI, Critical Congenital Heart Disease, and Newborn Bloodspot Screening programs: A good idea worth the added complexity.
 - a. Decreases duplication of effort by programs
 - b. Provides a comprehensive screening baby record
 - c. Birthing Facilities are more willing to use one system for all screening than use separate systems.
 - d. Different state staff involved in screening programs – logistics can be complicated
6. Electronic data systems: standards-based messaging reduces errors and enhances timeliness in reporting
 - a. Data element definition - essential for communication and for data reuse
 - b. Customized clinical decision support for real-time access to best practices
 - c. Analytics to show health care providers how they are performing
7. Capturing Consent: Different for different types of screening
 - a. State EHDI Programs,
 - b. Birthing facilities and other health care providers
 - c. Anchored to family needs
 - d. Capture consent electronically at different points of care (i.e., audiology)
8. Diverse populations and unique geography require creative thinking
 - a. Partnerships are vital – Collaboration with tribal health efforts to reduce lost to follow-up; local public health; tele-diagnostics to reach remote communities
 - b. Outreach to midwives increases screens outside the hospital
9. Relationships are important
 - a. Legislation helps; sometimes it is vital
 - b. Family and Provider Relationships are an important part of the solution
 - c. Be persistent

This presentation will be about hearing multiple divergent views from large and small jurisdictions on refining and delivering best EHDI practices to ensure innovation, quality, safety and value.

DEVELOPMENT OF A NATIONAL QUALITY ASSURANCE PROCESS FOR NEONATAL DIAGNOSTIC HEARING ASSESSMENTS IN IRELAND

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HSE ~ Dublin ~ Ireland

Introduction Universal Newborn Hearing Screening (UNHS) was rolled out to each of the maternity units on a phased basis in Ireland in 2011 becoming a National programme in November 2013. Babies who fail the initial hearing screen are referred to one of 9 Diagnostic Audiology Centres (DAC's) where further audiological assessment of the babies' hearing is undertaken, primarily using the Auditory Brainstem Response (ABR) test to determine whether a hearing impairment is present.

The ABR is a physiological and objective assessment; however it requires not only the correct methodology and clinical protocols being implemented but also the subjective interpretation/analysis of recorded waveforms. Further, the correct application of age / frequency and transducer specific correction factors to provide estimated hearing levels are required to ensure correct diagnosis.

To ensure maintenance of consistent and high quality ABR assessment of Newborn hearing screen

referrals, in compliance with the internationally recognised UK NHSP guidelines -5 the HSE tendered for an ABR Peer Review Information Technology System (ABRPRITS) to facilitate the introduction of a national peer review process in a systematic way. The System for Online ABR peer review (SONAR) was contracted by HSE in 2016 for this purpose.

This paper will outline the processes, issues and key benefits afforded by establishing a robust IT system which we consider essential for on-going efficient clinical audit, risk management and quality assurance.

1Guidance for Auditory Brainstem Response testing in babies, Version 2.1. (2013)

2Guidelines for the early audiological assessment and management of babies referred from the Newborn Hearing Screening Programme, Version 3.1. (2013).

4Updates to NHSP guidance for post-screening diagnostic testing, Update 1: BSA Electrophysiology Special Interest Group (BSA EP SIG).(2015)

5Newborn hearing screening and assessment – Guidelines for Cochlear Microphonic Testing, Version 2.0 Guy Lightfoot, John Stevens, Graham Sutton , Chris Brockbank and Steve Mason. (2011)

PYTHON, DATA ANALYSIS AND DATA VISUALIZATION FOR NEONATAL HEARING SCREENING

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Background: Most testing devices used for neonatal hearing screening create logs that contain information about each test performed by the device. By saving and downloading these test logs, it is possible to create a valuable database that can be used to evaluate the hearing screening program. The purpose of this study was to explore our machine-created test-logs database, using advanced tools for data analysis and data visualization.

Methods: The study cohort included all infants born in Tel Aviv Medical Center between 1 Jan 2016 – 31 June 2017 (18 months). All tests performed in infants born during the study period were included. All the tests were performed using Otoport Screener or Otoport OAE+ABR devices (Otodynamics). The database included 36,015 TEOAE (transient evoked otoacoustic emission) tests and 2,021 A-ABR (automated auditory brainstem response) tests. These data were analyzed using MS Access database management system (Microsoft) and were visualized using Python programming language.

Results: The analysis of the test log data provided a detailed profile of our hearing screening program. We will introduce the main findings, including the “refer” rate for each of the tests (for initial and repeated tests), test duration, test parameters distribution, and correlating factors. Further data analysis will address more complex issues such as noise management strategies and the optimal conceptional age for testing NICU (neonatal intensive care unit) infants.

Conclusions: Data analysis and data visualization of machine-created test log data are useful tools for understanding the main features of the neonatal hearing screening program and for improving test procedures.

GENDER DIFFERENCES IN CAREGIVER-CHILD COMMUNICATION MEASURED WITH THE LENA TECHNOLOGY - A PILOT STUDY

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Objectives: Infants and toddlers learn language in interaction with caregivers. The current study is part of a research program called “Words make a difference” which aims to explore the links between environmental factors and young children’s listening, socio-emotional and spoken language acquisition, and to validate the LENA method in different linguistic contexts. Our pre-validation studies have shown a moderate agreement between human transcripts and Swedish LENA audio samples for adult word counts and somewhat lower for child vocalisations (Nilsson & Olsson, 2015; Jonsson & Pettersson, 2017).

Gender equality is in many ways established in Sweden. However, it is not well understood how this situation affects language use and communication with young children. The aim of the pilot study was to

investigate possible gender differences in early audio-verbal communication between Swedish children with hearing impairment (HI) and their caregivers, measured with LENA, and compared to results of age-matched controls with Normal Hearing (NH). Another aim was to examine the children's screen time (TV, Ipad) during all-day recordings, and investigate its possible influence on audio-verbal communication (number of conversational turns, child vocalisations and adult words).

Method: Forty children (24 girls and 16 boys), aged 2-48 months, and with different hearing status participated in the study. Twelve of the children had NH and 28 children had some degree of hearing loss with early onset and used hearing aids and/or cochlear implants. Language Environmental Analysis (LENA) was used for all-day recordings in the children's home environment, with a mean recording time of 12 hours (7.33-15.53). Human transcripts of 15-minute samples from the LENA recordings from controls with NH were performed and results were compared to the automatic results, for validation reasons.

Results: A paired sample t-test showed that women (N=40) provided statistically significant more numbers of adult words per hour (987) in the presence of the key child, in comparison to numbers of words spoken by men (N=40) per hour (403), regardless of the child's hearing condition, $t(6.53)$, $df=39$, $p<.001$. The percentage of screen time during the all-day recordings was low for the vast majority of the Swedish cohort (N=40), with an average of 4 % of the total recording time. No statistical significant correlation was found for amount of screen time and number of adult words, child vocalisations or conversational turns.

Conclusion: Despite an expected gender equality between parents in Sweden, the early audio-verbal communication behaviour between young children and their caregivers revealed significant gender differences in the study cohort. Women were the ones who used the highest number of spoken words in the presence of the key child, compared to male caregivers. Percentage of screen time was more limited for Swedish children in this study compared to previous results in the literature. Emphasis should be made to encourage involvement of male caregivers in early language stimulation and habilitation of young children.

LECTURE

EARLY INTERVENTION - ETHICAL CONSIDERATIONS IN A MULTICULTURAL ENVIRONMENT

Monika Lehnhardt-Gorjany*

Lehnhardt Stiftung ~ Badenweiler ~ Germany

Professionals agree „the earlier the better“.

Neonatal hearing screening helps us to identify a potential hearing loss already a few days after birth. Early diagnostics has become possible due to advanced technology and babies can be fitted with bilateral hearing aids at the age of six months only. In case hearing aids do not help cochlear implant is the only way to provide access to hearing for the child.

It seems to be a simple and straight forward process.

But, what if ?

- the parents do not want their child to be subject to a hearing screening?
Is it morally acceptable to make NHS obligatory / mandatory?
- the neonatal screening is not done professionally – there are too many false positive / negative
how can we assure high level quality (technology, training)?
- the loss to follow-up rate is high
how can we achieve that parents understand the results of NHS and present for in-depth diagnostics
- the parents have not accepted the results of the medical and audiological investigations
how can we counsel and provide psychological support ?
- the hearing loss is not severe enough to justify a cochlear implantation
is there a global understanding about the audiological criteria for or against CI?
- the child has other serious handicaps
who decides whether a cochlear implantation is indicated?
do professionals have different approaches and different recommendations?
- the social environment is not „satisfactory“
is this a contra-indication and what are the consequences?
- funding is not available to pay for cochlear implantation
what are the options (try fund raising, learn sign language and send the child to a school for the deaf)?
- the surgeon performs a small number of CI p.a.
should there be a regulation according to which only surgeons, who perform a certain minimum number of C.I. annually will be „certified“, i.e. paid by Krankenkassen /governmental institutions?
- various manufacturers offer various models of implants and speech processors
who makes the choice – professionals or / together with / parents?
what are the criteria for making the choice?
- the child has two deaf ears
do we advocate bilateral / binaural CI or CI + HA?
should we „preserve“ the other ear for future technology?
- the family lives in a region where infrastructure is poor – lack of technical support
can CI still be „successful“?
how to reach CI recipients in remote places? (e.g. Telepractice)
- lack of professionals to provide (re)habilitation locally
is it still promising to provide CI?
experience in providing counselling of parents and (re)habilitation sessions Online
- (re)habilitation is offered by various more or less qualified professionals
should there be a quality control (TÜV) for (re)habilitation institutes / individual therapists?

SCREENING: PRE-SCHOOL, SCHOOL AGE

EVALUATION OF THE PAEDIATRIC AUDIOLOGY PATHWAY ALIGNMENT (PAPA) TRIAGE FOR PAEDIATRIC AUDIOLOGY REFERRALS IN IRELAND

Gary Norman*^[1], Mark Fenton^[2], Adrian Davis^[3], Mark Haggard^[4]

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Introduction There were 5918 children waitlisted nationally in Ireland for hearing assessment and management with Health Services Executive (HSE) audiology services in March 2016. Data from the HSE Business Information Unit (Primary Care) indicated 20% of children were waiting in excess of 12 months for assessment. The primary reasons for this related to the inability to recruit and retain paediatric audiologists and over referral of cases for diagnostic assessments. Records show that typically the audiology service discharged 70-80% (in common with most other services of this kind in Europe).

It is well established that hearing loss in children needs to be identified and managed as early as possible in order to ensure appropriate development of their speech, language, educational and social development, which can have lifelong consequences for the child and family.

The HSE Integrated Audiology Programme explored alternative options to provide an innovative, efficient and effective triage service to reduce waiting times for assessing children and place them on an appropriate audiology care pathway, termed paediatric audiology pathway alignment (PAPA), provided by an external provider (Northgate Public Services).

A proof of concept (POC) was conducted to evaluate the clinical appropriateness and viability of PAPA as a triage model; this was overseen by Senior Paediatric Audiologists from the HSE and piloted in Dublin.

Method A proof of concept, was implemented to determine the viability of PAPA. Standard objective audiometric techniques (transient otoacoustic emissions +/- tympanometry) and a validated questionnaire (Milovanovic et al 2016) was used to determine if a child had:

- A high probability of satisfactory hearing.
- A likely temporary middle ear disorder, requiring ENT management.
- High probability of a permanent hearing disorder of a level likely to impact upon speech and language development (> 35 dBHL).

Clients were sequentially taken from routine HSE paediatric audiology referrals on waiting list, split by under and over 4 years of age.

A randomised balanced design was implemented with 50% having either objective or behavioural assessment first.

All assessments were performed by qualified paediatric audiologists, with clinicians blinded to the outcome of the objective / behavioural assessment.

Results 594 Children were offered a hearing assessment with an attendance rate of 80% (N=476).

The PAPA approach was well tolerated with 89.9% (N=423) tolerating objective assessment.

15 children were identified with a PCHI and all were identified using the PAPA.

No child presenting with a mild or unilateral loss was missed by the triage.

Conclusions PAPA provides an effective mechanism to screen children waiting for a hearing assessment and allocates them to an appropriate pathway with the potential to fast track their service needs.

References:

Jovica Milovanovic, Snezana A. Filipovic, Paola Marchisio, Mark P. Haggard, Mary F. Zhang, Helen Spencer, Eurotitis-2 Study Group. 2016. Precision-scored parental report questions and HL-scaled tympanometry as informative measures of hearing in otitis media 1: Large-sample evidence on determinants and complementarity to pure-tone audiometry. International Journal of Pediatric Otorhinolaryngology. 83:11

VALIDATION OF A SOUND-IN-NOISE PERCEPTION TEST FOR HEARING SCREENING

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Hearing screening at school age, e.g. at school entry, is important to prevent the negative consequences of hearing problems. In Flanders, we aim to use supra-threshold tests because of their superior reliability and relevance compared to pure tone screenings. In older children (5th grade elementary and 3rd grade secondary school children), a speech-in-noise test based on the digit triplet test (DTT) is successfully used. Also, in adults the DTT can be regarded as a prototype speech-in-noise screening test. Unfortunately, this test has limited feasibility in younger children, as reflected by long test durations, lower test-retest reliability and attentional confounds. Moreover not all children know the written representation of the digits used, limiting the potential for self-testing.

A language-independent sound-in-noise test with easily recognizable pictures was developed: the sound ear check (SEC). In this test, 8 sounds are randomly presented in a sound-weighted masker via tablet, using a 2-up 1-down adaptive procedure. The study presented in the present paper aimed to obtain reference values for the test across the (adult) lifespan, and evaluate the relation with the pure tone average (PTA) and speech reception thresholds (SRT) obtained with the DTT. The performance of both the DTT and SEC to accurately classify participants as being normal hearing (NH) or hearing impaired (HI), based on the audiogram, will be compared when more data are available (data collection is still ongoing). Furthermore, the feasibility of the SEC for school-entry hearing screening in children aged 5-6 years old will be investigated. The study protocol and results will be presented at the conference.

At the time of abstract submission, 60 adult participants were already tested of whom 18 NH (age range: 26-69 years old) and 42 HI (age range: 22-75 years old) with a sensorineural hearing loss of varying degrees. Following routine clinical pure tone audiometry, the SEC and DTT were monaurally assessed in a test-retest design. Test order was counterbalanced randomized. For the SEC, the reference sound reception threshold for NH adults was -11.6 ± 0.6 dB, and could be determined with a test-retest reliability of 0.7 dB. No significant effects of age were found in this small sample. Test duration, including training, was on average 2 min 26 sec \pm 17 sec for one ear, compared to almost 4 minutes for the DTT. Significant correlations between the sound reception threshold and the PTA_{0.5-4kHz} ($r = 0.75$) and DTT-SRT ($r = 0.84$) were found. For the DTT, normative values and test-retest reliability estimates were in agreement with previous research, as well as the high correlation of the DTT-SRT with the PTA_{0.5-4kHz} ($r = 0.88$).

Should this test discriminate reliably between NH and HI persons, and be feasible in young children, it might be a useful common reference across many countries and allow efficient prevalence estimates of (childhood) hearing impairment based on a large dataset by hearing screening via mobile devices (apps) or the internet. Indeed, its language independence paves ways for international comparisons and/or collaborations.

THE PIRATES GAME: DIGITS-IN-NOISE HEARING SCREENING FOR YOUNG CHILDREN

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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.

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

HEAL 2018

Hearing Across the Lifespan

reliability are compared for the two screening methods, as well as perceived effort and sustained attention. Preliminary results confirm that this game-based screening enhances the children's sustained attention and motivation and thereby provides results that are more reliable.

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IS SCHOOL SCREENING STILL RELEVANT?

Christopher Fazakerley*

Christopher Fazakerley ~ Buckingham ~ United Kingdom

In the UK where we have a successful Newborn hearing screening programme, can we really justify our reasons for pre-school or primary school screening?

The vast majority of local populations are born and live in the UK up to the age of 18. However, access to school hearing screening depends entirely on your post code. Even living in more transient cities like London & Birmingham won't guarantee you have access to hearing healthcare at school.

In this talk we will look at:

How is school screening done in the UK at present?

What evidence based outcomes do we have to refer to?

Is there an optimum age to screen hearing after birth?

Does removing the service altogether have any safeguarding risks?

HEARING SCREENING PROGRAM AMONG SCHOOL-AGE CHILDREN IN EASTERN POLAND

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Background Hearing screening is significant component of secondary prevention. Many countries, including Poland have implemented newborn hearing screening. In spite of that, there is a significant number of children with hearing disorders. IFPS (the Institute Physiology and Pathology of Hearing) in collaboration with KRUS (Polish Agricultural Social Insurance Fund) developed and implemented the program of hearing screening in schoolchildren. The screening program is dedicated to children from primary schools living in rural areas. The choice of such a target group was because of the need to equalize the chances of access to medical care for children with villages and areas poorly urbanized. In addition, goal of the program is the early detection of hearing disorders, especially in children who start school. It allows to early detection of hearing disorders, thus enabling an early start of treatment and eliminating or minimizing the negative consequences associated with this type of dysfunction. Children with hearing impairments often experience delayed speech development and cognitive abilities, which can result in learning disabilities and reduce school progress. Moreover, during hearing screening specialist from IFPS increase the awareness of parents and the school environment about hearing problems.

Material and Methods Program of hearing screening was implemented in eastern Poland in 8 voivodships. Number of children included in the program was 67.689 from grades 1 to 6 in aged from 6 to 13 years. The most numerous group were children from the first classes over 80% of all pupils examined. Each child was assessed by pure tone audiometry. Examination was performed using the Platform of Sensory Organs Examinations. In addition, all parents or legal caregivers were asked to filled questionnaire. This tool including question concerning data on the potential causes of the child's hearing problems, medical history, possible presence of tinnitus, and any presence of learning difficulties.

Results Analysis of the obtained results of hearing screening showed that the positive result of the audiogram (audiometry in at least one frequency <20 dB HL) was found around 18% of the surveyed population. It was observed that among all the examined children, 64.5% of the detected hearing loss were one-sided hearing loss.

Results of questionnaires demonstrated low awareness of parents/caregivers of their child's hearing impairments – 73% did not notice any problems. Tinnitus has been observed that 12.8% of examined children from all classes experience tinnitus. It is worth noting that 31.3% of children who experience

tinnitus very often and often, and 26.1% of students who rarely experience tinnitus had a positive result of hearing screening.

Conclusion The obtained results confirm that in developing countries awareness about hearing disorders is low. Many school-age children have hearing loss, but often are not they are perceived by caregivers and teachers. Meanwhile even small hearing losses can cause difficulties communication, emotional or educational. Because early detection of hearing disorders is important. The screening programs allow to quickly select patients with hearing loss and at risk group and as soon as possible implement appropriate treatment and rehabilitation. That action improve the quality of life of patients and their families.

E-HEALTH (3)

COGNITIVE COMPUTING FOR THE DIGITAL MANAGEMENT OF CLINICAL DATA OF THE AGED COCHLEAR IMPLANT PATIENT

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Cognitive computing is applied for the meaningful use of unstructured and non-formatted clinical data generated during the visits of aged cochlear implants (CI) patients. The proposed system automatically 'understands' the meaning of narrative medical text in the medical reports of the patient folder and transforms unstructured information into a structured one that can be further used in a repository of diseases and can be processed by computers for clinical decision support. The results obtained using the proposed system on the real medical records longitudinally collected during the clinical practice will be discussed. The processed documents were derived from 52 CI patients, from the first enrollment visit to the last available follow-up. The system allowed to extract and organize into a structured format the patient's medical history and risk factors, the test results from medical examinations, the patient's communicative performances before and after CI implantation, and CI settings.

THE RISE OF SOCIAL MEDIA AS AN INTERVENTION TOOL

Rebecca Claridge, Diana Zegg*, Nicholas Kroll

MED-EL ~ Innsbruck ~ Austria

Participants will be introduced to the data generated from a research case study into the take up of three different intervention tools presented through varying social media forums. The data supports the claim that interest in obtaining information and intervention assistance through this medium is increasing. Participants will then receive instruction on the most popular of the free MED-EL intervention tools available through social media; The MED-EL Lesson Kits. Participants will learn how to access the resources, who is the target audience and how to use the materials. In addition, they will identify the learning domains covered in each lesson plan, the goals established and key strategies suggested and described for therapists to follow to improve the child's outcomes. Participants will recognise the potential of the lesson kits to provide experienced therapists with quality resources to minimise lesson preparation in addition to offering therapists new to the field of Listening and Spoken Language with a comprehensive instructional resource.

CLIMBING UP THE HEARING REHABILITATION LADDER USING NEW ONLINE TECHNIQUES – A RANDOMIZED CONTROLLED TRIAL

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Objective: Online hearing screening has been suggested to increase help-seeking rates, and be a promising way of reaching many people at a low cost. Although increased help-seeking rates have been observed, previous studies have reported mixed findings on the long-term effects on hearing aid uptake, and successful rehabilitation. Adding additional support and interventions that aim to increase motivation could potentially benefit an online hearing screening. Previous studies have focused on self-administered online hearing screening programs, but little is known how contact with a clinician during the screening phase impacts the results. This randomised controlled trial (RCT) aims to: (1) implement and evaluate an online hearing screening with extended components to increase motivation and knowledge about communication strategies, and (2) evaluate effect of additional clinician contact.

Method: Participants will be recruited through an online hearing screening, including a Swedish version of the triple-digit-test and measures of self-reported hearing difficulties. Recruitment starts in spring 2018. Adults who fail the triple-digit-test, have Swedish as first language, and who had never undergone a hearing aid fitting are eligible. Participants will be randomized using a 2×2×2 factorial design: (1) Feedback following the online hearing screening (with or without clinician support), (2) Motivation support, based on Motivational Interviewing (with or without clinician support), and (3) A five week intervention course on communication strategies, based on Active Communication Education (with or without clinician support). Primary outcomes are help-seeking, hearing aid uptake, and successful rehabilitation at 6 and 12 months after the intervention. Secondary outcomes are measures of self-reported hearing difficulties, anxiety, depression, and quality of life. All measures will be collected during the screening, after intervention, and at the 6- and 12-month follow-up.

Results/conclusion: Findings may shed light on what kind of additional support that is most likely to optimise an online hearing screening.

'OTOCALC': OTOTOXICITY GRADING SCALE AND MOBILE APPLICATION FOR PATIENTS WITH DRUG-RESISTANT TUBERCULOSIS

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Individuals respond differently to medication as a result of their genetic inheritance. These differences can result in the under- or over-dosing of medication, which may affect the efficacy, or in the case of aminoglycosides and polypeptides used in the treatment of tuberculosis (TB), result in ototoxicity. In South Africa, administration of the standardised Drug-Resistant Tuberculosis (DR-TB) medication regimen is simplified across four weight bands. These bands accommodate the formulations available in the country while complying with international requirements for minimum, maximum and average dose per kilogram. When ototoxicity is detected, dosages should be adjusted by the physician to minimise further ototoxicity and hearing loss. There is however no standardised grading system and user-friendly method to interpret hearing test results, calculate significant hearing loss and provide recommendations with regards to dosage adjustments and management.

To address this issue, a user-friendly ototoxicity calculator, 'OtoCalc', was developed specifically for the DR-TB population. The purpose of this mobile application is to: i) assist health professionals in assessing patients for ototoxicity; ii) establish the clinical significance of ototoxicity, by calculating the grade of hearing loss; iii) monitor the progression of hearing loss; and iv) enable systematic referral and management of patients according to their needs.

This research project created the first ever prototype of an ototoxicity grading system specifically, namely 'OtoCalc', for patients with DR-TB within a mobile application, designed for use by doctors, nurses as well as audiologists.

This presentation will provide an overview of development of 'OtoCalc' and its clinical use. It will further report on the sensitivity of 'OtoCalc' in comparison to existing ototoxicity grading systems.

SPECIAL SESSION ON ECoChG

ELECTROCOCHLEOGRAPHY: NEW APPLICATIONS FOR AN OLD TECHNIQUE

John Ferraro*^[1], Paul Kileny^[2]

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For over 3 decades, Electrocochleography (ECoChG) has been used as a clinical tool, primarily in the diagnosis, assessment and management of Meniere's disease (MD)/endolymphatic hydrops (ELH). While this particular application continues to be a primary one for ECoChG, several others have emerged over the years, including the assessment of "hidden hearing loss," diagnosis of auditory neuropathy, intraoperative monitoring during cochlear implant surgery, etc.

More recently, research in our respective laboratories has shown that ECoChG may possibly be useful in the prediction of MD/ELH in the offspring/siblings of individuals with a confirmed diagnosis, and also in the diagnosis of superior semicircular canal dehiscence (SCCD). This presentation will focus on new/emerging uses for ECoChG with emphasis on these latter two applications. J. Ferraro will report on a study from his laboratory that revealed a much higher incidence of positive electrocochleograms in asymptomatic offspring/siblings of patients with confirmed MD than in the general population. P. Kileny will present his research on the use of TM ECoChG in the diagnosis of SCCD. Both authors also will discuss the continued importance of ECoChG as a clinical tool in hearing health care, and the need to develop more standardized guidelines for recording, measuring and interpreting the electrocochleogram.

DEVELOPMENT IN TESTING (1)

NORMATIVE DATA FOR TM ELECTROCOCHLEOGRAPHY IN NORMAL HEARING SUBJECTS

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^[1]University of Sao Paulo ~ Sao Paulo ~ Brazil, ^[2]University of Kansas Medical Center ~ Kansas City ~ United States of America

Objective: Establish normative data for tympanic electrocochleography (TM ECoChG) parameters in normal hearing adults without Meniere's disease's (MD) symptoms. Describe TM ECoChG variables that help to distinguish normal from MD ears.

Material and methods: We enrolled 100 subjects (N ¼ 200 ears), 59 females, aged between 19 and 71 years from 09/2010 to 04/2014. Inclusion criteria: normal otomicroscopy, hearing thresholds 25 dB nHL from 250 to 4000 Hz, normal tympanogram, no symptoms of MD according to the AAO-HNS 1995 criteria and Gibson's score <7. We excluded subjects with dizziness, aural fullness or other symptoms of endolymphatic hydrops. The following parameters were analyzed: SP/AP amplitude ratio, SP/AP area ratio and the difference between AP latency with rarefaction and condensation stimuli.

Results: There was no significant difference between right and left ears (Intraclass correlation coefficient < 0.6). SP/AP amplitude ratio varied between 0.084 and 0.356 and SP/AP area ratio between 0.837 and 1.671 (percentiles 5 and 95). The AP latency difference to rarefaction and condensation clicks was between 0.0 and 0.333 ms.

Conclusion: Normative data for TM ECoChG parameters were established in 100 normal hearing subjects without MD. These data can be used to distinguish normal from pathological findings and in follow-up of MD patients.

THE SIMULTANEOUS REGISTRATION OF SEVERAL FREQUENCY-SPECIFIC AUDITORY BRAIN-STEM RESPONSES USING OVERLAPPED MAXIMUM LENGTH SEQUENCES

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The method for the simultaneous registration of several frequency-specific ABRs (Auditory Brain-stem Responses) was developed and optimized. For stimuli presentation we used MLS (Maximum Length Sequences) technique. In contrast with the early reported approaches to MLS stimulation the relatively large minimal inter-stimulus interval of 8 msec was used. Five sequences of different narrow band stimuli were combined together with the appropriate time shifts. These time shifts were chosen for the optimal separation on the recovered epoch not only of all five responses but also of the main MLS artifacts produced by stimulus interaction.

Central frequencies of stimuli were 0.5, 1, 2, 4 and 8 kHz, the band width of each stimulus was just one octave. The symmetrical stimulus shapes were calculated by filtering of the narrow click by a zero-phase pass-band filter. Narrow band chirp stimuli also were tested. It was found that despite the slightly better performance near the threshold the chirp stimulation could produce unpredictable latency jumps on higher levels, which was strongly undesirable for the further potential stacking.

For optimization of sequence positions in the whole mix the mutual masking of stimuli in most pairs of sequences as a function of time shift between them was studied. It was shown that the stimuli separated by at least one octave can be placed with small time interval about 1 – 2 msec without producing a significant MLS artifact.

The method was tested on 7 adult volunteers. The stimulation mixes were calculated by computer, were uploaded to Tucher & Davis System 3 signal processor and were produced by EARTone 3A earphones. The responses were collected by Medusa biological preamplifier of System 3 and were processed off-line.

It was shown that the proposed technique could provide the simultaneous registration of five ABRs during

the time comparable with the time needed for a conventional registration down to the same background noise of a single ABR on a click stimulus. These ABRs could be used separately for estimation of the hearing threshold level or together for composing the stacked potential. This stacked potential could be used for fast preliminary searching of threshold.

A COMPARISON OF ELECTRICALLY EVOKED AUDITORY BRAINSTEM RESPONSES AND NEURAL RESPONSE IMAGING SIMULTANEOUS RECORDINGS IN COCHLEAR IMPLANT USERS

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Aim: To investigate the correlation between results obtained in EABRs (electrically evoked auditory brainstem responses) registration and Express-NRI ECAPs (electrically evoked compound action potentials) simultaneous registration.

Material and Methods: 22 patients with AB (Advanced Bionics, USA) cochlear implants were included in the study. ECAPs and EABRs were parameterized with Growth AP (action potentials) on target electrodes 3, 7, 11 and 15. Corresponding stimulation generated simultaneously an ECAP and EABR (Van-den-Abbeele et al., 2014). Spread-of-excitation (SoE) with variable maskers were measured at an attenuation of 60 % to characterize neural stimulation pattern delivered by a particular electrode contact. Electrode contact integrity was controlled by impedances that were systematically measured at each session.

Results. The single session of objective measurements were conducted on a mixture of pediatric and adult patients post-operatively. For each target electrode contact, correlation between EABR, ECAP threshold and behavioral dynamic range between T and M-threshold was investigated. Channel interaction was assessed by SoE. Combination of these objective measures resulted in an overall estimate of electrode-to-nerve interface quality and the ability of each contact to deliver focused stimulation. Relevance of these measures as a tool for objective prediction of CI programming parameters was then evaluated by comparison to speech intelligibility scores (in adults) and speech therapist's reports (in children).

Conclusions: The simultaneous registration of electrically evoked responses of auditory nerve and brainstem provides information on the functional ability of structures of the auditory pathway which in case of ECAPs absence and positive EABRs could be used for the speech processor programming.

In a follow-up stage, recommendations for programming will be based on objective measures gathered with the Volta™ objective measures software. The assessment of post-implant performance progress will be investigated after 12 months of cochlear implant use.

DEVELOPMENT IN TESTING (2)

CHARACTERISATION AND PREDICTION OF HEARING LOSS TYPE IN INFANTS USING A TYPICAL TOAE STIMULUS PARAMETERS

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Background Since its first introduction in Audiological clinical practice, the routine measurement of Oto Acoustic Emissions (OAE) has become standard clinical practice world wide. A characteristic has been identified using the Otodynamics OAE Diagnostic Systems (eg Echoport) that gives a clear indication of, whether the hearing loss is likely to be related primarily to a middle ear or sensory neural disorder, however this cannot rule out a mixed loss, as the primary indicators, the stimulus shape and spectrum relates directly to the presence or absence of ME fluid

The morphology of the TOAE stimulus is rarely noted in clinical settings, rather the focus is upon establishing a response based upon the signal to noise ratio of the emission to characterise presence or absence. The stimulus morphology produced by neonates is different to that in older children and adults. Typically, the stimulus displayed for a click is monophasic in older children and adults and is 1 cycle (V-shaped) and occurs within one millisecond in the display window. In contrast, in neonates with normal middle ear function, the stimulus is typically biphasic, and is a 2 cycles /mS (W-shaped) response. In the presence of middle ear effusion, this becomes monophasic.

Additionally, examining the stimulus spectrum gives further information, in normal and PCHI ears the stimulus spectrum is broadband and has significant energy above 4 kHz whilst in ears with "glue ear" there is a significant drop in stimulus energy above 2 kHz.

Peak absorbance in neonates occurs at approximately 2 kHz and this is the same frequency as the "W" shaped stimulus spectrum observed in normal middle ears.

Method Retrospective data from a chart review of 45 recent UNHS diagnostic cases 15 (sensory neural), 15 (primary conductive pathology) and 15 (discharge) will compare the morphology of the TOAE and outcomes arising from the diagnostic assessments to outline the relationship and potential for predicting category of hearing loss.

Conclusion We believe that the morphology differences arising in the stimulus and stimulus spectrum are due to differences in middle ear function and hypothesise that the loss of the "W" shape is due to additional mass loading when there is middle ear fluid present.

The incidence of "W" shaped stimulus morphology when OAE is absent, has been found to be highly correlated with later diagnosis of sensory neural hearing loss.

TOWARDS UNDERSTANDING HUMAN COCHLEAR TUNING USING OTOACOUSTIC EMISSIONS

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Sharp cochlear tuning is essential for processing complex signals such as human speech. Previous reports suggest that tuning may be broader in some individuals who, despite having normal audiometric thresholds, show deficits in speech perception in noise (Badri et al, 2011). A quick and objective assay of cochlear tuning may be obtained using otoacoustic emissions (OAEs). Specifically, we describe a method for extracting tuning estimates (Qerb) from distortion product (DP)OAEs using a fixed-f2 paradigm at f2 frequencies up to 16 kHz. Frequency and level effects on Qerb were examined. OAE-based tuning estimates were compared with behavioral tuning estimates. Lastly, experimental data were compared with previously published linear and nonlinear cochlear models (Zweig, 1991; Sisto et al, 2015). Our

findings demonstrate that Qerb increased as a function of frequency and decreased as a function of stimulus levels. Additionally, there was a good match between experimental data and model predictions. However, OAE-based Qerb generally under-estimated behavioral frequency tuning. We conclude that the frequency- and level-dependence of Qerb from OAEs are consistent with the mechanical tuning properties of the cochlea. Thus, OAE-based tuning metrics may be useful for providing a faster and more objective window into cochlear processing before decrements are detected using conventional methods such as pure tone audiometry.

AUDITORY BRAINSTEM RESPONSE AUDIOMETRY IN YOUNG CHILDREN: TRIALS, TRIBULATIONS AND OPPORTUNITIES

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Leiden University Medical Center ~ Leiden ~ Netherlands

Objectives:

- a) Gain insight into current practice with Auditory Brainstem Response (ABR) audiometry in children in the Netherlands
- b) Compare usability of conventional ABR and the Vivosonic Integrity™ ABR device in achieving conclusive ABR results in children up to six years of age.

Methods

Study sample:

- a) All 30 Speech and Hearing Centers (SHC) in the Netherlands participated, with each completing a questionnaire on ABR testing of infants and young children in their center.
- b) Experience using the conventional and Vivosonic Integrity™ was compared in a cohort of 55 children up to the age of six years who attended the SHC in the Leiden University Medical Center (LUMC).

Design:

- a) A standardized questionnaire on current practice and experience with ABR testing of infants and young children in the year 2013 was completed during a telephone interview with audiologists from all SHCs in the Netherlands.
- b) Infants and children up to 6 years of age were tested with either the conventional ABR or the Vivosonic Integrity™ at the LUMC SHC. The test outcomes and the audiologist's experiences with the two devices were compared.

Results:

- a) ABR audiometry was performed in 26 SHCs in children under six years. An estimated 2317 ABR tests were performed in 2013, of which 1443 (62%) were in infants up to six months old. ABR audiometry was performed during natural sleep in > 97% of infants up to one year. Between 13 - 48 months, ABR was performed during natural sleep in many children, but was performed under general anesthesia in a strikingly large number of children. In SHCs attached to University Medical Centers this was the case in 57% of children between 13-24 months and 48% between 25-48 months and in SHCs in non-university medical centers in 12% and 19% respectively. This is probably due to children who are difficult to test being referred to university centers for general anesthesia, often in combination with other concurrent indications, e.g. neuroimaging. Occasionally a movie was shown as distraction. Sedation was not used. ABR audiometry led to a conclusive result in most SHCs in 80 - 95% of children. However this was often extremely time consuming. Audiologists expressed a wish to be able to carry out successful ABR testing in older children and children who are awake.
- b) In one center experience with the conventional ABR (n = 26) and Vivosonic Integrity™ (n = 29) was noted and compared. Both methods resulted in similar proportions of conclusive results in infants aged up to six months. In children older than one year the Vivosonic ABR device performed well and produced conclusive results for both ears in 10 of 14 tests. These are the children who are known to be difficult to test. The audiologist was satisfied more often with the Vivosonic Integrity™ (80%) than the conventional ABR device (58%).

Conclusions:

In children up to six months of age ABR audiometry in the Netherlands was performed in all cases during natural sleep and produced conclusive results. While general anesthesia was often used for conventional ABR in children over one year, the Vivosonic Integrity™ provided conclusive results in the majority of this age group. This eliminated the need for general anesthesia and a high degree of satisfaction was reported by the audiologist.

BONE CONDUCTION HEARING DEVICE FITTING PRACTICES IN PAEDIATRICS:

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For children who are not candidates for air conduction hearing aids, bone conduction hearing devices are available. Unfortunately, fitting protocols are not well developed for these devices. This is challenging for pediatric audiologists who rely on objective measures of hearing devices to support their patient's communication development. Bone conduction hearing devices and candidacy considerations for the pediatric population will be reviewed. Findings from a clinical survey will be offered to inform the current practices for fitting these devices in children.

AN EXTERNAL STRUCTURED PEER REVIEW SYSTEM FOR DIAGNOSTIC ABR TESTS ON NEWBORNS - THE FIRST 6 YEARS.

Inga Ferm*

Croydon Health Services NHS Trust ~ Croydon ~ United Kingdom

The external structured peer review (PR) of diagnostic ABR tests on newborns is an important component of clinical governance and quality assurance for this group.

In 2011, a structured, yet fairly simple, ABR PR system was established in South London using trained and accredited reviewers. It is carried out in a straightforward, effective way and has been accepted as routine practise by those carrying out the ABRs and was adopted by the English Newborn Hearing Screening Programme as their generic PR model. The system is managed by a co-ordinator and the system receives support from an external expert reviewer, who also provides the training, accreditation and moderation of the reviewers.

By the end of the 6th year 3898 reviews had been completed, each with an average turnaround time of 4 days (measured from date the test was completed to the date the review was returned).

A significant ($p < 0.0001$) improvement in the quality of the ABR testing was seen in the first two years. Further improvements have been seen in subsequent years.

This presentation will outline the PR process, the results and will include a discussion of the additional benefits seen since this system was introduced.

ADAPTING QUESTIONNAIRES FOR DIFFERENT LANGUAGES AND CULTURES

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Despite the many attempts in adapting questionnaires developed in English speaking societies to another language, there are uncertainties regarding the quality of the adaptation. The best attempt may follow published good practice guidelines to adapt healthcare related questionnaires that may not necessarily address issues related to hearing. For example, there are often careful efforts on forward and backward translations, without regard to how individuals in different countries may evaluate hearing and hearing needs or whether the listening situation is just as important in another culture. Response anchors are often translated without attention to whether they are equidistance apart and how cultural variations may influence responses.

This presentation will introduce the audience to the good practice guide newly published in the International Journal of Audiology (IJA) (Hall et al., 2017). This is a set of guidelines established based on a review of currently available guidelines and opinions from experts who have worked with patients from a diversity of cultural background. Members of two international organisations - the International Collegium of Rehabilitative Audiology (ICRA) and the TINnitus Research NETWORK (TINNET) contributed to the development of the guidelines via face-to-face meetings and emails. Various issues were thoroughly debated.

The presentation will introduce the audience to the six methodological steps and provide examples that illustrate how the guidelines should be applied in different cultures. The six steps are: 1) Preparatory work to involve and obtain permission from the source language questionnaire developer and define concepts; 2) Forward translation to the target language while paying attention to variations in culture, language and lifestyle; 3) Backward translation to the source language to ensure the nuances of the source-language questionnaire has been captured; 4) Committee review of the records from steps 2 to 3 to verify whether the purposes are met; 5) Field testing is used to examine issues that might not have been noted in previous steps and to reconcile outstanding issues, and 6) Reviewing and finalising the translation.

Reference:

Hall, D. A., Domingo, Z., Hamdache, L. Z., Manchaiah, V., Thammaiah, S., Evans, C., & Wong, L. L. N. A good practice guide for translating and adapting questionnaires for use in different languages and cultures: Preferred reporting items with explanations and examples. *International Journal of Audiology*, 2017; 56 (12):1-15.

HEARING SCREENING WITH THE DIGITS-IN-NOISE: IMPROVING TEST ACCURACY AND EFFICIENCY

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Hearing loss is a growing global health concern as the 4th leading contributor to years lived with disability, affecting close to 1.3 billion people annually. The recent development of a smartphone hearing test that uses digits presented in background noise provides a rapid self-test consumer solution for population-based screening. The Digits-In-Noise (DIN) test uses recorded digit triplets (e.g. 4-2-7) presented in background noise to determine the level of the digits relative to the noise level (signal-to-noise ratio, SNR) where a person can identify 50% of the digit triplets correctly (i.e. speech reception threshold, SRT). In this study, we assessed the use of a novel test paradigm of the DIN smartphone hearing test using dichotic speech, that could allow increased sensitivity and breadth of detection across all major forms of hearing loss using a rapid test in a consumer App without increasing test duration.

Method: Participants were 122 adults, 51 with normal hearing (PTA_{0.5,1,2,4} <25 dB HL); 47 with bilateral symmetric hearing loss (PTA >25 dB HL) and 24 with unilateral or asymmetric hearing loss (better ear PTA < 25 dB HL). We compared SRT using conventional, diotic testing with a novel, dichotic DIN test (digits interaurally out-of-phase).

Results: For listeners with symmetric hearing loss, dichotic SRTs were significantly more sensitive ($p < 0.001$) and strongly correlated with PTA ($r = 0.88$) than diotic SRTs ($r = 0.79$). Dichotic SRTs were also significantly more sensitive ($p < 0.001$) to asymmetric hearing loss than diotic SRTs. Dichotic SRTs showed greater sensitivity and specificity to hearing loss than diotic SRTs (receiver operating characteristics 0.94 and 0.85 respectively).

Conclusions: Across the entire sample, test sensitivity significantly improved with dichotic presentation, and dichotic SRTs were more closely associated with the degree of hearing loss. The dichotic DIN showed higher sensitivity to both unilateral and asymmetric hearing loss, a major innovation. The dichotic DIN could, in a 3-minute self-test for hearing loss, produce a more sensitive and wider-ranging screen and appropriate referral to a professional than the conventional diotic DIN.

TECHNOLOGY UPDATE

WHEN HEARING TECHNOLOGY UNLOCKS A CHILD'S FULL POTENTIAL, LIFE IS ON!

Stacey Rich*

Sonova, AG ~ Staefa ~ Switzerland

At Phonak we want to give every child, no matter what degree or type of hearing loss, the opportunity to hear and understand well in every situation so they can develop speech, communicate effectively, play, laugh and be confident in everything that they aspire to be or do.

In 2016 Phonak launched the first hearing instruments truly designed for kids, with specialized pediatric performance features including the only pediatric operating system called AutoSense Sky OS, the next generation of frequency lowering SoundRecover2 and activation of directional microphones within the Roger program becoming the only manufacturer to offer the powerful combination of Roger and directional.

With the launch of our new pediatric portfolio Phonak Sky B and the first rechargeable hearing aid for kids, we take a look back at the evidence behind the technologies and how the landscape of pediatric fittings has changed with the introduction of these specialized features for kids.

This presentation will provide a brief overview of Phonak pediatric hearing instrument technology including Sky B and Roger. The proven benefits of AutoSense Sky OS over the adult operating system and significant improvement in speech understanding for peer talkers with the Roger and directional setting will be discussed.

With our Target/CUPeR datalogging project which has been logging pediatric fittings for nearly 10 years, we can examine trends in pediatric fittings across more than 20,000 pediatric devices. Comparatively we will look at approximately 500 new fittings and examine the acceptance and overall success of these new pediatric features based on fitting data.

VARIATIONS OF DIGITAL NOISE REDUCTION PERFORMANCE ACROSS HEARING AIDS

Kimi Møller*, Lisa Sjolander

GN Hearing ~ Ballerup ~ Denmark

One of the main reasons that people with hearing impairment seek hearing aids is to improve their hearing in noisy listening situations. However, this is also one of the most-cited sources of dissatisfaction with hearing aids.

In order to improve satisfaction with hearing aids in noise, many modern hearing aids have various noise reduction strategies, including directional microphones, multiple program settings and single-microphone noise reduction, often called noise reduction.

The intention of noise reduction is to reduce background noise, while preserving audibility for speech. The general consensus is that noise reduction improves listening comfort, but there is only limited evidence that noise reduction improves speech intelligibility.

The aim of this research was to investigate noise reduction in five modern commercial hearing aids over several parameters, including the amount of gain reduction applied and activation time of noise reduction. The test methods will be explained in detail to provide professionals insight into how testing can be done in the clinic.

Five premium receiver-in-ear (RIE) hearing aids were programmed linearly to fit a mild, sloping hearing loss. Coupler targets were generated for the standardized ISMADHA N2 hearing loss. The targets were determined using the National Acoustics Laboratory-Non-Linear2 (NAL-NL2) rationale, using the NAL-NL software (v1.927), assuming an occluded earmould. For each of the hearing aids, coupler gain was matched to the NAL-NL2 targets within ± 3 dB between 500 to 4000 Hz using the International Speech Test Signal (ISTS). Two signals of 60-second duration were used: an unmodulated speech-shaped noise presented at 67 dB SPL, and this same speech-shaped noise with the Connected Speech Test mixed in at +4 dB SNR.

The results showed that there are great differences in how noise reduction is applied among different

hearing aid manufacturers. Results will be explained, including examples of what the differences could mean for hearing aid users. This presentation reinforces the importance of measuring hearing aids not only in quiet, but also in noise, and discusses the need for measurement standards that can be used in noise. This discussion can help hearing professionals compare noise reduction in hearing aids, assist in appropriate hearing aid selection for individual patients, and help setting realistic expectations.

EFFECT OF FREQUENCY-SHIFTING TECHNOLOGY ON AUDITORY STEADY-STATE RESPONSE MEASUREMENTS FOR VALIDATION OF HEARING-AID FITTING

Søren Laugesen*

Interacoustics Research Unit ~ Lyngby ~ Denmark

Validation of a hearing aid's success in making speech audible is an important final step in the fitting process. This is particularly important for infants, because of the – compared to adults – higher variability in the measured audiometric thresholds used to calculate the hearing aids' fitting parameters, and because of the high variability in real-ear acoustics among the tiny infant ears. However, validation of hearing-aid fittings is difficult in pre-lingual infants who do not reliably respond to the standard behavioural validation methods (aided audiometry, questionnaires, interviews etc.). Therefore, objective validation methods based on electrophysiology are of interest. Here, a specific approach based on the auditory steady-state response (ASSR) is considered. Such 'aided ASSR' measurements are associated with several challenges; for instance the effect of room acoustics when stimulating through a loudspeaker instead of insert phones, head movements during the measurement, and the fact that the ASSR stimulus will pass through the hearing aid. In this investigation, focus was on the potential effects of the hearing aid. For the sake of clinical convenience and face validity, an aided ASSR measurement would ideally be done with all automatic signal-processing features of the hearing aid activated, as would be the case during daily use. However, many of these signal-processing features are non-linear in their nature and may therefore be suspected to compromise the integrity of the ASSR stimulus. A technical examination of modern hearing-aid signal-processing features suggested that the potentially most problematic features were those based on frequency-shifting technology (e.g. for anti-feedback or frequency transposition of high-frequency speech components). An experiment was therefore conducted in which the ASSR was measured in conditions with and without frequency shifting activated. In order to focus on the effects of the hearing-aid processing conditions, the experiment was done with young adult normal-hearing test subjects and hearing-aid-processed stimuli recorded in a test box, which were subsequently presented to the subjects through insert phones. The results show that even with the most extreme processing parameters selected, the ASSR was unaffected by the use of frequency-shifting technology. In order to supplement the experimental results, an objective analysis of the different hearing-aid-processed stimuli was carried out. This analysis was based on the modulation power spectrum of each stimulus, since the modulation power has been found to be a good predictor of measured ASSR magnitudes. The combined findings suggest that the presence of a hearing aid in the stimulus path for aided ASSR is of no concern. This bodes well for using aided ASSR for validation of early hearing-aid intervention.

OPEN FIT HEARING AIDS FOR CHILDREN AND TEENS: CONSIDERATIONS FOR CLINICIANS

Dave Gordey*

York University/Oticon A/S ~ Toronto ~ Canada

New advancements in hearing technology mean that individuals with hearing loss have many options to consider for amplification. Many clinicians today are considering open fit style hearing aids for children and teens because of their design, size, discreetness, improved sound localization, and natural sound quality. However, there is little research on the use of this technology that examines candidacy, verification, outcome measures, and practical/management issues. This presentation will look at the considerations when selecting/fitting an open fit hearing instrument for children and teens.

USE OF HEARING AIDS (1)

HEARING AID COVERAGE ACROSS THE WORLD – MODELS, RESULTS AND CONSEQUENCES

Nikolai Bisgaard*

GN Resound ~ Copenhagen ~ Denmark

Prevalence of hearing loss is well established in many countries. The scientific literature on this topic is abundant and the consensus is that around 16 % of the population in most countries have some degree of hearing loss. WHO states that 5 % of the population suffers from a disabling hearing loss. It is also well known that the coverage with hearing aids vary considerably from country to country although very little solid information on this topic exists. The differences can arise from economic, cultural or other factors.

Data on unit sales is being monitored and published in a number of countries and for countries without public data, reasonably accurate estimates can be made, but that is still only part of the answer. Factors like bilateral fitting frequency and hearing aid replacement patterns are important to know in order to translate unit sales to coverage. Since 2009, Eurotrak surveys have been conducted in many different countries and have been repeated regularly in certain countries. The EuroTrak surveys do provide estimates of coverage for each country and using data from these countries, a model linking hearing aid unit sales to coverage has been developed. Using this model the hearing aid coverage can be estimated for any country with a reliable estimate of unit sales. This work will be explained and the results presented.

Multiple models for assessing the cost of untreated hearing loss have been promoted over the years. Some are relatively conservative expressing cost of lost work effort others are relying of quality of life cost models (QUALY) and bring forward rather inflated numbers. Recently, L. Hartmann has proposed a more balanced model also including the cost of treatment. This model originally developed for France is also based on the QUALY concept, but with different assessments of loss of quality of life depending on the degree of hearing loss. The cost of treatment is also differentiated according to the degree of hearing loss. The results for France is that the benefit from fitting hearing aids is tenfold the cost of the provision thus providing a very positive incentive for developing proper hearing care. This model has been generalized and applied to the coverage data developed using unit sales and EuroTrak data. The development of the generalized model and the results will be presented.

USE OF HEARING AIDS (2)

COMPARATIVE STUDY OF TWO PRESCRIPTION PROCEDURES IN THE PROGRAMMING OF HEARING AIDS FOR OLDER ADULTS

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Objective: To comparatively analyze the prescription procedures NAL-NL2 and DSL v5.0a according to the hearing aids individualized programming for older adults with hearing impairment.

Rationale: The use of prescription procedures in the hearing aids programming has as main objective the application of the recommended amplification to the users, improving the audibility of soft sounds and conversational speech and guaranteeing comfort for loud sounds. Different methods, however, may have different adjustment goals. Considering the modifications in the structures of the external acoustic meatus of older adults, an orientation on hearing aids selection and adaptation process in this population is necessary. This study is part of a proposal for the development of an individualized protocol that take into account the adjustments recommended by the prescription procedures.

Design: The study included 60 older adults with hearing impairment. After signing the Free Informed Consent Form, the participants of the study underwent a meatoscopy, RECD (Real Ear to Coupler Difference) measurement and hearing aids individualized programming with two different prescription procedures, NAL-NL2 and DSL v5.0a. Performance verification for each prescription was performed using REAR measurements (Real Ear Aided Response), SII calculation (Speech Intelligibility Index) and HINT (Hearing In Noise Test). Comparative statistical analysis of the data obtained in both situations was performed using the paired t test and the Wilcoxon test.

Results: There were statistically significant differences with better performance of NAL-NL2 in REAR evaluation in low and high frequency bands for medium and loud intensity input sounds, in high frequency range for low intensity input sounds, and in speech intelligibility index calculation for soft input sounds. DSL v5.0a presented better results with statistically significant difference in REAR evaluation in medium frequencies for medium input sounds, in low and medium frequencies for soft input sounds, in speech intelligibility index calculation for medium and loud input sound, and in HINT test in silence and noise situations.

Conclusions: It was not possible to determine a most suitable method for all evaluated parameters. However, on speech perception evaluation, which is fundamental in a study with older adults, seeing the difficulty of this population especially considering the signal-to-noise ratio, there was a very important difference between the procedures, having DSL v5.0a achieved better results. This is due to the proposal of the most recent DSL formula, which presents modifications that value more the aspect of speech perception in noise and the comfort of the user. This finding allows the use of this method with other populations besides the pediatric, offering a satisfactory alternative regarding speech perception in silence and noise for older adults with hearing impairment.

PSYCHOSOCIAL DEVELOPMENT HINGES ON GOOD LANGUAGE AND FUNCTIONAL PERFORMANCE: UPDATE ON THE LOCHI STUDY

Teresa Yc Ching^[1], Cara Wong^[1], Laura Button^[1], Vivienne Marnane^[1], Louise Martin^[1], Jessica Whitfield^[1], Vicky W Zhang*^[1], Linda Cupples^[3], Greg Leigh^[4], Harvey Dillon^[1], Robert Cowan^[2]

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Aims. This study reports the psychosocial development of children who participate in the Longitudinal Outcomes of children with Hearing Impairment (LOCHI) study. Factors influencing outcomes were examined, separately for children using hearing aids and those using cochlear implants.

Methods. Parents of 333 children completed questionnaires on their children's emotional and behavioural problems and prosocial behaviour (Strengths and Difficulties Questionnaire), social skills

development (Child Development Inventory), and functional auditory performance (Parent Evaluation of Aural/Oral performance of Children). Children completed standardized assessment of nonverbal cognitive ability (Weschler Non-verbal Scale of Ability) and language ability (Pre-school Language Scale v4) by 5 years of age. Information about demographic and audiological characteristics was collected. Multiple regression analyses were conducted to examine the influence of a range of predictors on outcomes.

Results. On average, the children did not show evidence of emotional/behavioural problems; but revealed deficits in social skills. Regression analyses showed that better non-verbal cognitive ability, language and functional auditory performance were significantly associated with better psychosocial outcomes in children with hearing aids. The absence of additional disabilities and better functional auditory performance were associated with better psychosocial outcomes in children using cochlear implants.

Conclusions. The findings suggest that early interventions targeted at not only language ability, but also the use of hearing in communicative situations in real-world environments are likely to benefit psychosocial development.

STUDY OF EXTERNAL EAR AND MIDDLE EAR FUNCTIONS AND HEARING AID ADJUSTMENTS TO DEAL WITH PATHOLOGICAL CHANGES

Anjan Muhury Muhury*

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The auditory system in human beings is a vastly integrated, navigational system wherein the external auditory world is sensed and converted to a spatial representation in the brain as perception, and cognitive expression by way of learning the environment, what it represents and the need to store such data for ongoing learning and movement in our daily lives. The human ear can process a wide band of sounds located between 20Hz and 20,000 Hz in our natural environments.

Acoustic energy entering the human ears undergoes a series of transductive processes and the mechanical energy within all incoming sounds is carefully identified and its characteristics retained in perfect proportional representation of the real world sound environment. The process of selectively amplifying incoming sounds has physiologic means in a step by step process as the sound vibrations are collected, and collated. The process, integrity and navigational pattern of all incoming sounds is retained as a clear replication of their contents, starting from the pinna, the ear canal, the tympanic membrane, the ossicular chain, and up to the stapes footplate. The vibrative mechanisms to amplify the incoming sounds function for adequate information to reach the inner ear (cochlea).

In this journey inbound to the inner ear, pathological intervention by way of blockages, diseases, and resonant changes do alter the proportional representations of these sound vibrations and lead to altered perceptions and stressful workloads when entering the cochlea for processing. Hearing aids need to be additionally adjusted when such pathologies are known and the changing characteristics are understood. To adjust for such changes, tympanometric testing of middle ear impedance greatly helps in fine tuning hearing aids for hearing satisfaction. It should be noted that our memory systems always function as a reference for the brain to compare with and fully understand the acoustic patterns.

This short paper will explore the challenges that exist in hearing losses within the external ear and the middle ear cavities that merit attention in the process of hearing aid fittings, how we can detect these challenges, how to overcome them with objective, straightforward methods to generate the right perception, and the right cognitive reactions that is the aim of every perceptive input that the human psyche needs for its existence. Currently known pathologies and its effects will be discussed at the forum.

ANSD

AUDITORY EVOKED POTENTIALS IN CHILDREN WITH AUDITORY NEUROPATHY SPECTRUM DISORDER

Maria Lalayants*, Natalia Brazhkina, Elena Geptner, Alexander Kruglov, Vigen Bakhshinyan, Tatyana Chugunova, Marina Goykhburg, George Tavartkiladze
National Research Centre for Audiology and Hearing Rehabilitation ~ Moscow ~ Russian Federation

The **aim** of this study was to estimate peculiarities of the auditory brainstem evoked potentials (ABR), auditory steady-state responses (ASSR) and cortical auditory evoked potentials (CAEP) in children with bilateral auditory neuropathy spectrum disorder (ANSD).

Subjects - 100 patients aged from 2 months to 13 years old with electrophysiological features of ANSD – presence of cochlear microphonic (CM) and/or otoacoustic emissions (OAEs) with absent or aberrant synchronous neural response on ABR.

CM was the main clue for the ANSD diagnosis, because OAE was absent from the first audiological testing in both ears in 49 children. ABR testing didn't reveal a synchronous neural activity bilaterally in 72 cases (out of 100). CM with aberrant neural response on ABR (stimulation level over 65 dB nHL) was detected in 38 cases. In contrast to ABR, ASSR thresholds were detectable at 0,5; 1; 2 and 4 kHz in both ears in 73% of cases (47 out of 64 tested). As it typical for ANSD, both ABR and ASSR in most cases were incomparable with the behavioral audiometric thresholds.

32 children underwent CAEP testing. In 8 cases out of 9 with mild hearing loss detectable CAEP were recorded. CAEP registration in 17 children aided with hearing aids and 6 children after cochlear implantation revealed concordance of CAEP detectability with the behavioral thresholds and rehabilitation outcomes in the majority of cases.

Conclusion: The ABR registration with CM evaluation is the most informative test for ANSD diagnosis. Despite of the fact that ABR as well as ASSR are useless for behavioral thresholds estimation, detectable ASSR thresholds but uncoordinated to ABR might point to ANSD in cases when reliable OAE or CM cannot be assessed (for example otitis media). The results of this study support previous findings that CAEPs can provide most valuable information (among auditory evoked potential tests) about audibility of sounds in children with ANSD, but these data require further investigation.

UNILATERAL AUDITORY NEUROPATHY SPECTRUM

Kaukab Rajput*
London ~ United Kingdom

Case presentation on three cases which presented with unilateral absent ABR but passed OAE.

Ultimately seen in Great Ormond street hospital after diagnoses of intracranial tumours.

Unilateral ANSD is very rare but is very likely to be missed if OAE screening is the only test offered to well babies.

IMPROVING HEARING CARE (2)

THE USE OF ELECTRONIC CLINICAL ALERTS TO PROMOTE AND SUPPORT EARLY AUDIOLOGY REFERRAL OF ADULTS BY PRIMARY CARE PROVIDERS

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Hearing loss (HL) affects 17% of Americans and has significant sequelae, yet it is poorly screened and diagnosed by family and other primary care physicians (PCP's). Electronic clinical alerts (ECA) have been effective for addressing other conditions, and might increase PCP referrals of patients deemed at high-risk for HL. The objective of the study was to determine if a HL-ECA increases the rate of appropriate referrals to audiology of patients 55 and older.

Setting: Five University of Michigan and four Beaumont-Oakland University family medicine sites using the EPIC electronic medical record (EMR).

Patients: All patients aged 55 years or older without a HL diagnosis on their problem list, seen at participating sites.

Design: HL referral rates were compared between study and baseline periods, using chi-square tests. Likelihood of referring patients with probable HL, using the Hearing Handicap Inventory (HHI) as the "gold standard," was determined using logistic regression. Descriptive statistics assessed the number of referred patients seen by audiologists and the percentage of time they diagnosed HL in these patients.

Intervention: HL-ECA activates in the EMR during clinic visits for all patients age 55 and older.

Main Outcome Measure: The proportion of patients referred to audiology and the percentage of those referred who have HL.

Results: Clinicians referred 62 of 434 consented patients (14.3%), significantly greater than baseline referral rates (3.5%; $p = 10$). Referral likelihood was significantly higher among patients with $HHI \geq 10$ versus those with HHI scores

Conclusions: ECAs can improve referral rates to audiology of patients at high risk for HL.

BARRIERS AND FACILITATORS TO OPTIMUM LEARNING OPPORTUNITIES FOR STUDENTS WITH HEARING LOSS: QUALITATIVE ANALYSIS OF INTERVIEWS WITH TEACHERS AND SUPPORT PERSONNEL

Surabhi Budhiraja, Yvonne Chia, Shani Dettman*
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In a landscape of revised models of service delivery and budget constraints, it is increasingly challenging for teachers, teachers of the deaf, and other support personnel who work with students with hearing loss to implement evidence based practice in special education. The emerging field of implementation science is highly relevant here as it can provide a framework to help us understand shortcomings in translating evidence based practice into daily educational practice. To set the scene, this qualitative study examined current models of student support with the aim of identifying facilitators and barriers to evidence based practice.

Teachers of the deaf, speech pathologists and interpreters working within a range of contemporary service delivery models completed one-hour semi-structured interviews. Seven topic areas guided these interviews; pathways to teaching, role of the profession, professional development, classroom role, goal setting, professional identity, and wishes for the future. The rich interview data were subjected to qualitative thematic analysis.

Barriers included: inequities in service delivery; shortages of qualified staff (fast turn-over coupled with slow replacement); negative perceptions/expectations regarding technology/the profession/hearing impairment, and sign language; unsuitable physical/acoustic environments for learning; wide geographical spread and therefore significant distances between students (with cascading consequences

to rapport/relationships and efficiency); limited access to internet/resources; diverse approaches to timetabling/funding/documentation/accountability ; and superficial understanding of student support personnel roles/responsibilities. Facilitators included; physical work environments which fostered professional collaboration (versus isolation); clarity in goal setting and documentation (shared notes/clear lines of communication); flexibility in adapting to student and workload demands; a positive and inclusive mindset from school leaders to all staff; access to resources and professional development opportunities. We need to understand how the above facilitators and barriers impact the reach, effectiveness, adoption, implementation and maintenance of evidence based practice in education (from both individual and organisational system perspectives) so as to effect meaningful change in support practices, and to optimize educational outcomes for students with hearing loss.

FAMILY EMPOWERMENT (1)

DEVELOPING AND IMPLEMENTING BEST PRACTICES IN FAMILY CENTRED EARLY INTERVENTION THROUGH INTERNATIONAL COLLABORATIONS AND PARENT-PROFESSIONAL PARTNERSHIPS

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There is a multitude of factors which influence the educational and socio-emotional outcomes of children who are D/deaf or hard of hearing. Research both within and outside of the field of childhood hearing loss has evidenced the crucial role of the family in relation to developmental outcomes, highlighting the importance of family systems interventions (Trivette et al 2010) and the level of active engagement and meaningful involvement of families as being predictive of child outcomes (Yoshinaga-Itano, 2000, Moeller 2000). The 2010 Global Coalition of Parents of Deaf and Hard of Hearing Children (GPODHH) Position Statement, written from the perspective of the lived experience and expertise of families, recognises and reinforces the research evidence in respect of individual family-professional partnerships, and advocates family involvement at all levels within Early Hearing Detection and Intervention systems.

Growing out of the first International Congress on Family Centred Intervention (FCEI) held in Austria in 2012, and drawing on a wide outcomes-focused research and evidence base, an international collaboration of parents and professionals (both hearing and deaf/hard of hearing from the fields of early intervention, speech and language therapy, medicine, psychology, audiology, social care and academia) produced an international consensus statement on Best Practices in Early Intervention (Moeller et al 2013). Since publication, the document has had significant impact, with several countries working to implement the ten principles of the consensus so as to improve services in their countries in culturally and context appropriate ways or to influence the development of strategy and policy.

The principles - in the domains of: 1) Early, timely and equitable access to services; 2) Family-provider partnerships; 3)Informed Choice and decision making; 4) Family social and emotional support; 5) Family-infant interaction; 6) Use of assistive technologies and supporting means of communication; 7) Qualified providers; 8) Collaborative teamwork; 9) Progress Monitoring; and 10) Programme monitoring - were revisited at the 2nd international congress in 2014. Progress in a wide range of countries with both mature and emerging early intervention programmes and initiatives was surveyed. Further examples of how the principles are being applied in practice were presented at the 2016 meeting and a culture of international collaboration, shared learning and multi-professional cooperation has developed in relation to research and evidence informed early intervention programme delivery, together with a strong focus on the infusion of D/deaf and Family leadership and expertise within multi-professional early intervention systems at both strategic and operational levels.

This presentation will draw on the survey responses to give an overview of the progress made within a range of country and programme contexts in relation to the Best Practice principles and will report on and give examples of the barriers encountered in some specific country situations and conditions. It will further focus on the innovations and developmental impact of the work being undertaken to positively influence strategy and the quality of culturally competent service provision, based on the strong collaboration and co-production of parents, families, and hearing and D/deaf professionals, from across the professional spectrum.

EDUCATIONAL AUDIOLOGY - EMPOWERING FAMILIES USING TECHNOLOGY

Joy Rosenberg*

Mary Hare partnered with University of Hertfordshire ~ Newbury ~ United Kingdom

INTRODUCTION New technology and guidance, such as integrated receivers and radio aids at first fit, makes close working between clinical and educational audiology, for the sake of empowering families using technology, more essential than ever. In order to assure the future of joined-up services for children and young people who are deaf and their families, the role of Educational Audiologist, has been carefully defined (Webster and Keen 2017) by the British Association of Educational Audiologists (BAEA) and the training route, at Mary Hare partnered to University of Hertfordshire, is evolving. A professional opinions survey was undertaken to inform the process (Rosenberg 2017b cited in Lamb 2017), and endorsement by the British Academy of Audiology (BAA) has been completed of the only Educational Audiology course in the UK. Consultations with interagency and family stakeholders has informed a potential course restructure which will allow greater uptake of course portions by members of both the clinical and educational sectors (Rosenberg 2017a). The opening of a voluntary registration of the Educational Audiology profession with the Registration Council for Clinical Physiologists (RCCP) is underway.

METHODS The programme team commissioned a survey of national Heads of Services and Practitioners in Audiology and Education. Thematic analysis of responses was undertaken based on key words and phrases. BAA endorsement of the academic portions of the course was undertaken by a panel including a BAEA representative culminating in a positive report with conditions. Officers of the BAEA were appointed to peruse historical and contemporary material to develop a role briefing document for communicating the essential but varied nature of Educational Audiology. It included anecdotal case studies collated by the National Executive Committee (NEC) to highlight value of the Educational Audiology role.

RESULTS Findings from the national survey of professional opinions highlighted training forecasts and concerns about future joined up working to empower families. Practitioners and Heads of Service conveyed interest in postgraduate stand-alone modules. Conditions were successfully met for BAA endorsement of the academic content, assessment strategy and documentation of the MS/PGDip Educational Audiology Course. The BAEA NEC approved and published a role briefing document on the BAEA website and is disseminating it via professional magazine article citations, for example. An e-learning CPD (continuing professional development) module was developed to present the value of Educational Audiology. This includes the anecdotal case studies which support the notion of the Educational Audiology role as essential bridge between Health, Education and Family working. Preliminary findings of revalidation consultations with interagency family stakeholders include support for postgraduate stand-alone modules to allow uptake from both Health and Education sectors.

DISCUSSION/CONCLUSIONS Findings are informing the way forward for the Educational Audiology training and the role of its graduates. Links with the BAA and information about the value of the Educational Audiology role continue to be developed and disseminated. Concomitant with opening a voluntary professional registration for Educational Audiology is the university restructure of the course to include stand-alone modules to increase joined-up working and training options for Clinical Audiologists, Educational Audiologists and Teachers of the Deaf all in partnership working with families.

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A PARENT-FOCUSED APPROACH TO INTERVENTION IN THE HOME USING MHEALTH AND LANGUAGE ENVIRONMENT ANALYSIS (LENA) TECHNOLOGY FOR INFANTS AND TODDLERS

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Introduction. Children with prelingual, severe-to-profound hearing loss benefit from receiving cochlear implants (CIs) at a young age. CIs provide them with access to meaningful, early auditory experiences which are important for developing speech and oral language. Primary caregivers play an influential role in their children's early learning, as caregiver-child interactions within the child's natural home

environment present opportunities for facilitating their children's language development. Research has demonstrated a strong association between the amount of spoken language which infants and toddlers are exposed to at home, and their later language outcomes. While there is growing research awareness with regard to measuring the amount of talk directed to children, establishing how best to provide feedback and coach caregivers on their language contributions to their children in the context of everyday life, has been a challenge in traditional service delivery models. To this end, speech and language processing technology, such as the Language Environment Analysis (LENA) system, provides clinicians with an automated method of measuring and imparting quantified information to parents about their child's auditory-language environment.

Objectives. The present study aims to evaluate the use of digital technologies (LENA and mHealth) in the everyday lives of families with young children with. The study hypothesises that the amount of talk spoken by adults in the home will be associated with factors related to the child and the family environment (e.g. socio-demographic and maternal characteristics). It is also hypothesised that there will be changes in response as measured by the quantities of talk after provision of feedback to caregivers (mothers) based on their LENA recordings and after use of a parent education mobile app.

Methods. Ten mother-child dyads (six hearing children; four children with bilateral severe-to-profound hearing loss) participated in a prospective intervention trial. LENA-generated language counts (adult words and adult-child conversational turns) were analysed for three study conditions: up to 16 hours of adult-child verbal interactions in the child's natural environments (Control Condition 1); up to 16 hours of adult-child verbal interactions following each mother receiving specific individualised feedback from a clinician regarding the quantity of talk (Feedback Condition 2); as per Condition 2 with the addition of the use of the mobile app promoting shared parent-child interactions (Feedback and App Condition 3). Demographic information was collected, including a measure of family socio-economic advantage, maternal education attainment, parental and child hearing status. Child language, maternal vocabulary, verbal and non-verbal abilities were assessed using standardised assessment measures and analysed in conjunction with mean adult word counts derived from the LENA generated data.

Results. Overall group findings suggested that there was a significant positive correlation between the verbal standard scores on the Kaufman Brief Intelligence Test-2 for mothers in this study and a higher mean adult word count. Changes in the amount of adult words and conversational turns were observed in both intervention conditions (2 and 3) as compared to the control condition (1). Participant views regarding the use of LENA technology and the mobile app will also be discussed.

Conclusion and implications. Emerging research has highlighted the potential of using mHealth and feedback to caregivers based on LENA technology to effect changes in the early language environment. The practical application of technology to enrich adult language input could be considered as a home intervention strategy and a complement to current service models for both hearing children and children with prelingual hearing loss.

EMPOWERING FAMILIES THROUGH TECHNOLOGY

Michelle Christie*

No Limits for deaf children ~ Los Angeles ~ United States of America

Research supports the importance of parent involvement as a predictor of success for the communication and language development of children with hearing loss (Yoshinaga-Itana, 2003). More than 90% of children with hearing loss are born to hearing parents, yet most families have never even met a deaf person let alone possess knowledge of hearing loss and its associated challenges. Parent support groups and the teaching of advocacy skills have been proven to alleviate the stress that parents encounter due to the enormous weight of decisions needed to ensure success for a deaf child in a hearing world (DesGeorges, 2003). It can be a daunting and lonely process. For economically disadvantaged families with minimal to no resources, it can often feel unbearable.

My presentation will outline the fundamental tools of family advocacy, as well as highlight methods to unite families and communities through digital media and story sharing. The presentation will feature the outcomes of the acclaimed theatrical documentary, *Silent NO MORE* (with a book of the same name), which has been performed at Carnegie Hall and throughout the United States. According to a study by Stanford University, stories are up to 22 times more memorable than facts alone (Aaker, 2017). *Silent NO MORE* demonstrates the power of storytelling by individuals with hearing loss and their families. This

advocacy movement features the real-life hardships and successes of growing up with a hearing loss. These are not actors, but rather people residing in the local community. The stories by hearing siblings, parents, and educators provide a comprehensive personal experience about how deafness has impacted their lives, allowing families to relate to and learn from one another. Surveys distributed after each performance highlighted significant outcomes. The surveys showed that parents found the stories inspirational, educational, emotional, and informative. By videotaping these honest, true-life stories (which are stored in an easily accessed digital library), educators can help parents of newly diagnosed children learn to advocate for their child's future and find a human connection to the often-overwhelming medical diagnosis of hearing loss.

The personal stories from adults with hearing loss are particularly powerful, as they not only provide role models for children with hearing loss, but also a way forward for the entire family. Based on a 2013 study by Rogers and Young, introducing families to a diverse range of deaf role models has been instrumental to making families feel reassured and thereby becoming more positive and confident about their child's deafness and future. As parents, educators, deaf adults, and siblings share their perspectives, parents can assess their own lives and gain insight about how to best care for their child with a hearing loss.

Data indicates that 80 percent of internet users own a smartphone (Smart Insights), Facebook has more than 1.66 billion monthly smartphone users (DMR), and there are 4.92 billion mobile internet users globally (We Are Social, 2017). Educators can capitalize on this incredible access to technology by working with clients to capture their stories on a smartphone or tablet, without having to drive to an educational center. Thus, parents from remote locations or who have few resources especially benefit. They can watch the stories or create their own video from home. These stories empower communities throughout the world via websites, YouTube, social media, and other media outlets.

Family advocacy through digital technology can capture, educate, and enliven one's own community and communities around the world by bringing role models and other families together so no one ever feels they are alone on this often-unexpected life journey.

USING EHEALTH TECHNOLOGY TO DELIVER FAMILY-CENTERED SERVICES

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EHealth models are being integrated into all aspects of the hearing healthcare pathway at an increasing rate. One area of particularly rapid growth is the use of videoconferencing technology to deliver early intervention and rehabilitation services to young children and their families (commonly referred to as "telepractice"). Despite the widespread use of telepractice for this purpose, there is little empirical evidence in the literature to support its use in the delivery of family-centered early intervention services.

This presentation will report results from a recent study that examined the use of family-centered practices in early intervention services delivered through telepractice. The two-stage comparison study involved a large group of almost 500 children who are deaf or hard-of-hearing and their families. The entire cohort received early intervention services from the same organisation, either in-person or through telepractice. In the first stage of the project, eligible caregivers were invited to complete a questionnaire examining their perceptions of self-efficacy and involvement in their early intervention sessions. Practitioners working with these families were invited to complete a similar questionnaire, which examined the practitioners' perceived use of family-centered practices. In the second phase of the study, a subset of the larger group was videorecorded during their usual early intervention sessions for four weeks. During this time, caregivers were asked to participate in two researcher-defined activities with their children in addition to regularly scheduled activities.

Final results from the caregiver and practitioner surveys will be presented, along with a description of methods used for video data collection and analysis. Conclusions drawn from the data will be shared and potential implications for the delivery of hearing healthcare services through telepractice will be discussed.

Keywords: eHealth, telepractice, family-centered, early intervention, research study

FAMILY EMPOWERMENT AND USE OF TECHNOLOGY

HELPING CHILDREN AND TEENS NAVIGATE TRANSITIONS SUCCESSFULLY: SESSION 1

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Ida Institute ~ Naerum ~ Denmark

Life is a journey packed with continuous change, opportunity for growth and possibilities for choice. As human beings we have an enormous capacity to grow and adapt to new circumstances. We can develop skills and knowledge that will help us approach changes and new opportunities with confidence and a belief that we will get through successfully.

While we may not be able to prepare for every possible situation we encounter, when we are not afraid and can foresee and plan for situations or potential challenges, managing change becomes easier. Whenever we adapt to a new situation and feel that we can manage it, we have gone through a transition. For children with hearing loss and their families, the typical adjustments children go through are often further complicated by opportunities and challenges related to managing communication and technology well.

As children grow, there are identifiable steps and stages through which all pass as they develop into adults. To meet the challenges of each new stage, children need to be able to develop skills, confidence and the ability to engage. To feel happy and successful, they must also be able to steer their lives in a way that is personally satisfying. Throughout these transitions, parents and caregivers are an important source of support, and can help to set learning goals that empower children, teens and young adults to navigate each stage.

One of the most important factors contributing to successful transitions management for children is self-determination - the ability and opportunity to steer one's life in a direction that is personally satisfying. Self-determination is correlated with a number of benefits. Children with a secure sense of themselves and a belief in their own ability are more likely to experience academic success and higher engagement. They also tend to be more involved and report a higher quality of life and positive experiences in early adulthood.

This presentation will introduce the principles of self-determination and discuss what should be in a young person's rucksack in order for them to thrive, grow and become happy and independent individuals. Participants will be introduced to a new online framework - Transitions Management - developed by the Ida Institute to help hearing care professionals, families and patients successfully manage the transitions throughout childhood and youth. Based on the principles of self-determination, this online tool takes a holistic approach to transitions management, focusing beyond technology to the healthy development and well-being of the whole child.

In "Helping Children and Teens Navigate Transitions Successfully: Session 2", participants will get a quick tour of the Transitions Management platform and learn how to use it with patients and families.

HELPING CHILDREN AND TEENS NAVIGATE TRANSITIONS SUCCESSFULLY: SESSION 2

Ena Nielsen*, Bert Meijers
Ida Institute ~ Naerum ~ Denmark

This presentation follows on from "Helping Children and Teens Navigate Transitions Successfully: Session 1", providing a hands-on demonstration of the online Transitions Management tool developed by the Ida Institute in collaboration with pediatric audiologists from around the world.

To help hearing care professionals, families and patients successfully manage key transitions throughout childhood and youth, the Ida Institute has developed the Transitions Management framework. This online tool takes a holistic approach to transitions management, focusing beyond technology to the healthy development and well-being of the whole child.

Through videos of the child's next environment, self-assessment tests to understand the child's readiness

for the upcoming transition, and guided exercises to help the child or teenager develop the skills required to succeed, the tool supports young people, parents and hearing care professionals in managing the child's next transition. The tool also provides inspirational videos of older children and teenagers with hearing loss who reflect back on what it was like to be a hearing impaired child in different environments and how they overcame obstacles.

The presentation will demonstrate the contents and structure of the tool and discuss how use of the tool can prepare children, teenagers and their families for successful transitions.

EMPOWERING AND MOTIVATING COCHLEAR IMPLANT RECIPIENTS WITH ACCESS TO SELF-DIRECTED REHABILITATION THROUGH DIRECT STREAMING

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Traditionally, Auditory Rehabilitation is carried out with support from a Speech and Language Therapist, usually in a clinical centre. Training may be required to acquire optimal performance from a Cochlear Implant, for example, speech recognition in challenging situations such as distance, background noise, different speakers, telephone use, etc. In addition, sequential cochlear implantation and new indications, such as SSD or asymmetrical hearing loss, require intense and specific auditory training.

Clinical studies of auditory plasticity following placement of Cochlear implants suggests that additional auditory training may be needed for reorganization of the brain to occur (1). Traditionally, this training has required an economic and time effort on the part of the patient, family or caregivers.

The literature also emphasizes many reasons that support the importance of daily practice taking advantage of routine activities and in natural contexts (2). There are software programs designed for this purpose, but there may be barriers to access such as cost and technical equipment requirements, etc.(3)

This paper will present one approach to empowering Cochlear Implant recipients to use the opportunities for listening practice and rehabilitation afforded by the Nucleus 7 sound processor and streaming with IOS devices. Options for using a range of different commercially available apps, many of them free, will be shared along with ideas for using data streaming, not always with a specific educational purpose, but through activities that can be more pleasant, engaging and entertaining for the patient such as listening to audiobooks, podcasts and other listening resources to build auditory experience and confidence. This paper will present options for using the N7 MFI processor for self-directed rehabilitation using streaming, to provide the patient with training possibilities tailored to his or her interests and needs, adapted to maximize and motivate their time availability; the incentive being the ability to select and design their own varied listening program.

The key elements of how to support and motivate recipients to design their own listening program plus the options and how this has been applied in clinical practice as well as clinical examples and outcomes will be addressed.

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FAMILY EMPOWERMENT (2)

TEACHING SCIENCE TO EMPOWER HEARING-IMPAIRED CHILDREN AND THEIR FAMILIES

Pia Luppino Doss*

Broadway Audiology for Veronica James Science Challenge for Hearing Impaired Children ~ Sydney ~ Australia

“Ut ager quamvis fertilis sine cultura fructuosus esse non potest, sic sine doctrina animus.”

“A mind without instruction can no more bear fruit than can a field, however fertile, without cultivation.”— Marcus Tullius Cicero, Tusculan Disputation

Summary This presentation will describe the Veronica James Science Challenge for Hearing Impaired Children (VJSC). The VJSC was held annually in Sydney Australia from 1989 to 2016. The VJSC helped generations of hearing impaired Australian students aged 5 to 16 to explore the world of Science via hands-on experiments.

The VJSC was not only for gifted science students, rather it was an opportunity for hearing impaired students of all abilities to explore and get excited about the world of Science. The VJSC helped open doors to higher education and Science, empowering hearing-impaired children and their families to realise their potential and participate fully in Australian society.

The VJSC 2018 HEAL presentation will communicate lessons learned over 27 years so others might repeat the VJSC success in other parts of the world. The presentation will describe the program structure, teaching resources and organisation.

VJSC History THE VJSC was founded by the Australian Scientist, Professor Veronica James. The VJSC began in the early 1980s when Professor James attended a meeting of the Quota International (QI) service organisation to thank them for raising money for breast cancer research Professor James led at the University of New South Wales (UNSW).

The QI service organisation ‘provides basic needs to women, children, the deaf, and hard of hearing in communities around the world’. At the QI meeting, Professor James listened to a report about a QI program to sponsor note takers for hearing impaired students at Australian Universities. Professor James learned that there were only 9 hearing impaired university students at all Australian Universities and only 1 at the UNSW among an enrolment of 20,000.

Professor James’ follow on investigation revealed that hearing-impaired students were discouraged from pursuing Science studies at an early age. She decided that early intervention was critical to change this, so Professor James designed the first Science Challenge programs for children as young as 5. The VJSC was a very positive factor that helped direct many participants to later complete advanced University degrees and pursue careers in science and engineering fields.

Presenter

Pia Luppino Doss is an Audiologist based in Sydney Australia. Pia began a career in Audiology when her young son was diagnosed with a permanent hearing loss in 1989.

Pia was on the VJSC organising committee for over 20 years. In this role Pia developed lessons, enlisted the participation of Universities and Corporations (e.g. Cochlear and Siemens), worked as a VJSC tutor and participated in the VJSC with her son.

Pia is co-director of Broadway Audiology, an independent Audiology practice in Sydney Australia. Her professional hearing sciences experience includes public sector Audiology at Australian Hearing, in the hearing sciences education sector at Macquarie University, and in the non-profit sector at the Shepherd Centre working with young children and their families as an Auditory Verbal Therapist, and Cochlear Implant Audiologist. Since 2008, Pia travels for a few weeks each year to remote communities in the Australian Northern Territory to provide hearing education and diagnostic services for Indigenous families.

Sponsorship and Promotion

<http://sydney.edu.au/medicine/pathology/vjsc/index.php>

RAISING EXPECTATIONS FOR EDUCATIONAL OUTCOMES THROUGH EFFECTIVE EARLY INTERVENTION

*Sarah Hogan**, Lilian Tomlinson, Abigail Hitchins
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Listening is a fundamental foundation for literacy. For families who choose an Auditory Verbal approach to communication for their deaf child, promoting learning through listening is crucial for their developing literacy skills. The advances in hearing technology, both in terms of diagnosis and enabling access to sound, together with our understanding of effective listening habilitation techniques, means that we can strive, not only for good listening and good spoken language, but for good literacy outcomes for our deaf children too.

However, recently published figures for literacy and numeracy for 11-year olds leaving primary school in England show that the proportion of deaf children achieving the expected standard in reading, writing and mathematics at Key Stage 2 is 33% (National Deaf Children's Society (NDCS), 2018). A recent study by Herman, Roy and Kyle (2017) found that over half of their group of 79 pre-lingually deaf 11-year olds with severe to profound hearing loss and using aural-oral communication had reading difficulties.

In 2010, a UK government report found that "[typically developing] Children achieving a good level of development by five years of age, reach the expected levels for reading at Key Stage 1" (Department for Children, Schools and Families, Publications 2010). Is this not true, then, for severely and profoundly deaf children?

Evidence of more positive educational outcomes for children whose families have chosen a listening and spoken language approach to early intervention are presented. The rate of language development as measured by the Pre-school Language Scales (PLS) were collated with the children's levels of national standard attainment tests (SATs) at Key Stages 1 (7 years of age) and 2 (11 years of age). Children were included in the study if they had participated in our AV pre-school programme for more than a year and had completed two or more PLS assessments.

The four different classifications for attainment levels of SATs were condensed into two categories: those children who have achieved or exceeded the national expected standard and those who have achieved below the national expected standard. The demographic profiles of our graduates for (i) socio-economic status (SES) and (ii) maternal education were analysed.

Families of 67 children who had been on the programme for more than 1 year and who left the programme between 2005 - 2014, were included in the analyses. No exclusion of children with additional needs were made. The families came from a broad range of socio-economic backgrounds with 25% of participants residing in the 50% most deprived areas across the UK (calculated using the Index of Multiple Deprivation, 2015). Mean standard scores of 'Total Language Scores' did not differ significantly across groups of varying socio-economic status (SES). We categorised the maternal highest level education into three groups; GCSE, Further Education and Higher Education. There was no strong correlation between Total Language Score and the level of maternal education (Spearman's rho 0.16; $p=0.35$).

At 7 years of age, the proportions of graduates ($n=48$) who met or exceeded the national expected standard were as follows: Reading (85%); Writing (77%); and Mathematics (87%). At 11 years old, 77% ($n=31$) achieved or exceeded the expected the national expected standard for these core subjects. These figures do not differ from the attainment figures of children with no identified special educational need (Note on attainment figures, NDCS 2018). Neither SES nor maternal education was a significant variable in spoken language and literacy outcomes for children who were on the programme for a year or more.

Within England, the attainment gap between deaf children and their hearing peers is significant by the end of KS1 and the gap increases by the end of primary school (NDCS, 2018). By contrast, children following an AV approach in their pre-school years, match the attainment of children without hearing loss at both KS1 and KS2.

Effective early intervention through listening and spoken language programmes for deaf babies and children, show that an early, positive start has a lasting impact on a child's learning outcomes at primary school. These data support the position that good listening is a crucial part of the development of good spoken language and can lead to educational outcomes for deaf children that match or exceed national standards.

ESSENTIAL PROGRAMS TO COACH AND EMPOWER

Joanne Travers*

Partners for A Greater Voice, Inc. ~ Massachusetts ~ United States of America

Good outcomes in a child's development (spoken language, emotional and social intelligence) necessitate parents have good self-perception, better psychological health, and high family function. Because caregivers are most influential in a child's development, attention to educating the parent becomes a priority. Essential Programs to Coach and Empower goes beyond content in hearing health and habilitation. The approach prepares parents to feel emotional ready and cognitively prepared to more successfully advocate for their child and maximize his/her child's potential. The paradigm shift from pathogenics to new parent supports that suggests caregiver well-being is a driver for change.

In many countries, and particularly in developing countries, coaching and empowering caregivers is challenging due to inadequate parent education programs, limited resources in otology and audiology, and scarce teacher and rehabilitation training in areas of deafness and aural habilitation. The complexity of the global hearing health and habilitation industry and the predicament of most parents seeking refuge and support to raise children who are deaf and hard of hearing imply a traditional approach to parent outreach and education is not effective and must change. Even in more developed countries, sustainable outcomes for children with hearing loss is challenging when parents are not engaged in developing their child's cognition, social and emotional growth.

Based on twenty years of qualitative experience, the science of positive psychology, and results from parent surveys, PGV (Partners for A Greater Voice) concludes that there is a need for targeted parent support. Addressing specific needs of parents that help them become emotionally healthy and prepared in their journey to raise children with hearing loss becomes a priority. Topics most relevant for parent learning and empowerment include ways to foster positivity, engagement, relationships, meaning, and achievement. For example, maximizing parent capabilities through strengths-based practice can guide parents toward feelings of empowerment and confidence. Essential Program to Coach and Empower suggests several distinct coaching and empowerment strategies in several modules (Fostering Parent Leadership, Breaking Stigma /Upholding the Potential of a Child). Training cultivates parent participation and promote self-determination regardless of income and economic status.

Further, PGV programs offered practitioners deeper insight to unique and distinguished parent supports and interventions that may be woven into their practice.

The presenter brings 20 years of experience raising two aural children, directing over 35 international training and mission, and supporting various parent support experiences (societies in Africa, Caribbean, India, Central and North America). She has consulted over 1000 parents of children who are deaf and hard of hearing from all levels of socio economics. She is founder of Partners for A Greater Voice, a founding Director of the Coalition for Global Hearing Health, and parent advocate for mainstream children who use listening and spoken language.

Three objectives of this presentation are:

- 1) Participants will learn ways to help parents engage in forward thinking, growth mindset.
- 2) Participants will learn at least one strategy for engaging parent as leaders.
- 3) Participants will learn effective coaching techniques that guide parents toward self-determination.

WHAT WORKS IN SUPPORTING PARENTS TO BE EFFECTIVE ADVOCATES FOR THEIR CHILD

Susannah Burden*, Isobel Weller, Sarah Hogan

Auditory VerbalUK ~ London ~ United Kingdom

Social, linguistic and educational outcomes for deaf children are highly correlated with parental engagement in the intervention that a child receives (DesJardins and Eisberg, 2007). Over the last 15 years at Auditory Verbal UK, we have grown in our understanding of how we can best support families in moving from not knowing what is possible for their newly diagnosed deaf child to becoming effective advocates for their child: We have formalised these ideas in Stokes' Six Stage Parental Journey (Hogan et

al, 2015). This model includes the parents as experts of their child. Empowering parents with strategies to support development of their young child's listening, talking, thinking and social skills are key to achieving successful outcomes. Parent empowerment is at the heart of Best Practice in Family Centred Early Intervention (Moeller et al, 2013).

The outcomes of children attending an Auditory Verbal early intervention programme were charted over a 10 year period in 2016. Four out of five children who had been with the programme for a minimum of two years started with age-appropriate spoken language, including those children with additional needs (29%) (Hogan 2016).

In an attempt to determine the necessary factors for success in the programme, Auditory Verbal UK conducted a survey of parent's opinions on completing the Auditory Verbal programme. Families reported feeling empowered and equipped to support their child in achieving their potential as a listener and a speaker and key themes emerged about the support they received during their journey. This support is aligned with Bandura Social Learning Theory of observation, modelling and motivation (Bandura 1969).

Successful collaboration with parents relies in part on a detailed understanding of the journey which takes parents from feeling uncertain for the future at the time of their child's initial diagnosis to being confident advocates for their children. Successful collaboration also relies on coaching parents in key techniques, strategies and procedures. 'Stokes' Six Stages' model provides a modern framework, based on practical experience of working with families in their early years, to guide Early Intervention practitioners in supporting parents and carers towards their goal of age appropriate spoken language.

An overview is given of the different aspects offered by the Auditory Verbal UK programme that support parental engagement: regular therapy sessions, parent consultations, individual guidance on navigating support services and wider support for the whole family, including grandparents and other carers. A survey was conducted for families that had left the programme, sampling parents' (retrospective) reflections on their emotional well-being at the start and end of the programme. Incidental parental feedback as parents moved forward on their journey was recorded on video. Areas of knowledge regarding their child's hearing status and management of their hearing technology were also explored as access to speech through listening is essential for the Auditory Verbal approach (AG Bell Academy; Ten Principles of Auditory Verbal therapy www.listeningandspokenlanguage.org).

The study provides an insight to the parent's journey from initial diagnosis to feeling that they are, in the words of one parent able "to teach my child to use her residual hearing and her hearing aid and cochlear implant and to reach her full potential as a profoundly deaf girl in a hearing world."

This oral presentation will use videos of children and their parent's experiences to explore the key themes that emerged from the study that provides practitioners working with babies and young children who are deaf an insight into what works in supporting parents to be effective advocates for their child.

FAMILY PERSPECTIVES

RELEVANCE OF THE INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH: CHILDREN & YOUTH VERSION IN EARLY HEARING DETECTION AND INTERVENTION PROGRAMS

Sheila Moodie*, Marlene Bagatto

The University of Western Ontario ~ London ~ Canada

Early hearing detection and intervention (EHDI) programs have been guided by principles from the Joint Committee on Infant Hearing and an international consensus of best practice principles for family-centered early intervention. Both resources provide a solid foundation from which to design, implement, and sustain a high quality, family-centered EHDI program. As a result, infants born with permanent hearing loss and their families will have the support they need to develop communication skills. These families also will benefit from programs that align with the framework offered by the World Health Organization's International Classification of Functioning, Disability and Health: Children & Youth Version (ICF-CY). Within this framework, health and functioning is defined and measured by describing the consequences of the health condition (i.e., hearing loss) in terms of body function, structures, activity, and participation as well as social aspects of the child. This presentation describes the relevance of the ICF-CY for EHDI programs and offers a modified approach by including aspects of quality of life and human development across time.

PARENT-TO-PARENT SUPPORT FOR PARENTS WITH CHILDREN WHO ARE D/DEAF OR HARD OF HEARING: A CONCEPTUAL FRAMEWORK

Sheila Moodie*, Rebecca Henderson, Andrew Johnson

The University of Western Ontario ~ London ~ Canada

An international consensus document titled "Best Practices in Family-Centered Early Intervention for Children Who Are Deaf or Hard of Hearing (D/HH)" provides 10 guiding principles to family-centered care intervention. Principle 4 identifies family social and emotional support as a priority, stating the importance that "families are connected to support systems so they can accrue the necessary knowledge and experiences that can enable them to function effectively on behalf of their D/HH children" (Moeller et al., 2013, p. 435). Providers and organizational decision makers are given objectives to achieve Principle 4 and are encouraged to ensure that all families have access to parent-to-parent support from other families of children who are D/HH, recognize the key role of parent-to-parent support in promoting social and emotional well-being for families, recognize and actively support parent organizations and networks for direct parent-peer support opportunities, and support connections between families and adult role models who are D/HH (Moeller et al., 2013, p. 435). This presentation will focus on providing attendees with the results of a two-stage study that addressed the question: "What are the constructs and components of a conceptual framework of parent-to-parent support for parents with children who are D/HH?" It will present the results of unique work conducted by Henderson, Johnson, and Moodie (2014) who first used a scoping review methodology to determine the constructs and components of a structured conceptual framework of parent-to-parent support for parents of children who are D/HH and then complemented that work with a second stage of research using an electronic Delphi study connecting with 21 experts from 7 countries to refine the framework (Henderson, Johnson & Moodie, 2016). This conceptual framework of parent-to-parent support for parents of children who are D/HH helps provide a better understanding of the role of parent-to-parent support in EHDI programs. This may have important policy development, program development, and evaluation implications and enhance evidence-based child and family-centred care service provision.

RELATIONSHIPS BETWEEN CAREGIVER DECISIONS ABOUT COMMUNICATION AND LANGUAGE OUTCOMES FOR CHILDREN USING COCHLEAR IMPLANTS

Shani Dettman*, Kristina Tachtsis, Dawn Choo

The University of Melbourne ~ Parkville ~ Australia

Aim. From before a child is born, parents shape their child's life with the medical, social and linguistic decisions they make. With the neonatal diagnosis of profound hearing loss, the complexity of parental decision making increases. The present study aimed to understand caregiver preferences regarding communication, the sources of information they used, and subsequent language outcomes for children using cochlear implants (CIs).

Methodology. There were 155 caregivers (4 grandparents, 19 fathers, 129 mothers, 3 unknown) who completed a one-off questionnaire "Parental Views about Communication" (PVaC) for 162 children using CIs (mean age at CI 3.74 years; SD 3.83)(90 male; 72 female). The PVaC replicated items from Watson and colleagues (2007) "Communication Journey" questionnaire and extended it for Australian conditions. Standard scores (SS) were reported for the PPVT-3 and 4 (Dunn & Dunn, 1997; 2007) and PLS-4 and 5 (Zimmerman et al. 2002, 2011). To enable inclusion of a more diverse group of children (including those with additional needs) data from the PPVT, PLS, CDI (Ireton, 1992) and RI-TLS (Rossetti, 1990) were also coded using the Categories of Linguistic Performance (CLIP; Dettman et al., 2017). Chi-square analyses explored the distribution and strength of caregiver responses to specific PVaC questions about the use of spoken language and/or sign language. Correlation between child/family characteristics, parental preferences and child language outcomes were explored.

Results. Caregiver responses that communication be "effective", "useful in the future" and "child preferred" received the strongest agreement. Caregivers indicated disagreement with statements that "child preferred sign", "speech impeded sign" or "sign impeded speech". More caregivers agreed with the statement that their child could "communicate well" than the statement "still delayed". Most caregivers (31%) indicated that a "combination of people" influenced decisions about their child's communication, with the teacher of the deaf as the second most cited source of information (17%). In this study, 43% of children (n=70) did not change communication approach from diagnosis to the date their parents completed the PVaC. Of the remaining 57% (n=91) who did change, there were 9 who shifted towards a greater use of sign language and 82 who shifted towards greater emphasis on spoken language. Changes in a child's communication approach before and after hearing diagnosis and, following CIs were unrelated to child language outcomes or family characteristics but were influenced to an extent by caregiver values and child preferences; the source of information was significantly correlated with caregiver's wishes for "the most effective means of communication with their child" ($r_s=0.27$, $p=0.013$). Age at CI was negatively associated with receptive SS ($r_s=-0.22$, $p=0.046$) and receptive CLIP ($r_s=-0.25$, $p=0.024$). Cognitive skills were negatively associated with receptive SS ($r_s=-0.47$, $p<0.001$) and receptive CLIP ($r_s=-0.465$, $p<0.001$). Other correlations between child language, presence of comorbid diagnoses, maternal education, cognitive skills, and caregiver responses to statements in the PVaC regarding "ease of communication" and "preferences for spoken language" were noted.

These results highlight the multi-faceted nature of decision making; parents/caregivers require and deserve unbiased support from professionals whilst undergoing this process. Consistent with previous research (Watson et al., 2007) child preferences were influential on parental decision making, but the present study demonstrated that child language and cognitive skills were also influential.

A 7 YEAR FOLLOW-UP STUDY ABOUT THE QUALITY OF LIFE OF DEAF AND HARD OF HEARING CHILDREN

Tirza Van Der Straaten*^[2], Carolien Rieffe^[1], Anouk Netten^[2], Wim Soede^[2], Johan Frijns^[2]

^[1]Leiden University, Developmental Psychology ~ Leiden ~ Netherlands, ^[2]Leiden University Medical Center, Otorhinolaryngology Department ~ Leiden ~ Netherlands

Objectives: To compare the QoL of DHH children with normal hearing (NH) children. And to examine the extent to which early detection and intervention, language skills, communication skills and HL related factors of DHH children contribute to the development of QoL.

Design, Setting, and Participants: 62 DHH children and their parents participated in this nationwide follow-up study. Developmental outcomes of these children were collected at the age of 4 and again

seven years later at the age of 11 years.

Main outcome measures: The Pediatric Quality of Life (PedsQL) questionnaire was completed by parents of children of both ages. Children were also able to complete the PedsQL self-report at the age of 11. The questionnaire consists of 4 subscales, including a Physical, an Emotional, a Social and a School domain. Results of the PedsQL were compared with a Dutch community sample. Language skills at the age of 4 were analysed by the Reynell Test. Communication skills were measured through the MacArthur-Bates Communicative Development Inventory III parent-questionnaire.

Results: Parents and DHH children reported a lower QoL related to school activities compared with NH children at the age of 4 and 11 years. Within the group of DHH children in particular, children following special education reported lower outcomes compared with children following mainstream education on the school activities QoL-subscale. The social-subscale of QoL (interaction with peers) revealed no significant difference between DHH and NH children at the age of 11. This is in contrast with seven years earlier, where parents of 4-year-old DHH children reported a lower QoL of their children on the social QoL-subscale compared with NH children. Communication skills, not language skills, were positively related to a better QoL development. The type of hearing device, the degree of HL, early detection before 6 months of age and early intervention before 12 months of age were unrelated to the development of QoL over time.

Conclusion and relevance: This follow-up study showed that DHH children had lower QoL outcomes related to school activities compared with NH children. The results also deduced that communication skills, not language skills, are essential for the QoL of DHH children. The knowledge that DHH children encounter problems related to activities in their school curriculum enables specific guidance or support within the class to increase their social support.

THE EXPERIENCE OF MARRIAGE IN THE CONTEXT OF SPOUSAL DISABILITY

Jessica West*

Duke University ~ Durham ~ United States of America

Hearing impairment is a significant health problem and chronic stressor for older adults and is associated with negative mental health outcomes. However, few studies have explored how hearing impairment extends beyond individuals to influence the mental health of those in their social support network. This is important because people exist in social networks, and the emergence of health problems can affect both individuals and those close to them. The development of hearing impairment may be particularly salient in marital relationships because spouses experience disability through the partner's impairment, which is called third-party disability. This concept is similar to the sociological notion of stress proliferation. Originally, stress proliferation explained how stress experienced in one situation (e.g. chronic illness) leads to the accumulation of stressors in other situations (e.g. financial strain from being unable to find work). The term has been extended to describe the collateral consequences when one person's stress spills over to others.

To date, only two studies have used large epidemiologic datasets to study the effect of hearing impairment on spouses. One study used the Alameda County Study in the U.S. and found that the spouse of a person with hearing loss is more likely to report poor physical functioning, not feeling happy, symptoms of depression, and having less energy than is expected for one's age. In contrast, the second study used the Nord-Trøndelag Health Study based in Norway found that spouses of people with hearing loss do not exhibit greater symptoms of decreased subjective well-being, depression, or anxiety. Given the conflicting findings of these studies, the association between hearing impairment and spousal mental health remains uncertain.

The current study builds on research on stress proliferation, gender, and marriage and uses longitudinal, nationally representative data from nine waves of the Health and Retirement Study (1998-2014) to examine the relationship between hearing impairment and spousal depressive symptoms among U.S. adults aged 50 and older. The analysis uses a multiple group analysis structural equation model to assess this relationship and examine the role hearing impairment plays on spousal depressive symptoms as a latent construct across male and female spouses. Preliminary results using the 1998 wave (n=8,544) reveal that when individuals self-report fair or poor hearing, their spouses (both male and female) experience a significant increase in depressive symptoms. Moreover, hearing aid usage is associated with

a decrease in female spouse depressive symptoms, but not male. These findings suggest that the stress associated with hearing impairment proliferates to both male and female spouses.

EVALUATION OF A COCHLEAR IMPLANT BROCHURE: SUITABILITY FOR THE SOUTH AFRICAN CONTEXT

Karin Joubert*^[1], Raeesah Kajee^[2]

^[1]University of the Witwatersrand ~ Johannesburg ~ South Africa, ^[2]Chris Hani Baragwanath Academic Hospital ~ Soweto ~ South Africa

It is essential that cochlear implant information brochures provided to parents of children with hearing loss be culturally appropriate as well as meet the recommended reading grade level in order to ensure that parents can make appropriate decisions regarding amplification options for their child. The aim of the study was to evaluate a cochlear implant brochure provided to parents of children with hearing loss in terms of readability and suitability.

A descriptive research design was used to evaluate the brochure using three standardised and validated tools. Ten participants were interviewed to determine their perspectives on the attraction, comprehension, self-efficacy and cultural appropriateness of the brochure.

The findings of this study indicate that readability level of the brochure as measured was well above the recommended fifth to sixth reading grade level. The suitability of the brochure was superior. Despite the high suitability score, aspects such as literacy demand and cultural appropriateness can be improved on to make the cochlear implant brochure more contextually appropriate for the South African context.

It is of utmost importance to develop a brochure that is contextually relevant and appropriate, as often brochures developed overseas are not always appropriate for other countries and contexts. Parents are often provided with brochures when seeking clinical interventions therefore brochures should cater to their needs examining all positive and negative aspects of intervention and be able to convey this in simple terms that any parent may be able to read and understand effectively in order to make an informed decision regardless of level of education.

PATIENTS' PERSPECTIVES

THE BASIC IMPACT OF HEARING LOSS - PART 1

Aïda Regel Poulsen*

Aïda Regel ~ Middelfart ~ Denmark

How do you develop or continue to live a “normal” life when you face a hearing loss?

How does knowledge regarding how the brain and hearing work help to fulfill expectations in life – yours as well as others?

How can you take charge of your personal life, career, and situation? Without trying to control everything? What does accessibility in society mean to your development?

Is it a myth that hearing loss may cause dementia? We are two presenters and will approach these questions and share some of our ideas and experiences concerning the impact of hearing loss with you.

As we are hard of hearing ourselves, we are personally using audiological treatments in our everyday life. We will share our thoughts about the implications of hearing loss and give advice on how to cope and manage when life changes dramatically by the loss of hearing as an adult. You can read about some of Aïda’s experiences in the link below: <https://www.hear-it.org/using-hearing-aids-makes-difference-other-people-to>

THE BASIC IMPACT OF HEARING LOSS - PART 2

Darja Pajk*

Darja ~ Ljubljana ~ Slovenia

Whether as a child or adult, when you have the onset of a hearing loss, what does it take to develop and adjust in order to oversee or remain in charge of your life and place in society?

What should you know about addressing social stigma and the perception of others when you have a hearing loss?

Is the cost in or to society concerning hearing loss only a question based on the economy? What about the quality of life?

We are two presenters and will approach these questions and share some of our ideas and experiences concerning the impact of hearing loss with you.

As we are hard of hearing ourselves, we are personally using audiological treatments in our everyday life. We will share our thoughts about the implications of hearing loss and give advice on how to cope and manage when life changes dramatically by the loss of hearing as an adult.

You can read about some of Darja’s experiences in the link below:

<https://www.hear-it.org/today-darja-refuses-let-her-hearing-loss-suppress-h>

C.I. SINGLE SIDED DEAFNESS

TODDLERS WITH SINGLE SIDED DEAFNESS AND A COCHLEAR IMPLANT

Anouk Sangen, Jan Wouters, Christian Desloovere, Astrid Van Wieringen*
KU Leuven ~ Leuven ~ Belgium

Every year, neonatal hearing screening services in Flanders (Belgium) detect single sided hearing loss in approximately 60 neonates, of whom about 20 have a profound sensorineural hearing loss, also called single sided deafness (SSD). As these children have no binaural hearing, they often will experience difficulties with localization of sounds and with speech intelligibility in noisy situations. As in many other countries, there is no standard care for these children in Belgium, while an increasing body of research suggests that single sided hearing loss is a risk factor for speech-language delays. A cochlear implant (CI) on the deaf side has the potential to restore binaural hearing. It is likely that early implantation is critical for bilateral auditory development.

In our ongoing multicenter study (Leuven, Antwerp, Gent), so far eight infants with SSD have received their CI between the ages of 0;8 and 2;2 (yr;mo) and are tested with age-appropriate materials at regular intervals. We compare data of these children to those of matched normal hearing peers and matched children with SSD without a CI. The children are tested with regard to their receptive and expressive language skills, their cognitive abilities and from four years of age onwards their ability to localize sounds and their speech in noise understanding. Furthermore, language environment is studied with the LENA system and parents are asked to complete questionnaires on auditory behavior, language development and social-emotional and adaptive behavior. Results of the first testing sessions, 2 months pre implantation and 4/(10/16/22/28/34) months post implantation, will be presented at the conference.

COCHLEAR IMPLANTS SIGNIFICANTLY IMPROVE LISTENING IN CHILDREN WITH SINGLE SIDED DEAFNESS

Wendy Arnott^[2], Anna Hyland^[2], Emma Rushbrooke^[1], Dimity Dornan*^[2]

^[1]*Hear and Say ~ Brisbane ~ Australia*, ^[2]*Hear and Say & The University of Queensland ~ Brisbane ~ Australia*

The aim of this pre/post single arm study was to evaluate the impact of cochlear implantation on the speech perception and functional listening skills of young children with single-sided deafness (SSD).

Participants were children with SSD enrolled in the Hear and Say cochlear implant (CI) program between 2014 and 2017 (n=19; 10 females). The children in this study all used spoken language as their only mode of communication, with English as their primary language, and did not have any diagnosed disability additional to hearing loss. The group's mean (SD) age at diagnosis was 2.34 (2.71) years; age at implant was 4.97 (3.19) years; and duration of deafness was 2.64 (2.01) years.

Data on the children's speech perception (at the sound and word level) and functional listening (Parents' Evaluation of Aural/Oral Performance of Children, PEACH) collected at approximately 6 months pre- and 6 and 12 months post-cochlear implantation as per standard clinical practice, were accessed retrospectively.

Earlier analysis of data for 15 participants using Wilcoxon Matched Pairs Signed-Ranks tests revealed statistically significant improvements ($p < 0.05$) in speech perception and functional listening at 6 months post implantation. This presentation will extend the analysis to include an additional 4 children with SSD who have recently undergone implantation and examine outcomes at 12 months post implantation. The impact of CI treatment will also be compared as a function of stage of language acquisition, that is whether the participant's hearing loss occurred pre- or post-lingually.

SINGLE-SIDED DEAFNESS: TREAT OR NOT TO TREAT

Martijn Agterberg*, Snik Ad

Radboudumc ~ Nijmegen ~ Netherlands

Potential treatment options for patients with single sided deafness (SSD) are a conventional contralateral routing of sound (CROS) hearing aid, a CROS bone-conduction devices (C-BCD), and a cochlear implant (CI). In some countries, cochlear implantation is becoming the standard treatment. Whereas the CI enables bilateral input, which might lead to some form of binaural hearing (Dillon et al., 2017), most countries only offer and reimburse CROS devices which do not restore binaural hearing, as they only lift the head shadow and stimulate the contralateral hearing ear. Ultimately a CI provides binaural hearing and the highest chance on success is probably implantation of listeners with acquired SSD later in live who do have a matured auditory system.

We present an overview of localization behaviour of SSD patients listening with a C-BCD or a CI. We focus on sound localization because this ability can be a reliable and easy measurable behaviour (Snik et al., 2015). Unfortunately, sound localization tests differ remarkably from clinic to clinic, ranging from setups with speakers positioned 60 degrees apart (Lovett et al. 2009), to setups with stimuli presented from every possible position (Agterberg et al., 2011; Kuhnle et al., 2013). Furthermore, the setups differ in the stimulus duration, pointing

method, bandwidth of the stimuli, visibility of the speakers and amount of roving of the sound level. These differences result in conflicting outcomes and in results that are difficult to compare.

Several studies reported moderate to good unilateral sound-localization abilities in unaided SSD listeners. We demonstrate that this ability is related to processing of monaural cues which are only available when SSD listeners demonstrate thresholds better than 40 dB HL for 4 and 8 KHz, and that these abilities are not affected when listening with a C-BCD. Sound localization is changed radical when listening with a CI because bilateral input is provided. However, the data indicate that true processing of binaural cues is absent and listeners mainly lateralize sounds. Which in daily live, when most sounds are not only audible but also visible, can be really helpful.

THE EU PROJECT SENSE COG

SUPPORTING HEARING AND VISION IN DEMENTIA: THE SENSE COG INTERVENTION FIELD TRIAL

Chryssoula Thodi*^[1], Piers Dawes^[2], Pavlina Charalambous^[1], Emma Hooper^[2], Leroi Iracema^[2]

^[1]European University Cyprus ~ Nicosia ~ Cyprus, ^[2]University of Manchester ~ Manchester ~ United Kingdom

Hearing and vision impairments are among the most common and disabling comorbidities in dementia, however there is little evidence to support appropriate management of these conditions when they co-exist. Importantly, hearing and vision impairments are reversible burdens on cognitive ill health and intervening to improve sensory function in dementia may be a means of improving the lives of people living with or alongside these conditions.

In a single arm, open label study, a new home-based intervention was implemented in 24 participants with dementia and their caregivers in Manchester, Bordeaux, and Nicosia. The intervention included identification of the sensory loss, supply of hearing aids and/or glasses, and additional support in participants' home for a period of 12 weeks. The specially trained sensory support therapist visited participants' homes and provided assistance with appropriate and consistent use of the hearing aids and glasses, suggestions for communication efficacy improvement, environmental modifications, and referrals for additional services. Participants and caregivers (n=48) completed a battery of scales assessing quality of life and health-related outcomes before the intervention onset and two weeks after intervention completion.

The intervention was accepted and tolerated by the participants. Delivery of the devices was most efficient when hearing and vision testing were concluded on the same day, with aids fit shortly after the assessment. Therapist home visits aided with use and care of the hearing aids/glasses.

Structured Session: Hearing loss and dementia: the Sense Cog project to promote mental well-being in older Europeans

THE SENSE-COG SUPPORT INTERVENTION FIELD TRIAL: EXPERIENCES AND PERCEPTIONS OF OLDER ADULTS WITH HEARING AND/OR VISION IMPAIRMENT AND THEIR CARE PARTNERS

Ines Himmelsbach*^[1], Lucas Wolski^[1], Chryssoula Thodi^[2], Piers Dawes^[3], Leroi Iracema^[3]

^[1]Catholic University ~ Freiburg ~ Germany, ^[2]European University Cyprus ~ Nicosia ~ Cyprus, ^[3]University of Manchester ~ Manchester ~ United Kingdom

Background/Aim: Cognitive impairment as well as hearing and/or vision impairment, especially in their co-occurrence, will increase in older adults within the next years. It is known that the progress of these concurrent impairments is accompanied by psychosocial burden. At present there are no adequate support interventions available to address cognitive functioning and mental well-being in this population. Therefore, one major aim of the Sense-Cog project is to develop a suitable support intervention to meet these requirements. The support intervention is provided by a specially trained Sensory Support Therapist (SST). In a field trial, a prototype support intervention including Correct visual/auditory impairment, Training in correct use of hearing aid/glasses, Communication Training, Home-based functional assessment, Referral to health and social care services, Provision of supplementary sensory devices, Referral to social/hobby/interest activities, Individualised goal setting and Referral to social/hobby/interest activities was conducted to find out about the acceptability, tolerability and feasibility of a multimodal intervention.

Methods: Semi-structured interviews, involving persons with dementia (PwD) with hearing and/or vision impairment and their care partner, were conducted at Manchester (UK) and Nicosia (Cyprus). The dyads were provided with the mini (Correct visual/auditory impairment, Training in correct use of hearing

aid/glasses) or the full (all mentioned) prototype support intervention. In Manchester (n=2) dyads received the full intervention and (n=3) dyads a mini intervention, whereas in Nicosia (n=5) dyads only received the mini intervention. The qualitative material was analysed according to Mayring's qualitative content analysis approach.

Results show that the dyads experienced the mini and the full support intervention positively. The Sensory Support Therapist (SST) is highly esteemed due to his central case management role as 'gatekeeper' and 'broker' within the intervention. The care partners report having better communication with the PwD, because comprehensibility was improved by the communication training. Apart from that, improved communication also led to a more active patient's behaviour in some PwD (e.g. less sleeping by day). The care partners also appreciated the training as to the proper use of the corrective devices (e.g. correct handling of hearing aids, battery change). Central for the positive evaluation is the locus of the intervention as being homebound as well as the SST acting in terms of a case manager and so being the key representative for all issues regarding the impairment of the PwD. In this setting the care partners also report on a reduction of negative psychosocial behaviour (e.g. being less aggressive). A limitation to the qualitative interviews in the field study was, that the sessions of the support intervention could hardly be remembered by the PwD's.

Conclusion: The findings from the qualitative field trial evaluation let assume that for a highly vulnerable group (as addressed in this study) and their care partners the provision of an intervention from one source (here the SST) seems to be crucial for its success. Furthermore, being approached at home also contributes to a better compliance and treatment. Especially when dealing with sensory and cognitive impairment all persons involved should be provided with information as to the progress on the impairment. Moreover a training regarding the proper handling of corrective devices and communication skills is recommend.

Structured Session: Hearing loss and dementia: the Sense Cog project to promote mental well-being in older Europeans

THE IMPACT OF HEARING IMPAIRMENT AND BENEFITS OF TREATING HEARING IMPAIRMENT IN PROMOTING COGNITIVE HEALTH AND PREVENTING DEMENTIA

Piers Dawes*

University of Manchester ~ Manchester ~ United Kingdom

Identifying potentially modifiable risk factors for dementia among older adults is a public health priority. We investigated whether hearing impairment and dual sensory impairment (both hearing and vision impairment) is independently associated with the risk of cognitive decline and dementia, and whether hearing aid use alters cognitive trajectories in older adults.

Data for individuals aged 50 and older were drawn from two longitudinal surveys: English Longitudinal Study of Ageing (ELSA) and the Health and Retirement Study (HRS). We used episodic memory (10 word immediate and delayed recall scores) to measure cognitive function and the 27-point Telephone Interview for Cognitive Status (TICS) to identify dementia cases. Sensory impairment was measured using self-reported hearing and vision.

Our study has two main findings. Firstly, using proportional hazards model analysis, we found that individuals with single (HR, 1.2, $p < 0.001$) and dual sensory impairments (HR, 1.45, $p < 0.001$) had higher risk for dementia than in those with no impairment. Secondly, using the spline methods, we found that the slope of episodic memory scores after the beginning of hearing aid use ($\beta = -0.02$, $p < 0.001$) showed slower decline than that before using hearing aids ($\beta = -0.1$, $p < 0.001$). This study is among the first to provide evidence of the slower rate of cognitive decline with hearing aid use.

Structured Session: Hearing loss and dementia: the Sense Cog project to promote mental well-being in older Europeans

THE EU PROJECT EUSCREEN

INVENTORY OF HEARING SCREENING PROGRAMMES ACROSS EUROPE

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OBJECTIVE: Within a European study, about the cost-effectiveness of hearing screening programmes and funded by the Horizon 2020 programme, we aim to understand the rationale for different models of practice for neonatal hearing screening programmes and the contexts in which they are implemented. Hence, following the 2014 inventory study by Sloot et al, an extensive questionnaire was developed to gather information about different aspects of hearing screening programmes across Europe.

METHODS: In order to gather pan-European data we first attempted to identify contacts in 41 European countries to become the representatives for the project. A website has been created and a link to enable registration and access to the questionnaire, containing 9 domains (demography and epidemiology, administration and general background, existing screening systems, coverage and attendance, tests used, follow-up and diagnosis, treatment availability, cost and benefit and adverse effects), was sent to these representatives. In terms of the hearing domain, country representatives registering are mostly otolaryngologists and audiologists.

To ensure the representatives have enough knowledge about their local screening programme, they first have to follow a tender procedure. In some countries there were no spontaneous registrations so representatives were found through professional networks and internet searches. Ongoing support is provided to country representatives from a core central project team in case of any problems. Challenges we are encountering in our data collection vary between countries. One major obstacle is the Information Governance regulations that exist in many countries, which can often restrict the country representatives from supplying comprehensive data. Securing the relevant permissions proves to be very time consuming. When a questionnaire is submitted, it is checked for completeness and validated.

RESULTS: To date 49 Country Representatives have been identified and are supplying data. 32 otolaryngologists, 8 audiologists/speech language therapist and 9 other professionals involved in hearing screening across Europe, registered to fill out our questionnaire. Representatives for 25 European countries have already completed the questionnaire. In a number of countries (eg. Bosnia, Cyprus, Finland, Estonia, Montenegro, Serbia and countries in the UK) several professionals are involved in the overall data gathering, enabling data supply from multiple sources covering elements such as costs, prevalence and treatment options. It has been challenging to identify a single representative with the breadth of knowledge and equally importantly the time to fill out the full extensive questionnaire. We have found that the more representatives are involved in clinical work, the less time they have to fill out the questionnaire.

Among 25 countries that have provided comprehensive data, all use otoacoustic emissions (OAE) and automated auditory brainstem response (aABR) tests but the number of stages and the sequence used varies between countries. The majority uses aABR for neonates at risk. A few countries test only unilaterally. A number of different professions are involved in screening and will perform screening in the first few days of the child's life, mostly in hospitals or child healthcare centres. Other differences between countries are in coverage, funding and the existence of preschool screening.

CONCLUSION: It has been challenging to identify appropriate professionals despite offering a remuneration. Despite some setbacks we have tried to motivate and support country representatives as much as possible in completing the questionnaire. We found the differences between hearing screening programmes throughout Europe are considerable, including screening protocols, age of testing, professions involved, coverage, funding and in offering screening at the pre-school stage. The cost-effectiveness model that is developed in the EUscreen study will use all the data compiled by the questionnaires to predict the most cost-effective screening programme for each country given the local circumstances and context.

IMPLEMENTATION OF NEONATAL HEARING SCREENING IN ALBANIA

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OBJECTIVE: The EUSCREEN study, funded by the Horizon 2020 programme of the European Commission, aims to enable good and affordable neonatal hearing screening (NHS) for all children in Europe. A cost-effectiveness model is being developed and will be packed into a tool to support culturally and contextually appropriate implementation or modification of NHS programmes in any country, taking local circumstances into account. To date there have been two previous attempts to implement hearing screening in Albania but with limited success. Our aim is to implement a sustainable NHS programme based on the model's prediction for three provinces in Albania, each with differing characteristics.

METHODS: Three regions in Albania (Tirana, Pogradec and Kukës) were chosen because they offer an appropriate representation of the general population of Albania. They include both urban and rural areas with a variety of socio-economic groups. The two maternities in Tirana have the highest numbers of births, about 10000 per year. The maternities in Pogradec and Kukës are much smaller and account for 700-800 births per year.

Using data from screening programmes across Europe and taking local conditions in Tirana, Pogradec and Kukës into account, the cost-effectiveness model evaluated several NHS scenarios for comparison. A test sequence of OAE-OAE-aABR was chosen for well babies and aABR-aABR for NICU babies. To limit repeat and referral in rural and mountainous Kukës a test sequence of aABR-aABR was chosen for all neonates born in the local maternity hospital. As nearly all women deliver in maternity hospitals, screening before discharge 1-2 days after birth was calculated to be most cost-effective. This can result in high coverage but also potentially high repeat rates due to residual fluid in the neonates' ears.

An implementation plan was developed with objectives, target population, protocols, training of screening nurses, devices, care pathways and follow up strategies. NHS started on January 1st, 2018. Requisites, facilitators and barriers, and the cost-effectiveness of the local NHS programmes are being assessed.

RESULTS: In Tirana environmental noise during screening was the main problem and the nurses needed time to organise the screening of large numbers of neonates efficiently. In rural maternities, heating the examination room and too few neonates to practise the screen were initial problems. Failed-test rates were 50%-80% in the first weeks of screening, but decreased as experience was gained. Screeners were proud of their accomplishments and motivated to improve their skills in order to perform screening as well as possible. Most parents were interested to participate in the screening programme. Only few refused out of fear of the test hurting their child. To date nurses are still struggling with convincing parents to return to the hospital for repeat screening tests.

CONCLUSION: Implementation of NHS in Albania presents diverse practical challenges but early progress is promising. Based on these observations, the cost-effectiveness model will be validated and an implementation strategy will be developed that can be generally used in low and middle income countries in Europe.

IMPROVING EHDI

UNIVERSAL NEWBORN SCREENING IS FOR EVERY BABY?

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Background: A number of babies that are medically eligible for a newborn hearing screen are directly referred to audiology by the Victorian Infant Hearing Screening Program (VIHSP) without commencing or completing their newborn hearing screen (NHS). Since 2012, VIHSP has provided state-wide universal NHS and related Early Support Services (ESS) for all babies referred to audiology. Despite a state-wide universal NHS program, a number of babies were still being directly referred to audiology without completing the NHS. VIHSP undertook a review of criteria for direct referral and referral outcomes. This investigation included determining;

- possible barriers to completion of screening
- burden to families
- workload for Early Support Service staff
- throughput to Victorian audiological services and
- family engagement following referral.

Following this investigation, an updated Direct Referral procedure was implemented and evaluated. The review, implementation process, and data are described here.

Methods: VIHSP requested and received eligibility, exclusion and/or screening criteria information from other Australian programs, the New Zealand Screening Unit and the UK Newborn Hearing Screening (NHS) programme. A literature review was conducted to determine the empirical evidence for newborn hearing screening exclusions.

Updated procedures regarding which babies qualified for a direct refer were drafted and reviewed (with a focus on evidence based practices in the light of universal NHS programs worldwide).

When the final version of the procedure was available, a long consultation period was required in order to engage all staff in implementing the change of practice, which involved managing concerns around relationships with health care colleagues and possible increases in families choosing not to engage with the screening service.

VIHSP reporting methodology was reviewed and improved to more accurately reflect all babies' journeys through the hearing screening pathway and subsequent program reporting.

In late 2015, the new VIHSP Direct Refer criteria were released and monitoring commenced.

Results: Data from the period Date of Birth (DOB) 2012 – 2015, prior to release of the revised protocol, were compared with data from the period DOB 2016 – 2017 following its release.

Results demonstrated a decrease in the number of directly referred infants following the release of the updated VIHSP Direct Refer criteria (DOB 2012 - 2015: 70 – 120 direct referrals per year to DOB 2016-2017: 40 - 45 direct referrals per year).

There was an increase in attendance at diagnostic audiology for direct refer babies with diagnostic outcomes available for 97% in 2017 compared to 68% in 2014.

Finally this change to the VIHSP Direct Refer criteria did not have a negative impact on participation; the decline rate remained unchanged from 2012 - 2017 and participation in screening increased by 0.1% from 2015 to 2017.

Conclusion: Reducing unjustified exclusions from newborn hearing screening and having stricter protocols for ensuring screening is offered to eligible infants does not detrimentally affect engagement in newborn hearing screening.

WHY MINIMIZING DAY OF DISCHARGE NEWBORN HEARING SCREENING IS IMPORTANT?

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CHOC Children's Hospital in Orange County is the first children's Hospital in California to implement state mandated NHSP (Newborn Hearing Screening Program) in 2002. More than 95% of the infants born in the US have their newborn hearing screening performed prior to one month of age and majority of those are done before their discharge home from the birthing hospital.

Very often NHS (Newborn Hearing Screen) is performed on the day of discharge (DOD) from the birthing hospital or NICU. The DOD from NICU is the most anxiety laden day for parents and performing NHS on the DOD becomes even more stressful. If the result of NHS turns out to be "refer" that further adds to their stress and anxiety. Re-screening and referral for diagnostic evaluation is warranted for this group of newborns and it may also delay the discharge process. In addition, by testing newborns before DOD we are maintaining both state of California and hospital compliance fulfillment. The DOD rate of NHS at CHOC Children's Hospital from 2013 to 2016 was above 25 percent.

Objective: To reduce the existing DOD hearing screening rate by 20% .

Method: Our primary focus was to achieve our objective by streamlining discharge processes from the NICU with ongoing interdepartmental education and communication through the following steps:

1. NICU staff was educated and made aware of new processes
2. A dedicated discharge nurse position was created
3. Improved communication between discharge nurse and screening techs
4. Screening techs made available on weekends and holidays

Results: As a result of above QI processes in 2017, we were able to reduce our DOD newborn hearing screening rate by more than 22 percent

WIDEBAND ACOUSTIC IMMITTANCE (WAI) MEASURES AS PART OF A NEWBORN HEARING SCREENING PROGRAM IN CANADIAN FIRST NATIONS AND METIS AND CAUCASIAN NEONATES

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Purpose: There are few data on the prevalence of Otitis Media (OM) in neonates of all ethnicities, especially First Nations and Metis (FNAM) neonates, at birth. There is a need to diagnose the type of hearing loss at the time of Newborn Hearing Screening (NHS) to determine the prevalence and to refer neonates for timely assessment and intervention. Wideband Acoustic Immittance (WAI) is a viable tool that can aid in the diagnosis of conductive hearing loss (CHL) at time of hearing screening.

Design: This cross-sectional study examined the application of WAI measures (Wideband Absorbance (WBA) at Ambient and Tympanometric Peak Pressure (TPP), and Admittance Phase ($Y\phi$) (YA)) as part of a regular NHS protocol. NHS pass/fail rates, likely diagnoses and WAI measurements in FNAM newborns were compared to newborns of other ethnicities. 213 neonates (426 ears) were recruited from the Royal University Hospital in Saskatoon, Saskatchewan. 382 ears met the inclusion criteria: 42 FNAM, 212 Caucasian, 48 Other Ethnicities, and 80 Undeclared Ethnicity.

Results: FNAM neonates had a significantly higher NHS fail rate than neonates of other ethnicities. The WBA of FNAM neonates who passed and failed the test battery was significantly lower than that of neonates of other ethnicities. WBA was significantly lower for neonates who failed the test battery and who failed TEOAE testing. WBA at peak pressure was better than ambient pressure in determining between pass and fail test battery results. $Y\phi$ was significantly lower in neonates who passed the test battery and who passed TEOAE screening.

Conclusions: WAI measures WBA and $Y\phi$ are effective in distinguishing ears with likely CHL from normal hearing ears. Pressurized WBA may be more effective than ambient WBA and $Y\phi$ is a promising

measure in the diagnosis of CHL.

FNAM neonates have a higher NHS fail rate and a greater prevalence of likely CHL. WBA of FNAM neonates is lower than that of other ethnicities. Further research is needed to determine if lower WBA in FNAM neonates indicates a greater prevalence of OM or if there is a difference in middle ear anatomy that reduces absorbance of sound compared to neonates of other ethnicities.

THE INFLUENCE OF GESTATIONAL AGE ON AUDITORY DEVELOPMENT IN PRETERM BABIES

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The incidence of hearing loss in population of prematurely born babies is twenty times higher (2-4 per 1000) than in well babies population (1-3 per 1000) due to numerous risk factors. Although early birth is not a risk factor for hearing loss per se, the number of risk factors is in strong correlation with gestational age (Nikolić, 2016). Hearing loss is not always present at birth, but it could be developed over first years of life as well. Progressive hearing loss could be missed through neonatal hearing screening, so that further monitoring of auditory function is mandatory in population of preterm babies (JCIH, 2007).

The goal of this study was to establish the impact of gestational age on auditory development in preterm babies. The study has been conducted in Institute for neonatology in Belgrade, which is the referent hospital for treatment and follow-up of prematurely born babies.

The group consisted of 150 prematurely born babies of both genders, 85 girls (56.7%) and 65 boys (43.3%)., which made gender neutral sample ($\chi^2 = 2.67$, $df = 1$, $p = .12$). The babies were born between 25. and 37. gestational week, with average gestational age of 31.87 weeks (Mdn = 32.5, SD = 2.67). The instrument for auditory assessment was LittleEars® Auditory Questionnaire (Tsiakpini et al., 2004), which is widely implemented for assessment of auditory development in preverbal phase. Previous studies have proven high correlation between scores and age, which implies that it is a good instrument for measurement of age related auditory behavior (Coninx et al., 2009; Nikolić, 2016; Tsiakpini et al., 2004; Weichbold, Tsiakpini, Coninx, & D`Haese, 2005). The data on auditory behavior of babies were summoned from parents at corrected age of 3, 6, 9 and 12 months for each baby. The data were analyzed using descriptive analysis, inferential statistics and hierarchy multivariate linear modelling.

The influence of gestational age on LittleEars® scale score have shown moderate positive correlation. Statistically significant correlation was found at 3 and 12 months corrected age (3 months - $r_s = .21$, $p = .01$; 12 months - $r_s = .22$, $p = .01$), which implies possibility of slower auditory development in babies with lower gestational age. The scores obtained at 6 and 9 months corrected age have shown positive correlation without statistical significance (6 months - $r_s = .16$, $p = .05$; 9 months - $r_s = .15$, $p = .07$). Further analysis have shown the impact of gestational age on auditory development, taking both calendar and corrected age of preterm babies into consideration. The results have shown considerable effect of gestational age on initial auditory achievement ($\chi^2(128) = 199.94$, $p < .001$), as well as on the pace of subsequent auditory development ($\chi^2(128) = 156.11$, $p = .046$). The results have shown that each week of gestation adds 0.39 points to the initial auditory achievement and 0.41 points to the dynamics of auditory development, during the first year of life in preterm babies (corrected age).

It is of utmost importance to determine criteria for follow-up of infants with risk factors for early or progressive hearing loss to develop quality early hearing detection and intervention (EHDI) program. Our study has shown that gestational age could significantly affect auditory development and help define precise criteria for typical auditory achievements of prematurely born babies.

Key words: hearing loss, preterm babies, gestational age, hearing screening

AN ANALYSIS OF EHDI QUALITY IN MORE THAN 1,000,000 NEWBORNS ACROSS THREE US STATES

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The goal of public health, early hearing detection and intervention (EHDI) programs is to maximize language and literacy for children who are deaf or hard of hearing (D/HH). The newborn nursery has provided a near universal captive population to achieve this goal. Hospital hearing screening has been in place for nearly two decades in many parts of the world including England, the United States and Australia. Yet success of EHDI programs ultimately depends on the availability, quality, and equity of care and services provided not just during the nursery-based screening but at sequential points of screening and follow-up, including diagnostic evaluations and enrollment into early intervention. Improving the quality of care of EHDI programs while reducing costs helps public health programs provide valid and meaningful measures that reflect critical aspects of the care delivered to the children they serve. The benefits of newborn hearing screening accrue when each subsequent step is timely and efficient. Recent surveys show gaps in the process that confirm that robust clinical quality measures are needed to help track the quality of hearing health services provided during the EHDI processes.

“Without consistent measurement and reporting, hospitals and other providers will be subject to a cacophony of measures from other insurers, and parents will be left without comparable information to engage in their child’s care” Several Clinical Quality Measures, or CQMs were developed by the Centers for Disease Control and Prevention (CDC) and endorsed by the National Quality Forum (NQF) to help track the quality of hearing health care services provided in the EHDI processes. They are now included as NQF performance measures to quantify outcomes associated with safe, cost-effective and high-quality care. They include EHDI-1a (NQF1354): Hearing Screening Prior to Hospital Discharge, EHDI-3 (NQF1360): Audiology Evaluation prior to 3 months of age, and EHDI-4 (NQF1361): Signed Individual Family Service Plan (IFSP) prior to 6 months of age. These will be discussed in detail for clear definitions. Leveraging today’s electronic health records (EHRs) and public health surveillance system functionalities, we tested three EHDI quality measures endorsed by the National Quality Forum using a retrospective sample of more than 1,100,000 newborns from 3 US states. Data were obtained using electronic health data available in the state EHDI Information Systems provided by OZ Systems (EHDI-IS). The results of the analysis reported from this large multi-state cohort provide a ‘real life’ benchmark for future quality improvement projects and of where EHDI stands today. We provide data to show that while NQF 1354 is reliable and valid to the extent that similar methods are used to provide an accurate denominator; it is the denominator even in this most basic measure that is crucial. Accuracy of other measures rest upon the denominator and comparability to other data require it. We identify methods to improve the denominators. We discuss why applying both NQF 1360 and 1361 will be challenging in other populations without further clarification of the definitions. We highlight the need to better identify the lost categories of patients. Innovative strategies, such as the use of standardized electronic data transmission across health systems, could improve data collection. Leveraging electronic data and enabling cross-sectional system communication are especially important to EHDI to ensure timely interdisciplinary service delivery, which will help support families of children with or at risk of D/HH within the critical early childhood brain and social-emotional development paradigms. Reflecting on these findings, additional suggestions are posed for enhancing the EHDI quality measures in future updates.

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UNDERSTANDING THE CHALLENGES - EXPERIENCES FROM ROLLING OUT THE ACCUSCREEN TO SCREENING SITES IN QUEENSLAND, AUSTRALIA

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During 2017 Queensland, Australia, chose to roll out Accuscreen devices to all of their Newborn Hearing Screening (NHS) sites. Changing NHS equipment can be a challenging experience for any NHS program. Hardware and software must be rolled out to screening sites, end-users must be trained properly, data tracking programs are often implemented, and – optimally – Key Performance Indicators (KPIs) with detailed data about e.g. refer rates should be collected to enable the NHS managers to track the screening program performance. In addition, switching from one NHS device to another implies a steep learning curve to be ascended by both NHS program managers and the end-users.

As a part of the Queensland roll-out, an extensive training program was implemented along with high-quality tracking of KPIs such as refer rates and noise levels. Initially, the Queensland NHS program experienced high refer rates. However, thanks to the close logging of KPIs and effective corrective and preventive actions, the refer rates decreased to acceptable levels. The Queensland Accuscreen roll-out may serve as an example of an effective, data-driven approach to problem-solving related to high refer rates when switching screening devices within an NHS program, and this presentation will give a more detailed view on this process.

ISSUES ON INFANT HEARING (1)

TALKER-SPECIFIC AUDITORY BRAIN TRAINING FOR CHILDREN WHO HAVE HEARING LOSS: PREPARING FOR NEXT YEAR'S SCHOOL YEAR

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Many children with hearing loss are mainstreamed into the public school system and each year, they must acclimate to a new classroom teacher. We are developing speech perception training programs that teach children to recognize the speech of their new classroom teacher. Customized learning: Exercises for Aural Rehabilitation (cLEAR) can provide auditory and speechreading training to children in a web-based, game-like format. A child's next year's classroom teacher records the training items in the spring using her personal computer. The cLEAR software instantly edits and inserts the recordings into the cLEAR computer games that are stored on the web. The child then may play the games over the summer and thereby learn to recognize the teacher's speech in anticipation of the coming fall semester.

Although perceptual training can be provided in the auditory or audiovisual modalities, common practice is for children who have hearing loss to receive only formal auditory training. Rarely do they receive formal speechreading training (i.e., training with both the auditory and visual speech signals). The prevalence of auditory training likely stems from the acoupedic and auditory-verbal educational approaches, where children with hearing loss are encouraged to use audition in lieu of vision for learning speech and language. The motivating premise is that if a child relies to any degree on vision for speech recognition, the child will never develop auditory potential nor develop the necessary phonetic repertoire for speech decoding. However, it is possible that speechreading training, or even a mixed approach where both types are provided, may be equally or even more beneficial. It is also possible that one kind of training might lead to improvements in auditory-only speech recognition whereas another kind might lead to improvements in audiovisual speech recognition.

In the current experiment, we are comparing three types of perceptual training possibilities: auditory training, speechreading training, or a combination of both, where auditory and audiovisual stimuli are interleaved throughout the course of any given training game. The question is, which type of training leads to the most improvement in tests of auditory-only and audiovisual speech recognition? Based on findings from cognitive psychology and second language learning, we predict that the combination approach will lead to the greatest improvements. This prediction rests on the perspective of input variability, where it has been shown that increased variability at input often leads to better learning (e.g., a child hears the word cart, a child hears and see the word cart). In addition, some research suggests that, at least for adults, training in one modality with a talker, such as audition, leads to relatively improved speech recognition of that talker in another modality, such as vision.

Forty-five children were assigned to one of three conditions, where 1) they received only auditory training; 2) where they received only speechreading training; and 3) where they received an interwoven combination of auditory and speechreading training. The training stimuli include the most frequent words of the English language and stimuli that train phonemic distinctions, discourse comprehension, and cognitive skills, including auditory processing speed, auditory working memory, and auditory attention.

The presentation will include a comparison of the effectiveness of auditory versus speechreading training versus combined training and an overall analysis about the effectiveness of talker-specific training.

EXECUTIVE FUNCTIONING – A COMPARISON BETWEEN CHILDREN WITH CI OR HEARING AID

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Executive functioning refers to cognitive processes, involved in self-regulation of thought, action and emotion. It includes mental processes such as planning, working memory, inhibition of inappropriate responses, flexibility in adaptation to changes and decision making. It is predictive of learning-related behavior such as listening to instructions, following directions, and accomplishment of tasks in a limited period of time.

The aim of the study was to assess EF in children with CI or HA and to analyze relations with speech perception and receptive vocabulary. The study group comprised 59 children aged 8 to 14 yrs. The CI group comprised 36 deaf children, the HA group 23 hearing impaired children.

A phoneme recognition score at 45 dB was determined. A word quotient was obtained with the Peabody Picture Vocabulary Test. Verbal memory was assessed with the Dutch 15-words test. Planning was assessed with a subtest of the Delis-Kaplan Executive Function System.

Independent sample T-tests showed a higher speech perception in CI children. Chi-square tests showed for both CI and HA children fewer above average vocabulary scores as compared to hearing peers. Chi-square tests showed a larger proportion of below average Verbal memory scores in both CI and HA children. Finally, fewer above average and more below average scores were obtained on the planning task for both CI and HA children. Associations were found for the HA group between speech perception and vocabulary, verbal memory and planning. These associations were not present in the CI group.

These results indicate that better speech perception for the HA group might improve their vocabulary, verbal memory and planning skills. The implications for CI indication criteria will be discussed.

IMPLICATIONS OF EXPOSURE TO NOISE IN THE PRESCHOOL ENVIRONMENT

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More than 90% of 4-5yr old children in Sweden spend most of their awake time at preschool. The preschool sound environment comprise intermittent, non-predictive and high frequency sounds from children activities and voices. Our measurements show that preschool children are on average exposed to 84 dB LAeqTime indoors, with maximum noise levels up to LAFmax 118 dB, hence reaching the Swedish Work Authorities limits. Preschool children's hearing and perception of sounds can be assumed to differ from an adult as the torso, head, pinna and ear canal amplifies sounds in the higher frequency range more for a small child. Studies on children's perception and behaviour also support a stronger response to high frequencies. To study the risk of hearing impairment for preschool children we have carried out two preparatory studies. One among 12 preschool children from two preschools in 2015, and one among 33 preschool children from six preschools in 2017. Hearing function was measured by Distortion Product Otoacoustic Emissions (DPOAE). Our first study showed a reduced function at 6 kHz (right ear) mean reduction of DPOAE amplitude 2.59 dB ($F=5,80$, $df=1$, $p<0,05$) after a day at preschool. Preliminary data from the follow up, show a reduced DPOAE amplitude over the week with similar effects sizes as the previous study, but with the most clear and significant effects for 3 and 4 kHz (right ear). The results imply that the sound environment at preschools may affect the hearing function among children, but further investigations are needed to validate the results.

ISSUES ON INFANT HEARING (2)

DEAFNESS AND LINGUISTIC COMPETENCE: THE APPROACH OF LOGOGENIA

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Aim of this abstract is to present the linguistic impairment of deaf people and the approach proposed by Logogenia to attend it. From the screening of a group of 15 deaf children, it emerges that their linguistic competence has difficulties in comprehension and production in Italian morphosyntactic structures.

To know a language as a mother tongue means to have competence in that language and if you have linguistic competence, it means that you developed the biologic human-specific language faculty. Its activation and development are due to the presence of two elements: the linguistic and the temporal factor. The former is the input given by the language exposition; the latter is the "critical period" during which the nervous system is especially sensitive to linguistic environmental stimuli.

These conditions are fully satisfied in the hearing's experience who acquire at a very early stage and naturally the language that they are exposed to. Deaf children instead, can't receive this rich oral exposition because of their impaired hearing so their language acquisition can be compromised.

Poor stimuli and the approach of critical period can therefore prejudice the process of the acquiring of a language. This impairment is not strictly related with deafness but with the kind of linguistic stimulus that must be qualitatively and quantitatively appropriate. For this reason, deaf people can acquire an oral language as mother tongue but we have to give them the possibility to receive this type of stimulation inside the critical period.

Logogenia has the aim to find a solution to this problem identifying which is the necessary and sufficient syntactic linguistic stimulus to develop the language acquisition process, not considering the irrelevant and redundant structures typical of the hearing's linguistic environment.

Through minimal pairs (M.P.), pairs of sentences and/or of orders that differ in only one syntactic element that brings distinct meanings, Logogenia gives to deaf children the necessary syntactical elements to facilitate the biologic linguistic faculty. M.P. use children's intuition avoiding any explicit grammatical analysis. This stimulation is made by the written form that has the advantage to use the sight (not compromised) and to leave a clear sign of the linguistic stimulus always accessible to deaf children.

The written form becomes the manifestation of the mother tongue for deaf children who are acquiring it, so it is important to exploit them to it. It is a necessary vehicle to improve the linguistic stimuli and have a better condition of exposition. In this way, deaf people can develop linguistic competence naturally, intuitively and not instructively as hearing people.

AUDIOLOGICAL PROFILE AND FOLLOW UP IN CHILDREN WITH SLIGHT-MILD SENSORINEURAL HEARING LOSS

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Aim: Slight or mild hearing loss has been considered as a factor affecting speech, language, learning, and academic outcomes, but the risk factors and treatments for slight-mild sensorineural hearing loss (SNHL) have not been ascertained. The audiological evaluations of children with bilateral mild SNHL were presented, along with a qualitative description of other clinical features that could be relevant to the etiology of the hearing loss. Another goal of this population-based study was to ascertain risk factors for slight-mild hearing loss, to determine the number of children using hearing aids and the speech and language development of these children.

Method: This study was carried out by examining the file of 40 children diagnosed with slight-mild hearing loss who referred to the audiology department of the Marmara University hospital between 2013-2017. The family form for demographic information and SSQ (Speech Spatial Qualities) form were filled by parents.

Result: Fourty children with slight-mild SNHL were identified between 2013-2017 in our audiology department. 11 children had a slight loss (16 to 25 dB HL) and 29 had a mild loss (26 to 40 dB HL). The

majority of the losses were bilateral and symmetrical. The most prevalent risk factor was neonatal intensive care unit stay. The audiological test results and SSQ results will be presented.

Conclusion: Neonatal hearing screening programs can help to identify slight and mild hearing losses earlier than ever. Early identification of hearing loss will lead to early intervention in these children.

HEARING SCREENING FOR FIRST GRADE PUPILS IN PRIMARY SCHOOL IN MAZOWSZE REGION (POLAND) IN YEARS 2017/2018

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Introduction Hearing is one of the senses provided proper development of cognitive and social processes. It also directly influences for intellectual development. In addition, the sense of hearing is fundamental for speech and language abilities. Disorders of hearing in children aged 5 - 7 years most often are caused by infections of the upper airways, birth defects or environmental factors such as noise. Often, hearing impairments are not detected by parents or caregivers. What is important, early medical intervention in a child with hearing disorders regardless of their etiology means faster improvement of its auditory pathway functions and thus better communication with the environment as well as reduction of costs for the patient and for the healthcare system. Therefore, school-entry hearing screening is especially important.

Materials IFPS (The Institute Psychology and Pathology of Hearing) has started new hearing screening programs, involving the entire Mazowsze region. It is the first in the world region where hearing screening encompasses the whole population of children beginning school education. Screening was organized under 37 projects under the framework of the Program of Hearing Screening for First Grade Pupils in Primary Schools in Mazowsze Region in years 2017/2018.

Methods Hearing screening protocol used in mentioned program including videotoscopy and pure tone audiometry. At the same time with audiometric examination, we conducted training for medical staff, led by experts and medical specialists: laryngologist, phoniatics and audiologist, speech therapist. In addition, specialist from the IFPS in Kajetany conducted training for parents and caregivers children from first grades.

Results The results of the audiometric tests were supplemented by the results of the questionnaire completed by the parents. This questionnaire including question concerning data on the potential causes of the child's hearing problems, medical history, possible presence of tinnitus, and any presence of learning difficulties. In addition, all results were performed using "SZOK" ® system. Use of a system to assist patients with remote diagnosis and to transfer audiological screening results to the Institute of Physiology and Pathology of Hearing in Kajetany. Integrating patient data into the "SZOK" ® system, will allow for quick service and thus shorten patient waiting times for visits to IFPS or other specialized facilities and as a comprehensive patient medical base. It is a unique solution in the field of telemedicine and e-health. Currently, we are examining children, therefore all results will be presented at the conference.

Conclusion Implementing universal hearing screening in school age children is a long and complicated process. Important issue is spread knowledge of necessary and significance of hearing screening. It is possible to use a telemedicine model to assess the hearing status of children and to provide a long-distance expert assistance. The latter is very important for rural areas without specialized medical services.

RESULTS OF HEARING SCREENING RESULTS AMONG SCHOOL-AGED CHILDREN IN LAGOS, NIGERIA

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Introduction Nigeria is a country where half of the population lives on the edge of poverty, without access to drinking water. In addition, the negligible development of otolaryngology and the lack of financial resources for health care, results in the lack of screening hearing tests of newborns, which are becoming to be a standard procedure in other countries. Hearing disorders disturb the child perception of sound, as well as the development of speech which in consequence negatively affects the child relations in society. The early detection of hearing impairments in children enables the effective implementation of medical and rehabilitation procedures or preventive treatment.

The **aim** of hearing screening in Nigeria was assessing the level of hearing in the group of school-aged children, as well as increase knowledge in the field of otolaryngology. The IFPS (the Institute Psychology and Pathology of Hearing) team provided numerous consultations, held interviews with teachers and provided guidance and information on diagnosis, treatment and auditory rehabilitation.

Materials Hearing screening was performed in group of 289 children from 5 to 12 years old. The most numerous group were children in 6-7 years old - 38,2% of tested pupils. Prior to testing, the children's parents were informed of the testing procedures and provided their written consent.

Methods All children were examined following tests: videotoscopic, pure tone audiometry which was performed on Sensory Examination Platform and also OAEs. Positive results of the screening test was defined as any hearing impairment greater than 20 dB HL in any ear, at any frequency from 500 to 8000 Hz. The results of the audiometric tests were supplemented by the results of the questionnaire completed by the parents. This questionnaire including question concerning data on the potential causes of the child's hearing problems, medical history, possible presence of tinnitus, and any presence of learning difficulties.

Results Analyzes of videotoscopy results showed that over 51% of the examined children had an incorrect result (including excessive earwax, mycosis, middle ear infections), of which almost half of them had this problem on both sides.

OAEs present in both ears was recorded in 30.5% of examined children, only in one ear in 28%, while the absence of otoacoustic emissions in both ears was found in 41.5% of tested children.

A hearing threshold value of 30 dB or more for at least one frequency in at least one ear was assumed to be a positive result of pure tone audiometry. In the group of children with positive results, moderate hearing loss was most commonly observed.

Conclusion Hearing screening conducted in Nigeria has once again confirmed the need to disseminate knowledge in otolaryngology, especially regarding ear hygiene. The results obtained suggest a significant prevalence of hearing problems. Based on the results, it would be important to introduce hearing screening as a routine, standard procedure. These tests should be carried out as soon as possible. Due to limited funds, it is important to introduce solutions generating minimum costs.

HEARING HELP SEEKING

"WHATTAGE": A USEFUL CONSTRUCT IN HEARING HEALTH CARE

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A number of variables mitigate personal awareness of a hearing impairment and reduce motivation to pursue corrective amplification. "Whattage" is a hypothetical construct that represents the frequency with which a listener uses "What?", cognate words or behaviors to prompt repetitions by a Communicatively Significant Other (CSO.) There are no such parallel communicative interactions inhibiting access to vision correction. Gender differences in communicative style enhance compliance. The concept of "Whattage" has broad implications for marketing the value of hearing correction to the general public as well as individual members of the communicative dyad.

A comprehensive, illustrated and annotated discussion of this topic can be accessed at <http://www.hearingreview.com/2017/06/whattage-hypothetical-construct-hearing-healthcare/>

An anecdotal follow-up can be accessed at: <http://www.hearingreview.com/2017/10/blog-whattage-deliver-counter/>

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PREDICTORS OF TAKING UP A HEARING-AID: A PROSPECTIVE STUDY IN OLDER HEARING-AID CANDIDATES

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Background: Reviews identified a number of factors that consistently predict the likelihood of hearing aid uptake in older adults: self-reported hearing disability, hearing loss (pure-tone average hearing thresholds), age, social support or pressure, and viewed barriers to and benefits of hearing aid use. Nonetheless, many other factors were either scarcely examined or show mixed results (e.g., stage of behavior change, coping, self-efficacy of hearing-aid handling). Moreover, past studies seldom included multivariable models and prospective data, limiting the findings' validity. The current study aimed to examine what are relevant predictors of hearing aid uptake by using multivariable prediction models and prospective data. The study builds on the results obtained in the PredictEAR study - a recent study by our group in which we identified the predictors of the step preceding hearing aid uptake: entering a hearing-aid evaluation period. That study showed that perceived hearing-aid benefits, social support and pressure, self-reported hearing disability, hearing loss, and stigma perceptions were significant predictors. Importantly, the predictive strength of self-reported hearing disability was stronger for persons who were relatively ready to take action on their hearing problems (and less so for relatively less ready persons). Interestingly, for persons who were unready for change, self-reported disability seemed to lower the odds to entering an evaluation period. In the current study, it will be examined whether similar predictors arise for hearing-aid uptake, and whether similar interaction effects by gender and readiness for change will emerge.

Methods: Secondary data analysis of the baseline data of the SUPR-study was performed. The SUPR-study is a currently ongoing cluster-randomized controlled trial aiming to assess the effectiveness of a support program for older (aged 50 years and over) hearing-aid candidates and their communication partners and is carried out in a hearing-aid dispenser setting. For the current study, baseline outcomes of 296 hearing aid candidates were used and included as potential predictors of hearing-aid uptake. Hearing-aid uptake (yes/no) was included as the central outcome of the current study. The following potential predictors were included and were treated as 'likely' predictors in the analyses: self-reported hearing disability, hearing loss, presence of a communication partner, and age. The following were treated as 'novel' predictors: use of communication strategies, personal adjustment to hearing loss (coping), self-efficacy of hearing aid handling, readiness to take hearing action, satisfaction with dispenser services, marital status, living situation, level of education, and occupational status. Multivariable logistic regression analyses (backward selection) were applied to firstly determine whether 'likely' predictors were significant predictors in our sample. Secondly, reclassification tables were used to indicate whether or not novel factors significantly added predictive value to the model. Lastly, interactions between significant predictors and the factors gender, age, and readiness for change were examined by assessing statistical significance ($p < 0.05$) of their interaction terms.

Results and Discussion: Results will be presented and will indicate whether or not the factors that were previously identified as predictive of entering a hearing-aid evaluation period are also predictive of taking up a hearing aid. Moreover, the results will shed more light on the interaction by readiness to take hearing action: does a relatively high readiness increase the predictive strength of self-reported hearing disability to take up a hearing aid? And does low readiness cause higher self-reported disability to hamper hearing aid uptake? These results and implications for future research and clinical practice will be discussed.

AUDIOLOGY AS FIRST POINT OF CONTACT IN PRIMARY CARE WITHIN UK NHS

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Introduction Traditionally in the UK, people with hearing difficulties, tinnitus and BPPV (undiagnosed) will present to their GP to seek advice and investigation. Many of these people will be referred on to Secondary Care Audiology or ENT for assessment and management.

It is well recognised that demands on Primary Care and General Practitioners is increasing and set to increase further. This scheme directly releases GP capacity by replacing the GP as the first point of contact with an Advanced Practice Audiologist.

In addition to releasing GP capacity this scheme enables Audiologists to contribute to a sustainable primary care workforce; enables provision of care sooner and closer to home; improves integration between primary and secondary care; raises the profile of hearing, tinnitus and BPPV as important health conditions; improves accessibility for these health conditions; improves patient satisfaction.

Method Currently 5.5WTE Advanced Audiology Practitioners provide a service to 31 GP practices. Adult patients reporting hearing loss, bothersome tinnitus or vertigo can be signposted directly to the Audiology Clinic. An audit record is maintained recording the referral route and outcome for each patient seen.

Results The results from the most recent data will be presented. The number of patients seen by the Audiologists in primary care now exceeds 5000. Results will include route of referral to the Audiology clinic, the reason for appointment and the outcomes. Feedback from both the patient's perspective and clinical staff within the GP practices will also be included.

Discussion This presentation will discuss progress to date against key service performance indicators. We also examine the steps taken to build the service, and explore the likely challenges and opportunities for further development.

ETIOLOGY AND MEDICAL ISSUES (1)

AUSTRALASIAN GUIDELINES ON INVESTIGATIONS FOR CHILDHOOD HEARING LOSS

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Background

Australia currently has a high quality universal hearing screening program. However, there are no existing guidelines beyond the screening process and clinical management of infants with newly diagnosed hearing loss seem suboptimal. In 2016, the International Pediatric Otolaryngology Group released consensus recommendations for childhood hearing loss investigations. However, international recommendations may not be applicable to the Australian setting. The Childhood Hearing Australasian Medical Professionals (CHAMP) Network was recently established as a network of pediatricians, otolaryngologists and geneticists to establish Australasian recommendations for childhood hearing loss investigations with the goal of facilitating and improving care of these children in Australasia.

Methods Expert opinions, round-table discussions and literature reviews by members of the CHAMP Network. Recommendations were made on the basis of hearing loss type, clinical presentation and available evidence, with consideration for the practicalities of limited resource settings and family preferences. Separate recommendations were made for children with bilateral versus unilateral hearing loss. Recommendations were also divided into three tiers: Tier 1 as first line investigations, Tier 2 as second line if Tier 1 investigations are negative, and Tier 3 as indicated for particular clinical presentations.

Key recommendations Saliva swab for cytomegalovirus (CMV) polymerase chain reaction (PCR) should be taken where possible within 3 weeks of birth for all infants with newly diagnosed hearing loss. Beyond 3 weeks of age, CMV PCR should be performed through the neonatal dried blood spot. Early magnetic resonance imaging (MRI) of the brain and parasagittal sections of the internal acoustic canal is recommended to all infants with sensorineural hearing loss or auditory neuropathy (ANSD) where resources are available. Most centres offer either

'feed-and-wrap' or sedation in the first few months to avoid the need for a general anesthetic (GA). In most settings where resources are limited, early MRI should be offered to those with unilateral/asymmetric/mixed hearing loss or those with bilateral severe/profound loss in preparation for the possibility of cochlear implantation. For those who did not have an early MRI, and where etiology is still unknown, an MRI without GA may be offered at school entry to consider enlarged vestibular aqueducts and allow for appropriate counseling and/or management. Genetic testing should be offered based on parental desire after adequate genetic counseling for those with bilateral hearing loss. Connexin testing and microarray are the recommended first line genetic tests, followed by gene panels/whole exome sequencing where available. The role of genetic testing in unilateral loss is limited. Audiology testing of first degree family members is recommended for all children. Ophthalmology examination is also recommended for all.

All other investigations should be offered according to clinical presentation. ECG should be offered to those with bilateral severe/profound hearing loss or those with a positive family history of sudden death. Older children without known etiology should be offered urine dipstick at around 10 years of age to exclude Alport syndrome.

SODIUM THIOSULFATE AS OTOPROTECTANT TO REDUCE THE INCIDENCE OF CISPLATIN CHEMOTHERAPY-INDUCED HEARING LOSS IN CHILDREN WITH LIVER CANCER: RESULTS OF A RANDOMISED CLINICAL TRIAL SIOPEL 6

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Background: Bilateral high-frequency hearing loss is a serious permanent side-effect of cisplatin (Cis) therapy; particularly debilitating when occurring in young children. Sodium Thiosulphate (STS) has been shown to reduce Cis-induced hearing loss. SIOPEL 6 is a phase III randomised trial to assess the efficacy of STS in reducing ototoxicity in young children treated with Cis for the most common form of primary liver cancer in children namely hepatoblastoma. This trial was restricted to children with localised disease who have an excellent prognosis and where previous studies have shown that 60% develop hearing loss. Cis is used to treat many cancers in both adults and children. This is a proof of principle trial. Although high-frequency hearing loss can be helped with hearing aids, these are not available to all children across the globe and do not provide normal hearing. These children have a long life-expectancy and permanent side effects of treatment severely affect quality of life, development and social integration.

Methods: Newly diagnosed patients were randomised to Cis or Cis+STS for 4 preoperative and 2 postoperative courses. Cis 80mg/m² was administered over 6 hours, STS 20g/m² was administered intravenously over 15 minutes exactly 6 hours after stopping Cis. Tumour response was assessed after 2 and 4 preoperative cycles with serum alphafoeto-protein (AFP) and liver imaging. The primary endpoint was centrally reviewed absolute hearing threshold, at the age of ≥ 3.5 years by pure tone audiometry. The Brock grading scale (0-4) was used to compare hearing loss between groups.

Results: 109 randomised patients (52 Cis and 57 Cis+STS) were evaluable. The median age at diagnosis was 13 months (range 3.0-98.6 months). The combination of Cis+STS was generally well tolerated. At median follow up of 52 months, 3-year event-free-survival (EFS) was Cis 78.8% (95% CI 65.1%-87.7%) and Cis+STS 82.1% (69.2%-90.0%); 3-year overall-survival (OS) was Cis 92.3% (80.8%-97.0%) and Cis+STS 98.2% (88.2%-99.8%). Absolute hearing threshold was assessed in 101 evaluable patients, hearing loss of Brock grade 1-4 occurred in 29/46 = 63.0% under Cis and in 18/55 = 33.0% under Cis+STS, showing a 48% reduction in the incidence of hearing loss (RR: 0.52, p = 0.002; 95% CI: 0.33-0.81).

Conclusion: This randomised phase III trial of cisplatin versus cisplatin plus sodium thiosulfate in localised hepatoblastoma showed that the addition of sodium thiosulfate significantly reduced the incidence of cisplatin-induced hearing loss without any evidence of tumour protection. These results support the use of the platinum otoprotectant STS in localised disease.

THE YIELD OF A SYSTEMATIC ADVANCED ETIOLOGIC APPROACH WITHIN THE ACTIVITY OF THE UNHS PROGRAM AND CHILDHOOD HEARING SURVEILLANCE (CHS) PROGRAM IN FRIULI VENEZIA GIULIA REGION, ITALY

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Most universal newborn hearing screening (UNHS) programs lack a systematic etiologic focus with reported percentage of permanent hearing loss (PHL) of uncertain etiology ranging from 30% to 60%.

The aim of this study was to obtain data on the diagnostic yield of a systematic etiologic approach within the activity of the UNHS program and childhood hearing surveillance (CHS) program in Friuli-Venezia-Giulia region, Italy. All newborns and children aged 0-3 screened or monitored during the period July 2012-June 2014 (19.468 subjects) were included in the study. The diagnostic data were further revisited in 2017.

UNHS is performed with A-TEOAE and A-ABR while CHS is performed by High Risks Registry (JCIH 2007). Neonates failing the screening or having an audiologic risk undergo complete audiologic diagnostic evaluation that includes: ABR, admittance testing, DPOAE, questionnaire of auditory development. Children with permanent hearing loss (PHL) undertake 1.level (ENT examination, ophthalmology, TORCH, ECG, GJB2/GJB6 mutation analysis) and 2. level etiologic assessment (neuro-imaging, clinical genetic evaluation, Targeted Sequencing Panel including 96 genes). Results are discussed by a multidisciplinary team and cases are further classified into 4 etiologic groups: (1) PHL of exogenous origin (2) defined syndrome that includes PHL (3) GJB2/GJB6 biallelic PHL (4) putative non-syndromic PHL. The latter group of subjects was identified for targeted re-sequencing by Ion Torrent PGM (Life Technologies) to analyze coding and UTR regions of 96 genes related to PHL and hearing function.

An etiologic diagnosis has been achieved in 90% of examined bilateral PHL cases. The Targeted Sequencing panel clarified etiology in 50% of subjects for whom the putative genetic aetiology was not characterized by the standard etiologic protocol. It is important to underline the high number of loss to follow up subjects in the articulated path of audiological and etiological investigation of a neonate or an identified child.

AUDIOLOGICAL FOLLOW-UP OF INFANTS WITH CONGENITAL CYTOMEGALOVIRUS INFECTION FOLLOWING ANTIVIRAL TREATMENT

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Background and Objectives: The most common cause of non-genetic sensory-neural hearing loss (SNHL) is congenital cytomegalovirus (cCMV) infection. Hearing loss may be present at birth or delayed in onset. Antiviral treatment (i.e. valganciclovir) was recently reported to reduce further worsening in hearing thresholds and in some cases even modestly improving long term hearing outcomes. The aim of the present study was to examine the audiological outcome of infants diagnosed with cCMV following antiviral treatment.

Methods: We retrospectively reviewed the audiological and medical records of 42 infants with cCMV infection who were treated with valganciclovir at the pediatric infectious disease unit at Sheba Medical Center between 2009 and 2017. All infants underwent audiological follow-up at the Hearing, Speech and Language Center, Sheba Medical Center. Thirty five infants were treated due to symptoms involving the central nervous system with or without SNHL and seven infants were treated solely due to SNHL. The median age of audiological follow-up was 13 months.

Results: Fifteen infants (24 ears) were diagnosed with SNHL prior to treatment. Following the antiviral treatment and the audiological follow-up, hearing thresholds in 14 of the 24 affected ears (58%) remained stable, improvement in hearing thresholds was observed in 5 ears (21%) and 5/24 (21%)

showed further deterioration in thresholds. Improvement in hearing thresholds was only observed in cases with mild hearing impairment. Late onset hearing loss was observed in one infant (1/27, 3.7%) of those who had normal hearing thresholds at birth.

Conclusions: The majority of infants who were offered antiviral treatment showed preservation of their hearing thresholds and in some cases showed minor improvement. Antiviral treatment did not prevent, however, hearing deterioration in some cases.

OPTIMIZING DETECTION OF CONGENITAL CYTOMEGALOVIRUS IN INFANTS WITH HEARING LOSS USING A MEDICAL DIRECTIVE

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Background Congenital cytomegalovirus-related hearing loss accounts for 20% of newborn hearing loss at birth. It is the only form of newborn hearing loss where a treatment exists to improve hearing outcomes – antiviral therapy – if initiated at an early age. Despite this, not all institutions routinely test for congenital cytomegalovirus infection.

Methods At the Children's Hospital of Eastern Ontario, we have developed a screening protocol for congenital cytomegalovirus in all children with newly identified hearing loss. Testing is performed by audiology immediately upon the detection of hearing loss. Baseline demographic data, clinical characteristics, and time to detection and treatment were recorded.

Results Screening results from January 2016 to March 2017 are currently available. The incidence of congenital cytomegalovirus induced hearing loss in children aged one year or less in this time frame was 16%. With the protocol, the mean age of congenital cytomegalovirus screening was 63 days, and mean age to treatment with valganciclovir was 78 days.

Conclusions The screening protocol by audiologists with a medical directive for congenital cytomegalovirus in cases of newborn hearing loss allows for early detection and facilitates earlier treatment with antiviral therapy. Further studies are needed to determine effectiveness of treatment in children with hearing loss and otherwise asymptomatic congenital cytomegalovirus infection.

SUDDEN SENSORINEURAL HEARING LOSS TREATMENT: INTRATYMPANIC STEROID INJECTION VERSUS SYSTEMIC THERAPY

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Introduction: The aim of this study is to verify the efficacy of the intratympanic steroid injection as first line therapy for the treatment of sudden sensorineural hearing loss and comparing its results with the ones obtained using a systemic steroid therapy alone or in association with the hyperbaric oxygen therapy.

Material and Methods: With a retrospective analysis, at the Otorhinolaryngology Department of the San Martino Hospital – University of Genova, we evaluated 90 patients affected by monolateral sudden sensorineural hearing loss that referred to our Hospital from January 2015 to September 2017: 23 underwent a systemic steroid treatment (EV), 50 were treated with systemic steroid treatment associated with hyperbaric oxygen therapy (EV + HBOT) and 17 only with intratympanic steroid injection (ITS). The hearing loss was evaluated considering the pre-treatment Pure Tone Average (PTA pre) and the one tested one month after the end of the therapy (PTA post). For the hearing outcome analysis we took into account the PTA variation (Delta PTA) and the relative Gain, respectively defined as $\Delta PTA = PTA_{pre} - PTA_{post}$ and $Gain_{PTA} = \Delta PTA / PTA_{pre}$. For the evaluation of the Hearing Outcome with categorical classification we used both the Siegel and Fuhrashi criteria. A statistical univariate analysis with the Chi squared, Fisher's exact and Kruskal-Wallis tests was carried out. The multivariate analysis was done using a logistic regression.

Results: The PTA pre analysis showed no statistically significant differences among the three groups. The ΔPTA for the patients that underwent EV, EV + HBOT or ITS therapies resulted respectively of 16 dB, 19 dB and 29 dB ($p=0,04$); the $Gain_{PTA}$ respectively 23, 27 and 50 ($p<0.01$). The Hearing outcome analysis demonstrated a therapeutic success in the EV, EV + HBOT and ITS groups of the 30%, 42% and 82% according to the Fuhrashi criteria ($p<0.01$) and of the 44%, 48% and 82% using the Siegel criteria ($p=0.02$).

From the multivariate analysis emerged that, among the clinical parameters reviewed, the only success positive predictor was the choice of the intratympanic steroid therapy with an Odds Ratio of 16 ($p < 0.01$) and of 10 ($p = 0.01$), applying the Fuhrashi and Siegel criteria. Therefore, the results of our study demonstrated the higher efficacy of the steroid therapy given by an intratympanic injection in causing a hearing gain and the stability of the result in time. Furthermore, the ITS treatment was the only variable associated with a better therapeutic success.

Conclusions: According to these results, we consider and propose the intratympanic steroid therapy as first line treatment in the sudden sensorineural hearing loss, both for the audiological outcomes and for its comfort (easiness of execution, limited number of administration, absence of collateral effects)

INCIDENCE AND OUTCOMES OF PERMANENT CHILDHOOD HEARING IMPAIRMENT IN NEONATES WHO RECEIVED THERAPEUTIC HYPOTHERMIA FOR SUSPECTED HYPOXIC-ISCHAEMIC ENCEPHALOPATHY: SINGLE CENTRE REVIEW OVER A 10-YEAR PERIOD

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BACKGROUND & AIM: Perinatal asphyxia is a recognised risk factor for permanent childhood hearing impairment (PCHI). Moderate whole-body therapeutic hypothermia (TH) has been recommended in moderate-to-severe hypoxic-ischaemic encephalopathy (HIE) since 2010 because it improves neurological outcomes. In the UK, all babies including those with HIE undergo routine hearing screening as part of the UK's newborn hearing screening programme. The process involves otoacoustic emissions (OAEs) and/or automated Auditory Brainstem Response (aABR; automated ABR) testing; if no clear response is obtained then diagnostic ABR is completed. Most babies on the neonatal intensive care unit receive both OAEs and aABR screening. Our aim was to define the incidence and audiological outcomes of permanent childhood hearing impairment (PCHI; ≥ 21 dB) in a cohort of infants who received TH for suspected HIE during the past decade.

METHODS: We reviewed newborn hearing screening results, the results of any later audiological testing, and diagnosis of PCHI in neonates who had received moderate whole-body TH (core temperature maintained at 33.0-34.0°C for ≥ 72 hours) for suspected HIE in our tertiary-level neonatal intensive care unit during the 10-year period 2007 to 2017.

RESULTS: Of 218 babies who received TH for suspected HIE during the study period, 21 were excluded because they died. Of 197 survivors, hearing screening results were available for 195 infants (98.9%). Of these, 183 (93.8%) did not have PCHI, and 12 (6.2%) had a diagnosis of PCHI. The clinical severity of the neonatal HIE had been graded as mild in two cases, moderate in three cases, and severe in seven cases. The newborn hearing screening results of the 12 infants who were later diagnosed with PCHI had shown no clear response for 10 (3 unilateral referrals; 7 bilateral referrals); 2 could not be completed before discharge. Diagnostic ABR testing indicated that 11 infants had bilateral impairment and 1 had unilateral impairment. Severity of PCHI was classed as mild in $n=2$, moderate in $n=9$, and profound in $n=1$. Seven had hearing aids fitted (two of them required later cochlear implants); three received advisory intervention but no amplification was required (these children have been actively observed with advisory input, including referral to specialist teachers for optimising listening environments at nursery and school); outcome data were unavailable for two infants.

CONCLUSION: This is the largest cohort study to date reporting audiological outcomes and the incidence of permanent childhood hearing impairment in neonates who received therapeutic hypothermia for suspected hypoxic-ischaemic encephalopathy.

POSTERS

P.01 - AUDITORY PERCEPTION, PROCESSING AND COGNITION

P.01.1

THE LONG-TERM EFFECTS OF UNILATERAL AND BILATERAL OTITIS MEDIA: A STUDY OF LONG-LATENCY AUDITORY POTENTIALS EVOKED BY VERBAL AND NON-VERBAL STIMULI

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Introduction: For speech and language development, a well-functioning hearing system is essential. The auditory system can be damaged in several ways, including from otitis media originating from inflammation of the middle ear, often associated with accumulation of infected fluid. Long-latency auditory evoked potentials (LLAEP) allow one to observe the neurophysiological substrate of processes that occur in the cortex related to cognition, such as memory, attention, sequential processing of auditory information, decision-making, and auditory discrimination. The elicitation with verbal stimuli provides additional information about the biological processes involved in speech processing, especially if it can provide complementary information to that obtained by standard behavioral evaluations, either cognitive, auditory, or linguistic. Few studies have looked at identifying OM-induced impairments in the central auditory function in children who have had a history of the complaint.

Objectives: The aim of the present study was to analyze Long-latency auditory evoked potentials responses elicited by verbal and nonverbal sounds in children who have had a history of OM in the first 6 years of life.

Method: A total of 106 school children participated in this study, 55 female and 51 male, aged between 8 and 16 years, and belonging to the elementary section of a public school. Control group (CG) consisted of 40 students (25 females and 15 males) with no history of OM and no school complaints; Bilateral experimental group (BEG) consisted of 50 students (22 females and 28 males) with a documented history of three episodes of OM, who had submitted to surgery for insertion of bilateral ventilation tubes in the first 6 years of age, and who had normal hearing at the time of evaluation; Unilateral experimental group (UEG) comprised 16 students (8 females and 8 males) with a documented history of three OM episodes, who had submitted to surgery for insertion of unilateral ventilation tubes in the first 6 years of age, and who had normal hearing at the time of evaluation.

Results: Statistical analysis of the sample showed homogeneity between the groups, both in terms of gender (male and female) and age group (8–11 years and 12–16 years). LLAEP with nonverbal stimulus (tone-burst): (i) a significant difference in the latency of /P2 and N2 in females; (ii) CG differs from BEG for both P2 and N2 latency in females; (iii) a difference between males and females in the amplitude of the P2 wave; (iv) there is no significant difference in P2 wave amplitude values for females between the studied groups. LLAEP with verbal stimulus (speech): (i) a difference between males and females in N2 wave latency values; (ii) a significant difference in the latency for waves N1, P2, N2 (female), and P300, with all of them being prolonged in the OM groups; (iii) a significant difference in amplitude for N1 and P2, with the OM groups showing smaller amplitudes.

Conclusion: Children who had suffered from secretory otitis media in their first 6 years of life and underwent myringotomy surgery for placement of unilateral or bilateral ventilation tubes presented poorer performance in their electrophysiological responses to verbal and nonverbal stimuli compared to children with typical development and normal hearing.

P.01.2

OTITIS MEDIA IN CHILDREN: CENTRAL AUDITORY SYSTEM ASSESSMENT AND REHABILITATION

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Introduction: the presence of otitis media in childhood may result in changes in the auditory processing information. Behavioral and electrophysiological evaluations contribute to verify the functioning in the

central auditory nervous system. Once detected a failure in decoding information, auditory training is applied in order to activate the neural circuitry for beneficial changes in auditory behavior and central nervous auditory system.

Objective: to analyze the central auditory nervous system function through behavioral and electrophysiological tests in children with a history of otitis media and subsequent bilateral tubes placement surgery and analyze the results of behavioral and electrophysiological evaluation after an auditory training program.

Methods: The participants were divided into three groups: control group (CG) consisted of 40 children with no history of otitis media; otitis media group (OM) consisted of 50 children with documented history of otitis media and undertook a surgery for bilateral tubes placement and otitis media group 2 (OM2) consisted of 20 children who performed a formal auditory training. All children completed audiological evaluation (audiometry, speech audiometry and immittance audiometry), behavioral evaluation (tests: dichotic digits, synthetic sentence identification with ipsilateral competing message, gaps-in-noise, frequency pattern and dichotic consonant-vowel) and electrophysiological assessment (Auditory Brainstem Response and Long Latency Evoked Potential). The participants who had two or more abnormal tests in the behavioral evaluation of Central Auditory Processing were invited to participate in an auditory training program and were subsequently reassessed.

Results: The OM group showed significantly poorer performance ($p < 0.001$) than the CG for all auditory abilities. The results in the Auditory Brainstem Response revealed significant latency delays and reduced amplitude ($p < 0.001$) of waves III and V. The measures in the Long Latency Evoked Potential Auditory showed significant latency delays of P2, N2 and P300 in children with a history of otitis media ($p < 0.05$). After the auditory training program, the OM2 showed considerable improvement in all behavioral tests. Trained children presented significant latency reduction in the measure of wave P300 ($p < 0,001$).

Conclusion: The results demonstrate the negative effect of otitis media in the auditory abilities and electrophysiological measures in children with a history of otitis media. The present study also reveals the effectiveness of the auditory training program as shown at the better performance in auditory processing tasks and reduced latencies of wave P300.

P.01.3

AUDITORY TRAINING: EFFECT ON THE AUDITORY ABILITIES IN CHILDREN WITH HISTORY OF OTITIS MEDIA

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Introduction: otitis media is one of the most common infections during childhood, and can damage the processing of auditory information. Through the behavioral evaluation it is possible to observe how the central auditory nervous system process information and to verify the presence of central auditory processing disorder (CAPD). Auditory training (AT) is an intervention based on neuroplasticity that aims to reorganize the neural substrate and improve altered auditory abilities. Objective: to evaluate the efficacy of AT in children and adolescents with history of otitis media.

Methods: prospective cross-sectional study. The sample was selected from a public hospital and composed of 38 subjects that were divided into three groups: auditory training group (ATG) - formed by 20 children who underwent an auditory training program; visual training group (VTG) - 14 children who performed a visual training program; and non-intervention group (NIG) - formed by 4 subjects who did not undergo any type of stimulation. All children completed audiological evaluation (audiometry, speech audiometry and immittance), and behavioral evaluation (tests: dichotic digits, synthetic sentence identification with ipsilateral competing message, gaps-in-noise, frequency pattern and dichotic consonant-vowel). Auditory training (AT) and visual training (VT) programs were conducted with activities from a website. In both interventions same abilities were stimulated for all subjects independent of CAPD type found in the initial evaluation. All subjects in three groups were re assessed after eight weeks.

Results: after the AT sessions, there was a statistically significant difference in performance for all behavioral tests (< 0.001). There was also a statistical difference in percentage of individuals in reference values for binaural integration (0.001), temporal ordering (0.0000), temporal resolution (< 0.0001) and figure ground (< 0.0001) in ATG. In VTG, there was no significant difference in the performance of behavioral tests and percentage of subjects within normal values. Regarding to the non-intervention group (NIG), the descriptive analysis of the average percentage of correct answers in the behavioral

evaluation revealed a slight improvement in dichotic digits and synthetic sentence identification with ipsilateral competing message tests, and worse performance post intervention in frequency pattern and gaps in noise tests.

Conclusion: Auditory training was effective as an intervention strategy to re-adjust the altered auditory skills in subjects with a history of otitis media.

P.01.4

CAPD - DICHOTIC LISTENING - IN CHILDREN WITH DEVELOPMENTAL DYSPHASIA

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The **aims** of our study: to analyse the role of auditory perception in children suffering from developmental dysphasia (DD) using speech dichotic central tests. Dichotic listening is a technique of simultaneously presentation of different stimuli in both ears.

Methods We developed special dichotic tests in Czech language. We have focused on comparison of dichotic listening in pre-school children with DD and in older DD children with dysortographia with normal developed children. Several types tests were used, from two-syllable words or from short sentences. The threshold value of presentation was at 60 dB HL using the two-channel audiometer.

Results evaluate the percentage rate of success of the words recognized. Group of 125 children with DD (age 6 – 7 yrs). The average rate of success of these children: 57 %, 64 %, 63 % (control group 92 %, 93 %, 91 %). Results in 52 older children (8 - 10 yrs.): 85 %, 86 %, 86 %; but only 73 % and 61 % in more exacting tests (control group: 98 %, 98 %, 99 %, 92 % and 87 %). Highly significant differences (p 0.001) were confirmed by statistical evaluation (pair t-test).

Conclusions Results of the dichotic tests in children with DD and dysortographia confirmed integration problems in the central perception area and the short-term memory disorder. The findings of pre-school aged DD children confirmed disability to synthesize 2 two-syllabic words during dichotic listening. Older children with dysortographia as residual forms of DD have difficulties on the phonological level and on the auditory differentiation level of distinctive phonemes features.

P.01.5

CLINICAL IMPLICATION OF COCHLEAR DEAD REGION IN TINNITUS: PROSPECTIVE STUDY

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Background and Objectives Tinnitus refers to external auditory stimulation or auditory awareness in ear or head without electrical signals and causes many disabilities in daily life in severe cases. There are many causes of tinnitus and many cases are unknown. Especially, 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.

Subjects and Method We performed a prospective study of 40 patients with normal hearing among the patients complaining of tinnitus in our department. 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.

Result In this study, 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 between the two groups. 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 As a result, 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.

P.01.6

LONGITUDINAL EVALUATION OF AUDITORY SKILLS OF CHILDREN WITH HEARING LOSS: A COMPARISON BETWEEN PARENTS' AND PROFESSIONALS' OBSERVATION

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Increasing implementation of universal newborn hearing screening programs has greatly lowered the age at identification and intervention of hearing loss. After early intervention enrollment, the evaluation of young children's functional auditory skills relies predominantly on parents' report. However, few studies systematically investigate the differences between parents' and professionals' evaluation on the development of auditory skills after enrolling in intervention. The purpose of the study was to compare parents' and therapists' observations on the longitudinal auditory skill development in children with hearing loss who were newly enrolled in the auditory-verbal program.

The parents and auditory-verbal therapists (AVTs) of 11 children (7 females) with hearing loss were recruited in the study. These children have been receiving auditory-verbal therapy services from the Children's Hearing Foundation in Taiwan. The children's auditory development was evaluated for 12 months at 3-month intervals (five evaluations were conducted: baseline, 3-, 6-, 9-, and 12-month). At baseline evaluation, the mean age of the 11 children was 27.18 months (range: 16 to 52 months). The evaluation tool was the Mandarin version of Auditory Skills Checklist (ASC), originally developed by Meitzen-Derr et al. in 2007 for evaluating and monitoring the functional auditory skills of children with hearing loss. ASC was translated into Mandarin and reviewed by four experts, including a special education professor, an audiologist, an AVT/audiologist, and an AVT/speech therapist. The construct validity is moderate to high ($r = .55-.97$) and the internal consistency reliability is high (Cronbach's $\alpha = .78-.98$). The Mandarin ASC consists of 34 items which can be divided into five sections: audiological management, detection, discrimination, identification, and comprehension. The last four sections correspond to the auditory development stages described by Erber (1982). A rating of 0, 1, or 2 was assigned to each item which represents the child not having the skill, developing the skill, or consistently demonstrating the skill, respectively. The first three items referring to audiological management were not scored; therefore, the maximum total score was 62.

After receiving auditory-verbal therapy, hearing impaired children's auditory skills increased over time based on both parents' and AVTs' reports. During the 12-month period, average parents' rating grew from 39.8 (64.2%) to 51.4 (82.8%); average AVTs' rating increased from 22.7 (36.7%) to 44.4 (71.6%). There was a strong positive correlation between parents' and AVTs' ratings in all five evaluations ($r = .72-.86$, all $p < .05$). A two-way ANOVA revealed a significant main effect for evaluator (parent or AVT) ($F(1, 10) = 15.22$, $p < .01$), and for evaluation time ($F(4, 40) = 28.01$, $p < .001$). Moreover, post-hoc t-tests indicated that parents' rating was significantly higher than AVTs' rating in all five evaluations (all $p < .05$). A possible reason is that, compared to AVTs, parents spent more time with children and they may have observed more auditory behaviors. On the other hand, without professional training, parents may have overestimated children's skills without considering some visual cues available to children when assessing auditory skills. In addition, results of post-hoc pair-wise t-tests on evaluation time indicated that parents seemed to take at least 6-month intervals to observe the significant growth. However, AVTs

observe a significant growth at every 3-month interval except for the interval from 3- to 6-month evaluation, which may be a learning plateau. The results implied that AVTs may be more sensitive to the improvement of auditory skills.

ASC is a practical tool for AVTs and other professionals to evaluate children's auditory skills and monitor the progress during the intervention process. The study suggested that when assessing children's auditory skills, both parents' and professionals' reports should be considered. Parents' report may provide daily observations which cannot be observed in therapy or testing settings. However, parental reports should be referenced with caution because they may overestimate children's skills. In addition, compared to parents, professionals seem to be more sensitive to the growth of children's auditory skills. Professionals may take advantage of ASC to advise the parents on assessing children's auditory skills.

P.01.7

PREDICTIVE VALUE OF A TEST OF CENTRAL AUDITORY FUNCTION, THE DICHOTIC DIGITS TEST, IN CONVERSION FROM MILD COGNITIVE IMPAIRMENT TO ALZHEIMER'S DISEASE

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Background: It has been suggested that central auditory processing dysfunction (CAPD) might precede the development of cognitive decline and Alzheimer's disease (AD). A convenient and valid method to assess central auditory function is the Dichotic Digits Test (DDT).

Aim: The objective was to evaluate whether the DDT scores had the capacity to predict cognitive decline after five years in a study group consisting of patients with mild cognitive impairment (MCI), a possible precursor to dementia.

Methods: 60 participants, (27 female and 33 males) with MCI were tested at baseline with pure tone audiometry, speech in quiet and in noise, and the DDT. The cognitive outcome was retrieved from medical files after five years. Group wise comparisons of the baseline DDT scores were performed between 1) those who had developed AD, 2) participants who had developed other types of dementia, and 3) those who had not developed dementia.

Results: Altogether 24 subjects developed any kind of dementia (40%). From the original 60 individuals within the MCI group, 16 developed AD and eight developed other types of dementia.

There was no significant difference in baseline DDT scores between participants who converted to AD and those who did not. However, the group who developed other types of dementia (especially frontotemporal dementia) had significantly lower scores in the left ear than participants who did not develop dementia.

Conclusions: The baseline DDT scores did not predict which participants with MCI that would developed AD during the study period.

Participants with MCI who developed other types of dementia, especially frontotemporal dementia, had poorer DDT performance at baseline than those who did not develop dementia. The study sample was too small to permit any general conclusions regarding the capacity of DDT to predict a conversion to dementia. However, even if DDT did not predict the conversion from MCI to AD, there are indications that a conversion to other types of dementia could be predicted.

P.01.8

LEXICAL KNOWLEDGE AND SPEECH RECOGNITION IN ADVERSE LISTENING CONDITIONS

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Individual listeners vary greatly in their ability to understand speech in adverse conditions. Cognitive factors, including working memory capacity, are particularly important when faced with difficult listening

conditions, as more explicit speech processing is required to correctly identify words. However, other listener-based factors are also likely to play a role. It is hypothesized that listeners exploit their knowledge of the statistical properties of a language (e.g., phonological neighborhood density, word frequency) when attempting to understand speech that is masked by noise. Hence, linguistic experience may contribute to a listener's ability to identify words, even among people who share the same native language. There has been limited study of how long-term language knowledge influences native listeners' ability to implement this statistical knowledge in adverse listening conditions. Specifically, it is unclear whether language knowledge influences word perception as listening conditions become more difficult.

This study examined whether, in native English-speaking listeners, cognitive factors, vocabulary knowledge, and the statistical properties of language were predictive of a listener's ability to identify words. Furthermore, we compared the strength of these effects at different levels of noise disruption.

One hundred and three (103) young healthy listeners (mean = 21 years, range = 18 to 34 years, 58 females, 45 males) completed (a) individual measures of vocabulary knowledge and cognition and (b) a speech perception task. All listeners had normal hearing threshold levels. For the perception task, listeners heard 128 phrases spoken by eight New Zealand English talkers (four male and four female). Phrases were mixed with noise to produce four levels of speech signal degradation—at -5, -2 +1 and +4 dB signal-to-noise ratio (SNR). A counterbalancing process ensured that each listener heard 32 phrases at each of the SNRs, with equal numbers of phrases from each of the eight talkers. Listeners were asked to state what they heard following each phrase and were reminded that these were all real English words. Orthographic transcriptions of individual phrases were subsequently scored for accuracy. A series of binomial mixed effects models were run with word accuracy (correct/incorrect) as a dependent variable. Four models were detailed, one for each level of SNR. Fixed effects included measurements of listeners' vocabulary knowledge, as well as their working memory capacity, processing speed, and non-verbal IQ. Measurements of word frequency and phonological neighborhood density were also included. Random slopes and intercepts were included for speakers, listeners, and word stimuli.

Across all listening conditions, measurements of word frequency and phonological similarity were predictive of correct word identification. However, these language-based factors exerted less influence in the lowest SNR level, where listeners were only able to identify 20% of the words produced. Working memory capacity and vocabulary knowledge also accounted for unique variance in listeners' ability to identify words, but this was only statistically significant in a mid-range listening condition, where listeners could identify 67% of words produced. These results provide evidence that there is a greater demand on both cognitive factors and vocabulary knowledge in cases where the speech signal is ambiguous. The effect of vocabulary knowledge suggests that native listeners' long-term linguistic experience may be used to help restore missing phonetic information as the speech signal becomes more degraded. However, these data also indicate that listener-based factors have floor effects. When the audibility of the signal becomes too low, listeners can no longer recruit cognitive resources to restore missing speech features, and the words' language-based, statistical properties have little influence on its identification.

P.01.9

COMPUTER-ASSISTED SPEECH PERCEPTION ASSESSMENT DATA IN HIV+ AND HIV- ADULTS

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The nature of the hearing difficulties in HIV+ patients has been difficult to quantify. Prior research on speech audiometry in HIV+ and HIV- adults has been limited to quiet environments and have shown ceiling effects. A more complex listening task, such as speech-in-noise testing is more clinically informative and can be used to evaluate effects of HIV on speech communication, which evaluates both peripheral and central hearing perception. The purpose of this study was to examine Computer-Assisted Speech Perception Assessment (CASPA) data in HIV+ and HIV- adults from the Multicenter AIDS Cohort Study (MACS) and the Women's Interagency HIV Study (WIHS). The hypothesis was that HIV+

individuals would have more difficulty on the CASPA compared to HIV- controls with similar peripheral hearing ability determined by audiometry. CASPA testing was completed in a sound-treated room via sound-field testing. The speaker was placed 3 feet from the participant at 0° azimuth. Ten consonant-vowel-consonant (CVC) CASPA words were presented from 45 to 75 dB SPL in 5-dB steps with a fixed babble noise at 55 dB SPL and performance-intensity functions were generated. Outcome measures were obtained from phoneme scoring and consonants only scoring. Threshold, in dB, was the 50% correct score. In HIV+ participants, disease severity data included nadir CD4+ cell count and total anti-retroviral treatment time for protease inhibitors (PIs), nucleoside reverse transcriptase inhibitors (NRTIs) and non-NRTIs (NNRTIs). Data were analyzed using a linear mixed model that examined the association between CASPA performance and audiometry results (better ear 4000 Hz threshold) with age included as a confounder. On average, HIV+ adults (n=57) and HIV- adults (n=44) had similar mean thresholds for phoneme and consonant scoring; however, the HIV- adults had slightly poorer better ear pure-tone averages (500, 1000, and 2000 Hz) and more high frequency hearing loss. A statistically significant interaction ($p < 0.05$) was found between HIV status and better ear 4000 Hz thresholds. HIV+ participants had poorer performance on the CASPA at lower 4000 Hz thresholds, suggesting a difficulty with speech-in-noise perception despite normal audiometry. In HIV+ adults only, after adjusting for nadir CD4+ cell count and hearing sensitivity in the better ear, total time on PIs was significantly negatively associated with both phoneme threshold and consonant threshold ($p < 0.05$). Specifically, the longer the individual was taking a PI, the better (i.e., lower) the mean threshold. Total NNRTI time was marginally associated with both threshold measures, but NRTI total time was not associated with phoneme or consonant thresholds. To conclude, CASPA performance showed a tendency to be poorer in the HIV+ adults and this was not related to HIV treatment. In HIV+ participants, these preliminary results suggest HIV treatment (i.e., total time on PI or NNRTI) may preserve speech communication abilities. These data suggest additional studies on hearing in HIV+ adults are needed, specifically focused on more demanding auditory tasks, such as the CASPA.

P.01.10

COGNITIVE SKILLS AND SPEECH RECOGNITION IN ELDERLY PEOPLE: A STRUCTURAL EQUATION MODELING APPROACH

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Successful verbal communication is fundamental in daily life. Evidence suggests that among peripheral hearing abilities, cognitive skills play a role in speech recognition. Previous studies have shown that cognition is more important for speech recognition in noise, than for speech in quiet. In addition, speech recognition of elderly listeners declines if the complexity of a situation increases (e.g., more sound sources, more reverberation). Recent research suggests a complex interaction between sensorineural hearing loss and age-related changes in cognitive skills that may be causally related to the observed decline in speech recognition. Conversely, a decline in speech recognition is also assumed to be associated with a reduction of cognitive skills. However, the contribution of different cognitive skills and the role of aging and (aided) hearing loss on speech recognition remain unclear. Therefore, the relationship between different aspects of cognition and speech recognition was investigated in a large sample of elderly participants (N = 223).

Participants were aged 55 to 81 years (mean = 67.3 years, SD = 7.3 years). According to their hearing abilities and hearing aid use, they were grouped into normal-hearing participants (n = 92), participants with unaided mild-to-moderate hearing loss (n = 57) and hearing aid wearers with different types of hearing loss (n = 74). All participants completed an extensive test battery including a general anamnesis, questionnaires, examination of visual acuity, balance, tactile- and motor-skills. Air and bone conduction pure-tone thresholds were measured, as well as supra-threshold auditory processing in terms of binaural temporal fine structure. Measurements of speech recognition took place in free field. They included varying speech material (words, sentences) and different background signals (quiet, stationary noise, speech babble, and realistic cafeteria simulation). Cognitive skills were assessed via a neuropsychological test battery measuring working and short-term memory, selective and divided attention, executive functioning, vocabulary skills and processing speed. To ensure audibility, and to standardize hearing aid provision, individual hearing aids were replaced by identical ones provided by the experimenter. In total, 131 participants were fitted with hearing aids based on the indication criteria defined in German

healthcare guidelines, irrespective of previous hearing aid uptake. The hearing aids were adjusted to the individual hearing loss using the NAL-NL2 formula.

Based on the resulting data, structural equation modeling of associations between speech recognition and different aspects of cognition were carried out. Hence, a latent factor model of cognitive skills and speech recognition in noise was built resulting from theoretical and empirical model approaches. In the model, potential confounders, such as age and frailty, were controlled. Since hearing aids may influence the degradation of cognitive skills, differences between elderly hearing-impaired people with and without hearing aids, and elderly normal-hearing people, were investigated. To this end, differences in model fit parameters and factor weights describing relations between latent cognitive factors and speech recognition are compared. The model provides deeper insights into the complex relationship between latent factors of cognition and speech recognition. It will also aid the understanding of whether, and how, differences in hearing loss change the relevance and interaction of distinct cognitive factors.

P.01.11

SPEECH COMPREHENSION IN OLDER ADULTS: LIMITED BY NEURONAL CAPACITY TO PROCESS PROSODIC CUES?

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Age-related hearing loss is not only a condition of the inner ear, but also of the brain, which has to repair the degraded sound input while also incurring structural and functional declines. This 'central' hearing loss may therefore manifest itself in various aspects of the brain, such as integrity of its structure, but also in its functional properties. In the last 15 years, relationships between cortical oscillations and speech comprehension have consistently been found. Specifically, oscillations in the theta frequency band (3-7 Hz) have been found to encode slowly changing acoustic speech cues like prosody. Several studies have shown that older adults make strong use of prosodic cues in order to process spoken sentences. Therefore, we tested whether older adults' neuronal capacity to process prosodic cues would influence their ability to understand speech in challenging listening environments. First results indicate that lateralization of theta oscillations during resting state is predictive of successful comprehension irrespective of age and peripheral hearing loss. Specifically, a more rightward lateralization of theta oscillations predicted better comprehension of speech in babble noise. This is in line with results from a previous study that related rightward theta lateralization to preserved integrity of the right superior temporal sulcus, which is a key area for prosodic speech processing. It is also in line with theoretical accounts of the function of cortical theta oscillations and with the finding that older adults use prosodic cues to a great extent.

P.01.12

CENTRAL AUDITORY PROCESSING DISORDER (CAPD)- HEARING SCREENING PROGRAMME IN GROUP OF CHILDREN IN SCHOOL-AGE

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Introduction CAPD (Central Auditory Processing Disorders) are defined as abnormality with processing of auditory information at higher level of central nervous system. It can impact on linguistic abilities, education and social aspect. The research conducted in World Hearing Center in group of 60 children showed that earlier detection of CAPD is connected with obtained clinical outcomes. The best results after therapy with using SPPS-Ska (Stimulation of Polymodal Sensory Perception- Skarzynski method), were observed in range aged 7-10 years old of children in comparison with group of children above 11 years old. Hearing screening programme enables an earlier detection and prevents of negative impact on child development. Use of e-Health tools and innovative solution such as: Sense Examination Platform ® enable to conduct a hearing screening in a large- scale.

The aim of this study was to evaluate the usefulness of the DDT (Dichotic Digits Test) using in order detect CAPD in school-age children during hearing screening.

Material & method During hearing screening programme in 2008-2010 in Poland, examinations were conducted in group of 76,429 children. Approximately 45,5% were 7 years old and 44,9 % were 12 y.o., using Sense Examination Platform ®. For CAPD's screening was used a Polish version of DDT, which comprising 20 pairs of digits from 1-9. In group of 7 years old's children was performed in the divided attention mode, in which children were asked to repeat all heard digits. In group of 12 years old, was performed both in divided attention and in focused attention for each ear separately. Parents also asked to fill out a questionnaire. In order to eliminate a hearing problems, pure tone audiometry was conducted.

Results Analysis of results showed that approximately 11,3% in group of 7 years old children was positive result in DDT test and 11,3% for 12-years- olds in a divided attention mode. In the focused attention mode the comparable result for 12 years old children was 9,7%. It needs to be highlighted that positive DDT result was correlated with other disorders such as dyslexia and social problems. In children with incorrect DDT results, parents indicated significantly more hearing problems, attention deficit problems, difficulties in social contact with peers.

Conclusions Analysis of the results of DDT tests as well and questionnaire data showed that hearing difficulties, speech dysfunctions and education problems occur significantly more often in group of children with incorrect result which can indicate of problems with auditory processing.

Combining an audiological method (DDT) and psychometric tools make it possible to fast and earlier detect hearing problems in a large-scale in school environment and prevent to develop difficulties in daily life. Also it enables to plan an adequate therapy.

P.01.13

TEMPORAL FINE STRUCTURE: RELATIONS TO COGNITION AND AIDED SPEECH RECOGNITION

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Many studies have demonstrated a clear link between cognition and speech recognition. There is evidence to suggest that sensitivity to temporal fine structure (TFS) may explain some of the remaining individual variability in both speech recognition and cognitive performance, once the effects of age and hearing sensitivity are accounted for. The aim of the present study is to further explore the links between TFS and both cognition and speech recognition in a large sample (n = 189) of adult hearing aid users with symmetrical mild to severe sensorineural hearing loss. Additionally, we will investigate the effects of age and hearing loss on performance on the tasks, and on relations between the variables.

The cognitive test battery included measures of working memory and executive function. Aided speech recognition was assessed using an adaptive sentence- in- noise recognition task.

By providing a greater understanding the relations between temporal processing, cognitive ability and speech recognition, the findings will enable us to discuss the effects of supra-threshold processing on speech recognition, and to critically examine competing theoretical explanations of these mechanisms.

P.01.14

CENTRAL HEARING LOSS AND SPEECH INTELLIGIBILITY PERFORMANCE IN OLDER AGED ADULTS: INFLUENCE OF BRAIN STRUCTURE, HEARING AIDS AND COGNITIVE FUNCTIONS

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We will show preliminary data from a quasi-longitudinal study about the dynamics of speech intelligibility in older aged adults. As Giroud et al. (2017) could show, in normal hearing older adults higher cortical thickness (CT) in auditory areas is associated with less hidden hearing loss and better auditory performance. To gain more insight into central hearing loss and aging, we replicated the study of Giroud

et al. (2017) with an extended study protocol and participant population, to investigate the relationship between cortical thickness and surface area, speech intelligibility performance, cognitive abilities and above-threshold auditory measures in older adults with and without hearing aids. Further we investigated a group of older aged adults with no hearing loss (< 25dB) as controls. The older adults were tested with an adaptive auditory test battery to measure not only traditional pure-tone thresholds, but also above individual thresholds of temporal and spectral speech processing. The participants' speech recognition in noise (SiN) was evaluated as well as their speech intelligibility performance, and a T1-weighted MRI image was obtained for each participant. We then determined the cortical thickness and mean cortical surface area (CSA) of auditory and higher speech-relevant regions of interest (ROIs) with FreeSurfer. Further, all participants were tested with a cognitive test battery, assessing different aspects of attention, working memory, inhibition and intelligence. Methodological steps involved the calculation of differences in behavior, anatomy and cognitive abilities between and within the groups, followed by multiple regressions with anatomical ROIs as predictors for auditory performance. According to preliminary data, we expect that cortical thickness will influence the performance in all groups and all tested auditory conditions. Therefore, participants with higher cortical thickness in auditory related areas will show better auditory performance in SiN (Wong et al., 2010) as well as in their speech intelligibility performance. Better cognitive abilities, especially in working memory and attention should also lead to better auditory performance. Further we expect to find more CT in hearing aid users compared to non-users maybe as a sign of a protective factor of hearing aids against age related atrophy. Detailed results will be presented on the poster and will be discussed within the current frameworks of speech processing and aging.

P.01.15

SELECTIVE ATTENTION CORRELATES IN ERPS AND THE ONGOING EEG USING INSTANTANEOUS PHASE ORGANIZATION MEASURES

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Early auditory selective attention and its possible indicators have been studied over the last decades. It has been proved that Auditory selective attention can be reflected in an enhancement of the N1 component of auditory late responses (ALRs), which are usually evoked with brief transient stimulation paradigms using clicks or tones burst.

In previous work, we analyzed this so called N1-effect of ALRs using instantaneous phase synchronization measures to assess the attentional effort in listening, showing that listening effort induced by task difficulty can be satisfactory quantified.

We extended the idea of an objective listening effort estimation to ongoing EEG activity in arbitrary, non-event-related listening tasks. For that, we repeated the seminal experiment of Hillyard et al., who first described the N1-effect to study selective attention in dichotic listening, and we applied for the first time circular analysis techniques to the segmented ERP data and to the same -but, unsegmented (ongoing) EEG data. Ten normal hearing subjects (mean age: 26.6+-6.24 years, 6m/4f, right-handed) participated in the study. Normal hearing thresholds were controlled by pure tone audiogram preceding the measurements. After a detailed explanation of the procedure, the subjects signed an information consent form. EEG was collected through Ag/AgCl electrodes (Schwarzer GmbH, Germany) attached at the right(M2) and left (M1) mastoids, at the vertex (Cz) and upper forehead (Fpz) for the common reference and ground, respectively. Electrode impedances were maintained below 5 kOhms. EEG data was filtered (1-70Hz). For the ERP data, we used the (inter-trial) phase synchronization stability whereas for the ongoing EEG filtered data we applied an approximation of Rayleigh's equation from circular statistics. We show that correlates of selective attention can be extracted from both data types by assessing the organization of the instantaneous phase suggesting a unified framework to analyze neural correlates of selective attention in ERPs and the ongoing EEG activity by using a circular analysis of the instantaneous phase.

P.01.16

MUSIC TRAINING IN HEARING IMPAIRED CHILDREN: COGNITIVE AND MOTOR SKILL EFFECTS IN 3 CHILDREN WITH HEARING AIDS

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Congenital hearing loss (CHL) has far-reaching consequences for several cognitive levels. Recent advances in hearing aids (HA) and cochlear implant technology are positively changing these outcomes and current evidence suggests that hearing-impaired (HI) children who receive early hearing devices and are included in a high quality training program can today reach adequate skills for a mainstream education. Nevertheless, HI children still demonstrate to lag behind their normal hearing peers in linguistic, cognitive and motor aspects and the scientific community has not yet reached a general consensus regarding the real advantage offered by the several existing habilitative programs available for CHL.

Recent studies highlight that musical training can improve perception, cognitive and motor skills in both typically developing and HI children, although little researches specifically evaluated neuro-cognitive and motor outcomes in HI toddlers using hearing devices.

In order to explore the benefit of a well-structured music training program on various neuropsychological domains, we conducted a pilot study in 3 children (age: 35-44 months) with isolated CHL of moderate-severe degree. All effectively use well fitted bilateral HAs and are included in an early speech-language intervention program. The musical training program consisted of two training sessions over 6 months (20 lessons each session with 2 months interval). Musical activities consisted of listening (sound detection, discrimination, identification, recognition and localization), linguistic production and musical making exercises. Exercises were specifically designed to combine cognitive, motor and linguistic skills. The neuropsychological evaluation was completed pre- and post- session, and 6 months after the end of the program, to verify the learning consolidation. The evaluation consisted of: Leiter-R cognitive scale, NEPSY-II (manual motor sequence, memory for designs and narrative memory), indirect qualitative musical skills evaluation provided by parental questionnaire, and by music educator's result judgements. All three children demonstrated neuropsychological improvement and consolidation, with greater improvement in motor sequence, memory for designs and visual attention tests. Indirect evaluation of music skills are similarly indicative of positive outcomes. The results are discussed in terms of clinical and educational perspective in the developmental trajectory for HI children.

P.01.17

OBJECTIVE AND SUBJECTIVE OUTCOME MEASURES OF SPEECH RECOGNITION IN NORMALLY-HEARING ADULTS

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Every day individuals engage in communication in sound environments filled with background noise and / or competing talkers. In the lab, objective tests of speech recognition (such as the Swedish hearing-in-noise-test (HINT)) are typically used, but the individual's subjective view is also important to take into account, because if objective and subjective measures do not correlate, perhaps the interpretations of such findings do not generalise very well to everyday situations/difficulties.

The present study aimed to investigate the relation between objective and subjective measures of speech recognition. Two-hundred normally-hearing (for their age) individuals were presented with sentences from the Swedish HINT, masked with a speech-shaped noise.

Results will be presented comparing the performance on the Swedish HINT with the ratings on the subscale speech from the speech, hearing, and qualities of hearing scale (SSQ), to determine if the performance in the HINT corresponds to the subjective ratings indexed by the SSQ.

The results from the present study may help identify differences and common links between a clinically used, objective measure, and a subjective measure of speech recognition, to further our understanding of how such findings can be generalised to everyday functioning.

P.01.18

THE STIMULATION OF THE LEFT CEREBRAL HEMISPHERE IN THE REHABILITATION OF CENTRAL AUDITORY PROCESSING DISORDERS

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Summary: The Central Auditory Processing Disorders (CAPD) are disturbances of performance of the sense of hearing resulting from abnormalities at the level of the Central Nervous System (CNS), with proper construction and functioning of its peripheral part. In people with CAPD, both physical and conductive hearing is normal, while dysfunction takes place in the central, i.e. nervous part of the auditory system and is manifested by improper processing of auditory stimuli. It is estimated that CAPD occur in 2-3% of children in the world.

The stimulation of the left cerebral hemisphere by application of unilateral FM system on the right ear finds its theoretical justification in neuropsychological research. Neuropsychology aims to deepen the knowledge about the complex physiological mechanisms that underlie the higher human nervous functions such as: thinking, speech, observation activities, memory and attention.

Objectives: Scientific evaluation – supported by research on a group of 51 children with CAPD – whether the stimulation of the left cerebral hemisphere will bring positive rehabilitation effects, which will be reflected in the results gained from the tests and will translate into better functioning in everyday life.

Materials: The results were obtained from the set of tests for diagnosing the CAPD, which includes: auditory reaction test – TRS, speech understanding in noise test – ASPN, dichotic listening test – TSR, frequency sequence test – FPT, time resolution of the auditory system test – GDT, sound pitch differentiation test – DLF.

The results of individual tests take into account the age norm of the examined person.

The first group of results concerned the tests carried out in patients at the time they were first diagnosed with CAPD.

The second group of results was obtained after applying the stimulation of the left cerebral hemisphere by FM System receiver unilaterally on the right ear for a period ranging from 3 to 18 months.

Methods: 51 patients were examined. These were children aged 6 to 12 years, diagnosed with CAPD.

All of them were tested twice – before the implementation of the stimulation of the left cerebral hemisphere and after its application. They were diagnosed using the same research tool and by the same specialist.

The study group excluded children with co-occurring disorders, e.g. Asperger's Syndrome and CAPD or high-functioning autism and CAPD.

Results: In 100% of cases the improvement of results was obtained, visible as the achievement of the correct result after the application of stimulation of the left cerebral hemisphere in the test in which the previous result was abnormal (below the age norm), or as the numerical improvement of results (although the overall result still remains abnormal – the norm for age has not been reached).

Conclusions: The detailed analysis of the results of the study showed that the stimulation of the left cerebral hemisphere has brought positive results in the rehabilitation of children with CAPD, despite the fact that the method was used for a relatively short time ranging from 3 to 18 months.

P.01.19

STUDYING AUDIOVISUAL SPEECH INTEGRATION WITH EVOKED-RELATED POTENTIALS TECHNIQUE: VALIDATION OF AN EXPERIMENTAL PARADIGM FOR FRENCH-SPEAKING CHILDREN

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Speech perception is a multisensory experience. Visual speech cues have been demonstrated to improve timing and accuracy of auditory processing in adults and children. Incongruent audio-visual inputs degrade speech perception, resulting in perceptive illusions (e.g. McGurk & MacDonald, 1976). At the electrophysiological level, visual speech cues attenuate the amplitude and shorten the latency of the auditory N1 and P2 event-related potential components, which index early processes of audiovisual integration.

The present study aims to validate an audiovisual electrophysiological paradigm in a sample of French speakers. A target word-detection task, adapted from Knowland et al. (2014), is presented in five

conditions: Auditory-only (AO), Visual-only (VO), Congruent audiovisual (cAV), McGurk (MG, incongruent audiovisual combinations possibly resulting in fusions) and Mismatch (MM, incongruent audiovisual combinations not resulting in perceptive illusions).

Fourteen French-speaking adults completed the experiment. Stimuli set consisted in 37 monosyllabic CVC nouns, such as "pomme" and "bouche": 5 targets (colour names), 16 non-targets (creating potential perceptive McGurk fusions) and 16 filler nouns (promoting binding of auditory (A) and visual (V) inputs). Participants had to detect the 5 targets.

A female native French speaker was recorded (lower face) while pronouncing each stimulus. Each token was edited to be 2000 ms long, including 800 ms before auditory onset (only visual cues were available during this period). Recordings were used as stimulus set for the cAV condition. AO and VO stimuli were created by splitting the cAV tokens into their A and V components. Incongruent audiovisual stimuli were created: half of them were McGurk fusions (A "pomme" + V "gomme" ⇒ fusion "tomme") and the other half not (A "coeur" + V "bouche"). Targets and filler nouns were presented in AO, VO and cAV conditions; non-targets were presented in AO, VO, cAV, MG and MM conditions.

Stimuli were presented on a computer screen and via headphones. Participants were told to press a button whenever they saw and/or heard a colour name. They completed two blocks of 381 trials. The electroencephalographic signal was recorded by 32 electrodes embedded in an electrocap according to the 10-20 system and referenced to the tip of the nose.

Behavioural results indicated that participants responded faster to audiovisual stimulation (cAV) than to unimodal stimulations (AO and VO targets). Participants were also more accurate for AV and AO stimuli than VO stimuli, but no difference was observed between AO and AV stimuli.

Electrophysiological data didn't show any modulation of N1 latency in cAV condition compared to AO condition. Only a shortening in MM condition compared to MG condition was observed. Contrary to the claim that N1 latency shortening is based on redundancy of auditory and visual inputs (van Wassenhove et al., 2005), our data suggest that the visually induced speeding up of N1 depends on the initial phoneme predictability.

For N1 amplitude, a decrease was indicated in cAV condition compared to A+V condition, suggesting a reduction in the neural resources for audio-visual speech processing. The absence of difference between the three AV conditions means that this attenuation is congruence-independent. It suggests that N1 amplitude reflects some non-phonetic audiovisual integration mechanisms in pre-representational stages of stimulus analysis and an intersensory priming effect (Besle et al., 2004).

The analyses of P2 latency did not point out any modulation. For P2 amplitude, a decrease was observed in cAV condition compared to A+V condition, suggesting a reduction in the neural resources for audio-visual speech processing. Differences between the AV conditions depend on congruency, which confirms that P2 amplitude reflects some phonetic audiovisual integration mechanisms (Klucharev, Möttönen, & Sams, 2003). Moreover, the attenuation is larger for the MM stimuli than the cAV stimuli, suggesting that this modulation reflects the competition between sensory inputs (Knowland et al., 2014).

The current study replicated the behavioural speeding up of the auditory speech processing and the amplitude modulations of N1 and P2 components among adults. With some adjustments, the experimental paradigm seems relevant for studying audiovisual speech integration among French-speaking children.

P.02 - LISTENING EFFORT

P.02.1

A BEHAVIORAL APPROACH TO EVALUATE PROCESSING EFFORT IN SPEECH RECEPTION INSIDE WORKING CLASSROOMS WITH 5 TO 7 YEARS OLD CHILDREN

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Purpose Experiments on effortful listening with young children face the challenge that the test variability is increased by many factors (e.g., the cognitive development related to age, the individual characteristics as L1 or L2 language), and that children have limited attentional and test management capabilities. This implies a preference for a familiar, not distracting, setup and a need for having a test procedure as simple as possible. This study investigates speech reception and effort in working classrooms with 5, 6, 7 - years olds pupils (5Y, 6Y, 7Y). Two main research questions were: RQ1 - how does the processing effort change with background noise and during the lesson? RQ2 - how do the L1 and L2 differences, if any, show up in the working classroom? The approach employed was a behavioral one, based on a speech intelligibility (SI) test paired with the collection of single-task response times (RT). In fact several literature results interpreted the decrease of single-task RTs as a release of cognitive load, and hence as a proxy estimate for a diminishing of processing effort.

Methods Tests inside four classrooms of two kindergarten and two primary schools in the city of Padova (Italy) were accomplished. A total of 175 normal hearing pupils both L1 and L2 were involved (5Y: 246 L1 - 11 L2; 6Y: 52 L1 - 189 L2; 7Y: 457 L1 - 17 L2). The L1/L2 subdivision was based on a questionnaire compiled by teachers and parents. The SI test based on a WIPI task with six alternative pictures. Inside the classrooms a target loudspeaker operated at "normal" vocal effort. A second loudspeaker emitted continuous spectrally speech-shaped noise. Two conditions were set: baseline with speech-to-noise ratio (S/N)>15 dB (second loudspeaker off), and running classroom S/N \approx 0 dB. For each condition, two sets of 10 words were presented (repetitions R1 and R2 in the following); the condition order was randomized across repetitions. Children had a touchscreen terminal for the picture selection; single choices and RTs were collected for data analysis. The test lasted approximately 30 minutes. Then, sound levels, reverberation time and Speech Transmission Index (STI) were measured. The statistical analysis employed the GLMM method, including children as a random factor. Due to the sample sizes, differences in the outcomes during R1 and R2 were analyzed for L1, 6Y and 7Y only.

Results As regards RQ1, 5Y and 6Y, 7Y were treated separately due to different STI values in the respective classrooms. The 5Y did not reach 100% in quiet and for both groups SI decreased with noise (-16.4% for 5Y; -7.1% for 6Y and 7Y with no effect of age). A main effect of condition was found for RT both for 5Y (+301 ms) and for 6Y, 7Y (+90ms), the latter without effect of age. Then outcomes across R1 and R2 were analyzed for 6Y and 7Y. For SI there was no main effect of age or repetition but only of condition. Conversely, RT showed a main effect of repetition besides condition and interestingly an interaction of condition and repetition too. Both 6Y and 7Y were slower in R2, with a further RT increase (+91 ms) when noise was present. As regards RQ2, 6Y and 7Y were clustered and compared to 5Y; SI and RT outcomes were averaged across repetitions. The statistical analysis showed for SI main effects of condition, age and mother tongue and interactions of condition and age, and language and age. As expected, developmental and language skills were the main responsible for these results. RT results provided a main effect of condition and its interaction with age but not the main effects of age and language. This might be ascribed to the task being relatively simple so that once the phonological cues were available no distinction between L1 and L2 showed up.

Conclusions Based on an ecological classroom setup and with experiments lasting as a typical lesson, the present results benefit from a realistic approximation of the attentional involvement of children inside their familiar classroom environment. Results from RQ1 for 6Y and 7Y highlight changes in processing effort during the lesson and clearly outline the role of noise in slowing down cognitive processes whilst SI is kept at ceiling. They confirm and extend previous findings with pupils aged from 8 to 10 in running classrooms.

P.02.2

MEASURING LISTENING EFFORT USING A DUAL-TASK PARADIGM: A SHORT-TERM TEST-RETEST RELIABILITY STUDY

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Aim. In complex listening situations, speech understanding can become a challenging and often exhausting experience because the information in the speech signal can be degraded by background noise or by hearing loss. Difficulties with speech understanding are typically quantified using standard pure-tone audiometry in combination with speech audiometry. However, these standard audiological measurements are not suitable to detect and differentiate the degree of difficulty and effort related to speech understanding in specific listening situations. Hence, there has been a surge of interest regarding the assessment of the amount of effort related to speech understanding, also known as listening effort. One method to measure listening effort is based on a dual-task paradigm. However, as no standardized dual-task paradigm is available yet, more systematic analyses are necessary in order to evaluate the usefulness and reliability of such paradigms. Therefore, the present study aims to evaluate the reliability of a recently developed dual-task paradigm for measuring listening effort.

Material and Method. Listening effort was measured in 23 normal-hearing young adults 18-to-34 age bracket by means of a dual-task paradigm at two test moments with a time interval between one and two weeks. The dual-task paradigm consisted of a primary speech-recognition task in different listening conditions and a secondary visual memory task. These tasks were performed both separately and simultaneously. Listening effort was calculated as the change in visual memory performance from the baseline to the dual-task condition. The test-retest reliability was evaluated using a comprehensive set of statistical measures, among others a repeated measures analysis of variance (ANOVA), the intraclass correlation coefficient (ICC) and the coefficient of variation of the method error (CVME). The standard error of the mean (SEM) and minimal detectable differences (MDD) were also calculated, as well as cumulative frequencies of the absolute score differences.

Results. Repeated measures ANOVA revealed no significant differences between the test- and retest condition for both the speech-recognition and visual memory task as well as for listening effort. The ICC-values showed a large variation in reliability for the different conditions of both the speech-recognition task and visual memory task as well as the amount of listening effort. In contrast, CVME-values showed good reliability for both the primary and secondary task, with values ranging from 3.1% to 14.0%. Reliability of the amount of listening effort was rather low with a large variation in ICC-values and CVME-values ranging from 37.8% to 83.8%. Regarding the SEM and MDD, values were low for the primary and secondary task separately. An overview of the SEM and MDD as well as the cumulative frequency distribution for the different tasks and listening conditions will be presented at the conference.

Conclusions. The variation in reliability according to the ICC raised questions about the reliability of the dual-task paradigm that was used. However, the ICC outcome may be misleading as only normal-hearing young adults were included, which could lead to a lack of between-subject variability. Therefore, CVME-values were calculated, which are not affected by between-subject variability. Based on the CVME-values, both the speech-recognition task and the visual memory task demonstrated good reliability. Hence, these tasks are potentially useful in scientific research and clinical practice. However, the amount of listening effort seemed to be less reliable. Therefore, further research pertaining to the test-retest reliability of dual-task paradigms and, more specifically, the amount of listening effort is necessary. Nevertheless, it can be suggested that a dual-task paradigm for measuring listening effort can reliably be used over time by interpreting the outcomes of the primary and secondary task separately. Particularly, the use of the MDD and cumulative frequency distribution would make it possible to detect any changes in the performances of both tasks due to, for example, alterations in hearing sensitivity or cognitive capacity. Moreover, a validated test of listening effort can provide information over and beyond standard speech-recognition outcomes, which could be beneficial in, among others, the evaluation of therapeutic interventions such as hearing aids.

P.02.3

BRINGING FUEL TO KIDS IN THE CLASSROOM: WHAT CAN EYES CAN REVEAL ABOUT CHILDREN'S MOTIVATION AND LISTENING EFFORT?

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The Framework for Understanding Effortful Listening (FUEL; Pichora-Fuller et al, 2016) describes the cognitive demands of listening under challenging conditions and how motivation can influence the deployment of cognitive resources during effortful listening. Within FUEL, listening effort is defined as "the deliberate allocation of mental resources to overcome obstacles in goal pursuit when carrying out a task that involves listening". Above all, FUEL highlights the role of motivation in managing the cognitive resources required for active listening in noisy situations.

Until recently, this framework had only been applied to adults. However, children also engage in effortful listening, not least in school. When listening to a teacher in the school classroom, children have to contend not only with the noise of other children talking in the background but also possible hoarseness (dysphonia) in teachers' voices straining to be heard above the background noise. In a recent study, we showed that background noise consisting of multiple child talkers reduces auditory passage comprehension in children, as well as the ability to remember what is said later on (Nirme et al., 2018; Rudner et al., *subm*). Further, we have shown that dysphonia reduces motivation to listen, even though it does not always reduce auditory passage comprehension. This means that children may not optimize their deployment of cognitive resources during a listening task in the classroom. In particular, a dysphonic voice together with background babble noise may pose a particular challenge when listening, understanding and remembering (Rudner et al., *subm*).

Work has only just begun on elucidating the interplay of motivation and listening effort. There is evidence that the motivation of adult listeners can be increased both by task instructions and by the prospect of reward, leading to great effort and better task performance, especially under challenging conditions (Pichora-Fuller et al., 2016). We will present a planned project in which we will manipulate children's motivation during a listening task by using task instructions that either provide or withhold reward in the form of praise and encouragement. The task will be listening comprehension presented with varying degrees of dysphonia and background babble consisting of multiple children's voices. We expect that motivation will induce children to exert more effort to listen under challenging conditions with improved task performance, especially if they display grit, ie. perseverance and long-term goal pursuit (Duckworth et al., 2007). To capture listening effort we will apply pupillometry and monitor the children's pupil dilation. This is an established measure of listening effort for adults and has recently been validated for children (McGarrigle et al., 2017). Further, we will track eye movements to determine what, how and when critical information is processed during challenging conditions.

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P.03 - SPEECH DEVELOPMENT AND TESTING

P.03.1

A COMPARISON OF THE SIX PERSIAN VOWEL FORMANTS IN CHILDREN WITH NORMAL HEARING AND HEARING LOSS CHILDREN

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As a result of inadequate access to sounds in addition to a lack of environmental auditory experience, speech sound in children with hearing loss is usually produced erroneously. An important issue is that analyzing abnormal production of sounds based only on perception and without resorting to laboratory instrumental equipments is not always possible. In many cases, being familiar with acoustic phonetics reveals this issue to a greater extent. Vowel production errors are one of the errors in the speech production of children with hearing loss. The aim of the present study is to analyze the acoustic features of Persian vowels using PRAAT and to present the vowel quadrilateral in children with normal hearing (NH), children with moderate hearing loss using a hearing aid device (HA) and cochlear implanted children (CI) between ages 5 to 7. In this paper, the duration, fundamental frequency and the first 3 formants of the six simple vowels in Persian language (i.e. /e/, /i/, /a/, /o/, /o/ and /u/) have been examined in a CV(C) context for each group. The results indicate that among the three NH, CI and HA children, significant differences can be observed in the duration of /o/, fundamental frequencies of /a/ and /o/, the first formant of /a/, the second formants of /e/, /i/, /o/ and /u/, and the third formants /a/ and /o/. In addition, the vowel quadrilateral reveals that the vowel production in CI children is within the range of NH children and that these children produce vowels closer to that of normal NH age peers.

P.03.2

CHARACTERISTICS OF SENTENCES IN DEAF AND HARD OF HEARING STUDENTS AND STUDENTS WITH COCHLEAR IMPLANTS

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Written language represents a significant aspect of communication for hearing-impaired children. Their spoken language is limited and very often incomprehensible, and thus it is necessary that the children be enabled to use written language in different life situations.

The work on forming, extending and enriching sentence structure is one of the main aims of mother tongue teaching in schools for deaf and hearing children. However, it is often the case that the written language production of hearing-impaired children is completely incomprehensible due to their ungrammatical sentences.

Sentence development, in other words, level of expression has its developmental process, which is in turn followed by the development of speech-language abilities in children. The first words spoken by children bear the meaning of entire sentences. Acquisition of linguistic competence at a later stage leads to the development of more complex types of sentences. In the development of speech and language in deaf and hard of hearing children, there is a certain level of deviation from spontaneous sentence development, due to inadequate reception of spoken information.

The importance of using the picture in education of serbian language and literacy is big. Complete pictures, as well as pictures in series (row), making easy the work on the classes, and to contribute the dynamics and the development of the language culture of the students. This work included visual perception and language expression.

The aim of this paper was to evaluate the characteristics of sentences, ie. the level of expression in deaf and hard of hearing children and children with cochlear implants attending elementary school.

Within the scope of the study the Test for Evaluating Linguistic Productions – strip situation (M. Milenkovic, I. Ivic, R. Rosandic, V. Smiljanic), was applied. The sample consisted of 46 deaf and hard of hearing pupils; attending grades four to eight of elementary school (37 with hearing aids and 9 with cochlear implants).

The obtained results show that pupils with cochlear implants had better results in comparison to the pupils with hearing aids, although without statistical significance. Pupils with cochlear implants most often expressed themselves at the level of complex sentences, whilst pupils with hearing aids most often express themselves using compound sentences. Their written linguistic expression is characterized by a poor vocabulary and disproportional use of verbs and nouns in relation to other types of words. The lexicon used by the deaf and hard of hearing students characterizes with scantiness, disproportionate use of nouns and verbs, in relation to other types of words, as like the difficulties in construction and understanding the structure of the sentence.

The systematic influence of school, especially of mother tongue teaching, contributes to overcoming these problems with age.

All results will be shown in tabular and graph form.

Key words: deaf and hard of hearing, cochlear implant, level of expression, sentences

P.03.3

DEAFNESS AND LINGUISTIC COMPETENCE: RESEARCH RESULTS ABOUT BILINGUAL DEAF EDUCATION IN MAINSTREAM SCHOOL IN MILAN

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The World federation of the Deaf propose bilinguism as a basic human right for deaf Children in education. Literacy highlights the enablement of these programs already in the 70's for Northern Europe and United States, with mixed results, open to many interpretations. (Marshark, tang, Knoors, 2014, pp. 15-16). Italy have started with these projects in 1994 in Cossato followed by few other experiences (Teruggi 2003)

During the 70's, Italy has been one of the first countries in the world to promote the inclusion of individuals with disabilities into the mainstream education system (law 118/1971 and 517/1977). In the majority of cases, deaf pupils attend the lessons together with their hearing peers: this evolution allows them to exit a separate education channel but they have to face two important issues: less chances of attending schools with other deaf students and a hurdle in practicing the sign language, commonly adopted in Italy mainly by deaf children of native signer deaf adults.

The research Quality of inclusion and deafness carried out by CeDisMa- Research Centre on Disability and Marginality, Università Cattolica del Sacro Cuore, Milano - aimed to analyse the quality and the effectiveness of an educational and teaching project based on the use of bilinguism (sign language and oral method) for the integration of 20 deaf students mainly native signer in an Italian school (kindergarten, primary and secondary school; In particular, the project aimed to verify the sustainability, the effectiveness and the possible transferability of the inclusive teaching model adopted by this schools.

The research project develops according to the action research methodology: this is a methodological framework often used in the field of pedagogical research, especially when it is necessary to understand the process of planning, carrying out and evaluating the path in progress.

Among the different research actions implemented, we can report: the observations within the classes to analyse the effectiveness of the teaching methods used and the relationships between deaf students and the other classmates; the interviews with deaf students to verify their language skills; the specific tests administered in order to investigate the actual comprehension abilities of the scholastic curriculum.

The results show positive and negative aspects and offer the opportunity for important pedagogical reflections and future research. Among the former are a wide sensibility for issues linked to hearing impairment from hearing pupils and their families; widespread use of the sign language managed by deaf educator; good relationship atmosphere between deaf and hearing students; improved knowledge from teachers on education specific for deaf pupils. The latter enlists diminishing linguistic benefits for deaf students; diversified LIS skills, even for native signer pupils; difficulties for schools in codifying detailed signs and specific for school subjects; lack of understanding capabilities on written text for about half the sample population which includes Italian and foreign deaf pupils; almost 20% achieved the same result as hearing students (all Italian native signer).

P.04 - EPIDEMIOLOGY

P.04.1

AWARENESS AND INTENDED BEHAVIOR TOWARDS HEARING CONSERVATION IN GENERAL PUBLIC

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Background and Purpose: Noise-induced hearing loss (NIHL) is a typical acquired hearing impairment resulting from exposure to loud sound. With urbanization and industrialization, there are many places with high intensity sound, in which are easily accessible in general public. However, repeated and habitual exposure to loud noise allows the general public to occur high prevalence of NIHL. Purpose of the present study was to investigate people's knowledge about hearing conservation, types of protective behaviors they would adopt towards noise, agreement between people's knowledge and intended behaviors in hearing protection, and reasons why they would not take any protective action against noise.

Methods: For surveying by a questionnaire, 'Hearing Conservation Questionnaire (HCQ)' which Chen et al. developed in 2008 was adapted while being in translation and back translation from English into Korean. The HCQ-K consisted of 4 categories: 1) basic information, 2) knowledge about hearing, noise hazards, and hearing protection, 3) intended behaviors in noise, and 4) reasons why people would not take protective actions in noise. Basic information included 4 items and each item was related to general issue of hearing. The knowledge section about hearing, noise hazards, and hearing protection was consisted of 21 items having the 3-point scale (e.g., yes, no, do not know). The section of 'intended behaviors in noise' was responded by 6 different behaviors such as using earplugs, walking away, blocking ears with fingers, shortening stay duration, moving to quieter place and doing nothing. In the final section, 'reasons why people would not take protective actions in noise' was classified by various reasons; no knowledge of protecting hearing and the danger of noise, discomfort of hearing protection devices, trouble of using hearing protective devices, laziness of taking precautions and so on. The online survey was directed to 1000 random Korean people who equally composed of 500 females and 500 males and were divided into four groups by age; 20s, 30s, 40s, and 50s and older.

Results: In the knowledge section, participants scored the highest in subcategories of noise hazards (63.27%), followed by their knowledge in hearing protection (61.34%) and general health (51.01%). For the knowledge about taking protective actions against noise, it showed that the type of action general public intended to take against noise, from high to low, was blocking ears with fingers (43.0%), walking away (37.2%), moving to quieter place (36.7%), shortening the duration (22.0%), and using earplugs (17.0%). As further analysis of knowledge and appropriate action in age groups, 'using earplugs' did not know how to do, resulting in not taking protective action, especially in 20s, 40, and 50s and older groups. On the other hand, 'blocking ears with fingers' and 'moving to quieter place' knew its knowledge and provided appropriate action in all age. Interestingly, 'shortening stay duration' was already known by people, but they did not take any action for the protection.

Conclusions: People's knowledge and their noise-protective behavior were partially correlated. However, knowledge did not guarantee that people would adopt such behaviors when they were exposed to loud sounds. Therefore, current results showed the necessity of appropriate education about hearing conservation toward the noisy situation in general public. It is also important to increase people's knowledge about hearing protection and hazardous noise as common sense as well as to encourage actual protective actions.

P.04.2

HEARING SCREENING PROGRAMME IN SCHOOLS IN RURAL AREAS AND SMALL TOWNS IN THE EASTERN OF POLAND

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Early detection of hearing disorders prevent to develop difficulties in social, education and psychological aspects and enables to plan an adequate therapy and obtains of satisfactory results of treatment. In an ideal healthcare system, hearing screening should be conducted in each age group in order to detect hearing problems. Epidemiological study realized by The Institute Physiology and Pathology of Hearing in the collaboration with governmental institutions and NGO's showed that on average one person in three experiences some problems related with hearing. New solutions enable to conduct a hearing screening in a large-scale and reduce costs.

Between March and June 2008, the Institute Physiology and Pathology of Hearing in collaboration with the Agricultural Social Insurance Fund and the Association of Deaf and Hearing Impaired "Homo-Homini" implemented the programme of hearing screening for children in range age 7-12 from rural areas and small towns (below 5000 inhabitants) in the eastern regions of Poland. The necessary condition was the consent of parents or care-takers.

The main aims of this programme were: detection of conductive or sensorineural hearing loss, increase of awareness in group of parents and teachers about potential of early detections and therapy in cases of hearing loss. During this programme, information about epidemiology of hearing disorders such as hearing loss, tinnitus and central auditory processing disorders were provided.

During this programme 92,876 children were examined by 131 researchers who were trained in the methodology of screening examinations and in proper use of the equipment. Information about hearing screening programme were propagated by mass media: TV and radio programmes, press articles, during press conferences. Also information materials about screening were delivered to communities and schools.

The screening hearing were performed using the „Audiometr S” which was developed through the cooperation of the Institute Physiology and Pathology of Hearing and the Institute of Innovations in Mining Industry EMAG in Katowice. This system consisted of the PDA microcomputer, headphones and the button (when patient hear the sound- press the button).

During hearing screening were conducted: air conduction hearing threshold audiometry for frequencies 250-8000 Hz and the test of central processing of auditory information- Dichotic Digital Test- DDT). Examinations were conducted during lessons in quiet rooms in school.

Results of all tests were collected in database and uploaded to the central database, assuring the highest quality of data security. Afterwards, the audiologist based on the results, selected of children in need of further audiological attention (for example: otolaryngology consultation). It needs to be highlighted that results of hearing screening programme reported high percentage of hearing problems among school age children and also demonstrated the deficiency of parent's and teacher's knowledge about early detections of hearing dysfunctions.

P.04.3

RELATIONSHIPS BETWEEN LOW-LEVEL VOLATILE ORGANIC COMPOUND EXPOSURE AND HEARING

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Acute exposure to volatile organic compounds (VOCs) such as benzene, styrene, toluene, and xylene has been associated with auditory deficits in numerous animal models. In humans, occupational exposures to

high levels of VOCs have also been correlated with hearing difficulty, tinnitus, and/or hearing loss. However, little is known about the relationship of low-level exposure to VOCs and hearing, despite the ubiquity of VOCs in modern life. This study examined the statistical association of VOC metabolites in urine and three aspects of hearing; self-reported tinnitus, self-reported hearing ability, and behavioral pure-tone thresholds in a large, representative sample of United States adults. Based on previous literature showing auditory effects at high doses, we examined metabolites of acrylamide, benzene, cyanide, styrene, and toluene in the National Health and Nutrition Examination Survey data from 2011-2012. When controlling for age and gender, there was no statistically significant relationship between any of the VOCs examined and self-reported tinnitus. Subjective hearing difficulty was significantly associated with VOC metabolite levels for styrene and toluene. Behavioral thresholds for the mid- and high-frequencies were also associated with levels of styrene and toluene metabolites in this sample, though no such association was observed for low-frequency thresholds. VOCs are encountered daily by many adults from sources such as automobile exhaust, paint, cigarette smoke, and adhesives, and so understanding the potential effects of these exposures is important. These data are consistent with VOCs affecting auditory sensitivity in humans even at low-levels of exposure, though causality cannot be confirmed due to the correlational nature of the study.

P.04.4

EPIDEMIOLOGY OF NEWBORN HEARING SCREENING IN THE WEST BANK OF PALESTINE

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Hearing loss (HL) is among the most common congenital birth defects identified in newborns. Although universal hearing screening has been adopted by most developed nations, this is not always the case in other developing regions. In low-to-middle income countries newborn hearing loss rates can vary (from 13.7/1000 in Jordan to 51.2/1000 in Kuwait) but typically trend towards higher than the rates in more developed countries. The incidence, prevalence, type, and causation of HL affecting Palestinian children has never undergone thorough, intensive scientific investigation to the standards necessary to understand this phenomenon. Previous studies on the incidence of sensorineural hearing loss (SNHL) in the Middle East were either retrospective in nature, did not screen infants at the birthing hospitals, or were somehow otherwise limited. The research describes the epidemiology of neonatal hearing loss of newborns screened at a Palestinian Maternity hospital & if they failed the initial screening & the retest they were referred to Caritas Baby Hospital (CBH) for subsequent testing. The purpose of this study was to estimate the incidence of hearing loss in full term newborns in the West Bank and determine the relevant causes. The sample population consisted of 5,357 full term newborns screened within 48 hours for hearing loss risk factors and tested using the Transiently Evoked Otoacoustic Emissions (TEOAE) between the period of August 4, 2014 & May 31, 2016. Newborns with risk factors or failing the initial screening were retested by TEOAE within two weeks later. At CBH, study participants who failed the repeat TEOAE were sent for automated Auditory Brainstem Response (AABR) and study participants with known risk factors also underwent AABR. Participants who failed the AABR underwent tympanograms. Study participants with normal tympanograms (type A) were referred to audiology for a diagnostic ABR air and bone. Study participants with abnormal tympanograms (types B and C) were referred to an Ear Nose Throat (ENT) specialist to evaluate possible middle ear pathology. Following resolution of middle ear problem study participants were sent for diagnostic ABR to document hearing status. Study participants with evidence of SNHL underwent a targeted history and physical by a medical geneticist with training in evaluation of children with HL. Study participants with syndromic HL underwent a targeted genetic analysis in conjunction with the molecular biologist. Study participants with non-syndromic SNHL underwent imaging using high resolution computed tomography scan to look for evidence of known inner ear anomalies. Study participants were also tested for infectious disease & had serum obtained for molecular testing. Study participants with identified inner ear anomalies underwent targeted genetic analysis. Study participants with positive infectious disease testing underwent further evaluation by the medical geneticist. Study participants with negative imaging and infectious disease tests had their blood samples evaluated initially for common genes implicated with HL in the Palestinian population. If initial genetic testing was negative, their blood samples underwent further evaluation by the molecular

biologist. Once the etiologic genetic cause of HL was identified, the patient was referred back to the medical geneticist and genetics counselor for guidance and counseling. Data collected was uploaded & analyzed using Microsoft Excel & SPSS software. Of the 5,357 newborns tested, 677 (12.7%) failed the first test, of which 84% (569) passed the retest, 6.4% (43) failed, while 65 (9.6%) patients did not come. Factoring in non-compliance, 1.9% of newborns were identified with SNHL. Approximately 22 patients returned and entered the diagnostic algorithm. Of these, approximately 15% were found to have an infectious etiology & approximately 85% a genetic etiology. Molecular testing elicited previously identified HL loci in 25% of these patients. Of the remaining 75%, to date, one has been found to have a newly identified locus. The high incidence (19/1000) of hearing loss in these newborns is higher than equivalent samples in Israel and Jordan. An effective and expand screening program would significantly improve the well-being of the Palestinian newborns & discover new mechanisms of HL at a molecular level and lead to new treatment protocol.

P.04.5

HEARING LOSS AND COMORBIDITIES IN OLDER ADULTS: EPIDEMIOLOGY, MODIFICATION TO PRACTICE, AND AUDIOLOGIC REHABILITATION OUTCOMES

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Purpose: People seeking audiologic rehabilitation are often older adults who also present with medical comorbidities. Yet, these realities of clinical practice are poorly understood. Therefore, the present study aimed to examine a) the frequency of identification of relevant medical conditions and their patterns of co-occurrence in clients of a geriatric audiology clinic, b) the influence of comorbidities on audiological practice, and c) the effect of comorbidities on rehabilitation outcomes.

Methods: Seven comorbidities were selected due to their association with hearing loss and their potential effects on audiologic rehabilitation: visual, manual dexterity, and cognitive issues, depression, falls, hypertension, and diabetes. Audiology charts from 135 clients who completed a hearing aid evaluation at a geriatric hearing services clinic in 2015 were examined: The frequency with which audiologists noted medical comorbidities was determined, and information about audiologic rehabilitation recommendations and outcomes was obtained. In addition, information about comorbidities was also gathered from the hospital electronic health records (EHR). Furthermore, focus groups with audiologists were conducted to explore how they modified practice to accommodate the needs of medically complex clients with various comorbidities during the assessment and when recommending and delivering treatment.

Results: Of the clients seeking audiologic rehabilitation at this geriatric clinic (n = 135; Mage = 86 years, SD = 7.4, Range = 66-99; 61% female), almost one third (43/135) were aged between 91 and 99 years. The frequency of identification of comorbidities was 68% for vision loss, 42% for manual dexterity issues, 50% for cognitive issues, 16% for depression, 33% for falls, 43% for hypertension, and 13% for diabetes. Two or more of the investigated comorbidities were identified for most participants (97/135). Notably, the frequency of identification for the combination of visual, manual dexterity, and cognitive issues was 23%. Integrating information from the audiology chart and the EHR provided a more complete understanding of comorbidities. Non-hearing health care professionals entered information about hearing loss into the medical record for 59% of these patients, while audiologists documented it in the EHR for only 25% of the cases, typically hospital inpatients. In the clinic where this research was conducted, modifications to practice were common and varied depending on the type of comorbidity. This held true despite a lack of comprehensive recommendations from professional organizations and regulatory bodies for the assessment, documentation, and modification of audiological practice with regards to comorbidities. During the process of audiologic rehabilitation, hearing aid(s) purchase and retention was lower for clients with cognitive and vision issues, respectively, compared to those with no such comorbidities. However, results from the Client Oriented Scale of Improvement and qualitative measures indicated improvements independent of the presence of comorbidities.

Conclusions: High rates of multiple comorbidities with hearing loss were observed, and the number of comorbidities increased across old age. With the modifications to practice implemented by the

audiologists in this clinic, successful outcomes were nevertheless achieved for older adults with medical comorbidities relevant to hearing care, even for those in the oldest old age group. However, since it is a geriatric clinic, these audiologists may be particularly sensitive to the presence of comorbidities in their clients, despite the lack of comprehensive practice guidelines. These results thus highlight the need for and potential value of modifications to best clinical practices for older adults with concurrent medical conditions in audiologic rehabilitation. More communication between clinicians in the circle of care could improve outcomes for older adults with hearing loss. Ensuring effective understanding of and accommodation for hearing loss and medical comorbidities by allied health professionals and hearing healthcare professionals, respectively, could enhance patient-centered care by meeting the needs of the rapidly growing older and oldest old segment of the population.

P.05 - GENETICS

P.05.1

INFANTS WITH COMPOUND P.V37I PLUS OTHER GJB2 PATHOGENIC MUTATION HAVE A HIGHER FAILED RATE OF UNIVERSAL NEWBORN HEARING SCREENING

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Mutations in GJB2 gene represent the most common known cause of autosomal recessive non-syndromic hearing loss. The c.109G>A (p.V37I) variant in GJB2 was originally reported as a polymorphism, is found highly prevalent in Asian deaf population. In order to clarify the pathogenic characteristics of p.V37I variant, the failed rate of universal newborn hearing screening (UNHS) for the infants with compound p.V37I plus other GJB2 pathogenic mutation were analyzed. 43 of 95 infants with compound heterozygote of c.235delC/ c.109G>A failed the UNHS and the failed rate is 45.3%. 1 of 9 infants with compound heterozygote of c.176del16/ c.109G>A failed the UNHS and the failed rate is 11.1%. 11 of 30 infants with compound heterozygote of c.299_300delAT/ c.109G>A failed the UNHS and the failed rate is 36.7%. All of these rates are higher than the failing rate of normal infant population, which strongly suggested the pathogenic role of c.109G>A (p.V37I) variant in GJB2.

P.05.2

MICROARRAY-BASED MUTATION SCREENING OF HEARING RELATED GENE IN CHINESE NEWBORNS

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For years 2014-2017, 1.33 millions of Chinese newborns were screened for nine hot spot mutations in four of the most common deafness-related genes, including GJB2, SLC26A4, GJB3, and 12s rRNA. The incidence of positive genetic variants was 4.59% with the current set of target genes. Among them, 0.24% of newborns have 12s rRNA mutations. Homozygote or compound heterozygote of pathogenic mutations in GJB2 and SLC26A4 are 0.01% respectively. Microarray testing is a helpful and instrumental screening method in the diagnosis of genetic hearing loss.

P.05.3

GJB2-LINKED HEARING LOSS DOES NOT CHANGE SIGNIFICANTLY FROM BIRTH TO ADOLESCENCE

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Congenital hearing loss is a significant medical and social problem. Early detection and rehabilitation provide speech and language development of hearing impaired children comparable with normal hearing peers. Due to universal newborn hearing screening the number of children with mild and moderate congenital hearing loss increased. Parental anxiety does not depend on the severity of hearing impairment. At the same time in the cases of mild and moderate hearing loss parents often don't notice an uncertain reaction to the sounds, do not realize the need for medical help and, when recognized a problem, are afraid of hearing amplification. Meanwhile more than half of congenital non-syndromic sensorineural hearing loss cases have genetic nature, among which 80% are GJB2 mutations. Currently there is insufficient data about the possibility of hearing loss progression in mild and moderate congenital hearing loss. It is assumed that genetic testing can assist in answering this question.

The aim of the study was to evaluate the frequency of hereditary etiology of mild and moderate bilateral non-syndromic hearing loss and the likelihood of progression.

Materials and methods. 87 children 5-16 years of life with mild and moderate bilateral non-syndromic sensorineural hearing loss identified in early childhood were included in the study. Previous medical history assessment, otorhinolaryngological and audiological examination (PTA (pure tone audiometry) and impedance measurement) were performed. GJB2 gene investigation by Sanger sequencing was carried out. Patients with no GJB2 mutations were studied using the targeted panel "hereditary hearing loss". Audiometry was carried out 2 times a year to each child.

Results. Mild bilateral sensorineural hearing loss was diagnosed in 21 children, among them 4 children had pathological GJB2 genotype. Among 66 children with moderate bilateral sensorineural hearing loss GJB2 gene mutations were confirmed in 18 children. Total 21 children from the study group were identified by newborn hearing screening. According to the results of the genetic study, 22 patients were homozygotes for GJB2 gene mutations and 2 - carriers of one mutation. Longitudinal observation revealed stable hearing thresholds in most patients. One child had a progression of hearing loss resulting in elevation of PTA hearing thresholds from 35 dB to 50 dB at all frequencies.

Conclusion. Our results indicate a high frequency of hereditary etiology and stability of the hearing thresholds among patients with mild and moderate congenital bilateral non-syndromic sensorineural hearing loss. We suggest that clinical protocols should include genetic testing in all cases of congenital non-syndromic sensorineural hearing loss of any severity. Genetic investigation highlights the true cause of hearing loss and informs parents about disease prognosis and rehabilitation opportunities.

P.06 - AUDITORY NEUROPATHY SPECTRUM DISORDERS

P.06.1

IMPACT OF AUDITORY NEUROPATHY SPECTRUM DISORDER ON AUDITORY AND LANGUAGE DEVELOPMENT IN CHILDREN WITH NORMAL HEARING SENSITIVITY: CASE REPORTS

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Approximately 10% of children with permanent hearing impairment have auditory neuropathy spectrum disorder (ANSD). The most prominent clinical indicators are absent or abnormal auditory brainstem responses (ABR) with presence of cochlear microphonics (CMs) and/or otoacoustic emissions (OAEs). The behavioral hearing thresholds may range from normal to profound. The hearing level may fluctuate or transient in nature, making the audiological management in ANSD children a challenge for pediatric audiologists and otolaryngologists.

Among those children diagnosed with ANSD, there is a small portion of cases who demonstrate hearing sensitivity within normal range. Sininger & Oba (2001) described the audiologic findings of a group of 59 patients with auditory neuropathy. In the 101 ears they tested, approximately 15% had hearing sensitivity below 20 dB HL. Based on a database of 260 patients with ANSD, Berlin et al. (2010) and Berlin, Morlet, & Hood (2003) observed that around 5% to 7% of their patients showed nearly normal hearing sensitivity and developed normal speech and language spontaneously. Also, some cases have been reported to develop hearing and speaking ability normally with no auditory complaint or just some difficult hearing in noise (Morlet, Rose, & Brashears, 2003; Tharpe & Seewald, 2016.). However, among the previous literature, there is scant discussion of the audiological management of the ANSD children with normal hearing. Frequency-modulated systems or close monitoring of the child's performance in noisy environment are mostly recommended audiological management (Gökdoğan et al., 2016; Tharpe & Seewald, 2016). It is emphasized that pure-tone audiograms could not predict the speech perception ability of the individuals with ANSD (Sininger & Oba, 2001; Rance, 2005) and that normal detection hearing thresholds do not indicate normal signal processing performance. To what extent the impact of ANSD on auditory and language development in children with normal hearing sensitivity warrant investigation.

In this presentation, two ANSD children with normal audiograms will be reported in order to facilitate hearing-health professionals towards a broader understanding of ANSD. The two cases were a five-year-old boy and a two-year-old girl. Both failed hearing screening at birth and were subsequently confirmed bilateral ANSDs. Repeated diagnostic hearing tests when both cases were one to two years old still showed clinical characteristics of ANSD with evidence of absent ABRs as well as present CMs and OAEs in both ears. Complete battery of audiological assessments were completed at regular follow-up hearing review sessions. All test results revealed age-appropriate auditory development in both cases. Cortical auditory evoked potentials and visual reinforcement infant speech discrimination tests were also conducted with evidence of normal speech detection ability at cortical levels and speech discrimination ability at soft presentation levels. Speech recognition test administered in noise when the boy was 4 years and 11 months old also revealed that he did not seem to struggle with recognizing speech in competing noise.

Parental reports of the two children's communicative development and direct language assessments showed age-appropriate development at various assessment stages. Overall, the two children have been developing normal hearing and speech/language ability despite the diagnosis of ANSD at the time of this presentation.

The audiological profiles and the development in auditory and language ability of the two reported ANSD children provided important clinical implications. The roles of the clinical indicators for diagnosing ANSD, such ABR, OAE and middle-ear muscle reflexes in speech perception will be discussed.

P.06.2

OUTCOME OF CHILDREN WITH AUDITORY NEUROPATHY SPECTRUM DISORDER FITTED WITH HEARING AIDS

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Our study is focused on data obtained from 2012-2017 at the Audiological Department at Odense University Hospital in Denmark. In this period 16 children with ANSD (Auditory Neuropathy Spectrum Disorder) were diagnosed. Three of the children were later referred due to cochlear implant and one child recovered spontaneously. Seven of the children had unilateral ANSD of which three had aplasia of the hearing nerve.

All of the children were fitted with hearing aids or bone anchored hearing system.

Etiological evaluation of the children were performed and the outcome of the children was evaluated with the MacArthur-Bates Communicative Development Inventories.

P.07 - RISK FACTORS

P.07.1

OTOACOUSTIC EMISSIONS IN CHILDREN TREATED WITH GENTAMICIN IN A SECONDARY HOSPITAL

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Introduction: The National Commission for the Early Detection of hearing loss (CODEPEH) recommends the re-evaluation of the hearing in children who have suffered any potentially harmful event, such as the prescription of ototoxic antibiotics like Gentamicin. The evoked otoacoustic emissions (EOAE) are a good method in order to assess the integrity of the cochlear functionality.

Material and Methods: A prospective study was presented, including 92 children who were treated with intravenous Gentamicin for septic risk / sepsis or urinary tract infection. Those children underwent serial EOAE: At admission, at the end of treatment and one month later (if altered on discharge).

Results: In the end, no subject was affected by the treatment.

Conclusion: Gentamicin appears to be a safe antibiotic in treatments lasting <10 days and at the doses described. EOAE are an inexpensive, fast, non-invasive and reliable method to check for gentamicin ototoxicity . This could save in the determination of drug levels.

P.07.2

CANNABIS USE IS ASSOCIATED WITH REDUCED OTOACOUSTIC EMISSION AMPLITUDES IN YOUNG ADULTS

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Background: The increase in cannabis legalization in the United States has made its use progressively widespread. Although cannabis may have health benefits, smoking cannabis has been associated with cardiovascular disease (CVD), particularly ischemic stroke. Other risk factors for CVD (e.g., diabetes and tobacco smoking) have been studied extensively in regards to their detrimental effects on the auditory periphery. However, few studies have investigated the relationship between cannabis use and auditory function. Those that have evaluated this link are limited to the central auditory system. Given the connection between smoking cannabis and CVD, we postulate a connection between cannabis use and peripheral auditory dysfunction.

Hypothesis: We hypothesized that heavy cannabis smokers have impaired auditory function compared to non-smokers.

Methods: We studied two groups: heavy cannabis smokers (defined as smoking at least three times/week for one or more years) and non-smokers. Behavioral hearing thresholds were obtained from 0.25-16 kHz. Twelve cannabis smokers and 14 non-smokers completed audiometric testing. The better-hearing ear (defined by the puretone average at 0.5, 1, 2 and 4 kHz) was selected for distortion product otoacoustic emission (DPOAE) testing. DPOAEs at the frequency 2f₁-f₂ were obtained using discrete tone pairs for f₂ ranging from ~0.65 to 19.03 kHz in 1/8-octave steps using primary levels of L₁=65 and L₂=55 dB SPL. Data points at each frequency with 6 dB signal-to-noise ratio were included for analysis. DPOAEs were collected in 11 smokers and 14 non-smokers. Thresholds and DPOAE levels at each frequency were compared between cannabis smokers and non-smokers using a one-way ANOVA. Data collection is ongoing.

Results: Cannabis smokers were primarily female (58%; mean age= 23.3 years, [SD=2.5]) as were non-smokers (73%; mean age= 24.6 years, [SD=5.8]). There was no difference in behavioral hearing thresholds between the two groups at any frequency. Cannabis smokers (n=11) had significantly lower (poorer) DPOAE amplitudes than non-smokers between 3-10 kHz (n=14; F(1)=57.09, p<0.001). At other

frequencies, emission levels were comparable between groups. Results will be confirmed upon completion of data collection.

Conclusions: Preliminary results indicate that smoking cannabis may negatively alter the function of outer hair cells. This subtle cochleopathy is evident in the absence of measurable differences in behavioral hearing thresholds between cannabis smokers and non-smokers. Future work will evaluate the dose-response relationship between cannabis intake and DPOAE amplitude.

P.07.3

KNOWLEDGE OF COLLEGE STUDENTS FOR PERSONAL LISTENING DEVICES USE AND HEARING CONSERVATION

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Background and Purpose: As the rapid industrialization and development of electronic technology, accessibility of personal listening devices (PLDs) is continuously increased in all age groups. In particular, MP3 player's function of smartphone among various kinds of PLDs allows to users to listen to music regardless of exposure time and loudness, while ignoring a limitation provided by the device. That is concerned about noise-induced hearing loss and increase the risks (i.e., traffic accidents) caused by 'iPod oblivion' in young people. Considering these risk factors, the present study investigated and analyzed knowledge and experience of PLDs of college students. Results will provide their use pattern of listening devices, and confirm a necessity of education and/or campaign related to safe use of the listening devices, and eventually help hearing conservation of young group with an effective way.

Methods: For a questionnaire, 'Personal Listening Device and Hearing Questionnaire (PLDHQ)' which Danhauer et al. developed in 2009 was adapted while being in translation and back translation from English into Korean. Although the original version of PLDHQ was consisted of 83 items having college students' knowledge about, experiences with, attitudes toward, and practices/preferences for hearing health and PLD use, the present study only included 78 items while removing redundant 5 items with less relevance. The online survey was directed to Korean college students using the advertising capability on Social Network Service such as Facebook and Instagram. As an incentive for participation, the online respondents were offered a chance to win \$5 ~ 50 for completing the questionnaire. Participants' responses to the online version of the questionnaire were already tallied by Survey Monkey, which also calculated the percentages answering in each category for each item.

Results: A total of 500 college students responded to the online version of the questionnaire so far. (Will continue to collect data from 1,000 students.) Most of the college students know about how to maintain hearing health and to prevent hearing loss, and also what is the sign of hearing loss. That is, they did not seem to unsafe use of PLDs to be damaged. Regardless, 96% of college students habitually used PLDs, of which smartphone accounted for 92%. They reported to use the PLDs most frequently in environments with high levels of ambient noise (i.e., during public transport, in health gym). Surprisingly, they responded that the use form of PLDs would not change significantly even if hearing loss could occur.

Conclusions: When using PLDs conscientiously, most college students do not cause serious problems related to hearing loss by only using PLDs. However, some college students seemed to be most at risk because they listened to their PLDs at high volume levels for long durations using earbuds have concerns. Nowadays, the use of PLDs is inevitable in modern life and the most college students report that the use form of PLDs does not change significantly even if hearing loss can occur. Therefore, it is necessary to improve awareness of college students through publicity and campaign by college students' preferred media.

P.08 - EHDI PROGRAMS

P.08.1

EFFECTIVENESS OF RUSSIAN NEWBORN HEARING SCREENING PROGRAM IN DETECTION OF CONGENITAL AND PRELINGUAL HEARING LOSS

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The newborn hearing screening program in Russia has been conducted since 2008. Automated otoacoustic emission inpatient testing is conducted in birth facilities with subsequent outpatient re-screening for referrals or initial outpatient screening for non-hospital births within the first month of life. Full audiological assessment is performed for babies failed the screening as well as for high-risk babies. The prevalence of hearing loss in children in the first year of life in 2016 was 2.5 per 1,000.

To evaluate the effectiveness of hearing screening in the detection of congenital and prelingual hearing loss medical records from 405 children born in 2012 who underwent full audiological assessment at the age from 0 to 4 years old in the National Research Centre for Audiology and Hearing Rehabilitation were analyzed. Screening results were available in 335 cases. 81% of newborns received hearing screening before 1 month of life. Full audiological assessment before 3 months of life was conducted only in 32% of children that are not consistent with newborn hearing screening guidelines. 276 children were concerned as permanent congenital and prelingual hearing impaired. 88% of cases were bilateral, sensorineural hearing loss was confirmed in 84% of cases. The median age of diagnosis was 7 month of life (interquartile range 3-14 month) though only 70% of cases of congenital and prelingual hearing loss were diagnosed within the first year of life. A genetic cause of hearing loss was revealed in 58% of patients assessed for GJB2 gene mutations. 12% of babies had been diagnosed with hearing loss due to ear malformations. Risk factors of hearing impairment were cytomegalovirus and other intrauterine infections, prematurity 32 weeks of gestational age or less, family history of hearing loss, syndromes associated with hearing loss, perinatal hypoxia, hyperbilirubinemia, craniofacial abnormalities, neurodegenerative disorders and meningitis.

The main outcome of the national newborn hearing screening program is decreasing the age of detection of hearing loss though the timely audiological assessment of referrals remains an issue.

P.08.2

BONE CONDUCTION ABR ASSESSMENT IN CHILDREN REFERRED FROM UNIVERSAL HEARING SCREENING

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Newborn Universal Hearing Screening was introduced in Catalonia (Spain) in February 2010 by Public Health Department. The protocol included detection, diagnosis, treatment and follow up. ENT Department of Sant Joan de Deu Children's Hospital was designed as Unit Reference of Diagnosis.

Diagnosis protocol includes air conduction ABR (AC-ABR) as a first step and a second step of AC-ABR and ASSR in case of permanent hearing loss. In case of a result of transmission hearing loss in the first AC-ABR, a second bone conduction ABR (BC-ABR) has been introduced in our protocol before the second step (AC-ABR + ASSR), usually practised with anaesthesia.

We present our conclusions using this hearing protocol pointing out the advantages and disadvantages that we deal with in our daily work with children.

P.08.3

THE NORTH DAKOTA EARLY HEARING DETECTION & INTERVENTION PROGRAM'S 3 C'S; CONSIDERATION, COLLABORATION AND COMMUNICATION

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Introduction: North Dakota (ND) is a rural state with a land area of 69,000.8 square miles an estimated population of 755,393 in 2017. In 2017, approximately 12,000 children were birthed in North Dakota at 12 different hospitals. North Dakota has 15 diagnostic audiologists located in four of the most populated cities in the state.

The ND EHDI program staff consists of one full-time staff and two part-time staff totaling the equivalent of 2.41 staff. ND is one of seven states without legislation requiring hearing screenings or reporting of results to the EHDI program. The ND EHDI program is also without state funding to support the program. ND relies solely on federal grants to provide support for the ND EHDI system of care.

Purpose: Despite the barriers and challenges faced by the ND EHDI program, the program has continued to progress each year. The success of the ND EHDI program is attributed to the strong relationships that have been developed throughout the state with hospital staff, audiologist, early intervention providers and most recently family support providers. The relationships are built on consideration and respect for each other's limitations and consideration for the needs of the families, which are the purpose of the collaborations. Collaboration is essential, as each professional has a role in the hearing health system of care. Communication is key to assuring those identified with a hearing loss are obtaining the necessary health care as well as social and emotional support.

We will provide a view of how the ND EHDI program has developed a system of care that continues to grow stronger each year with the support of strong relationships with our partners.

P.08.4

RIGHT CARE IN THE RIGHT TIMES: UNIVERSAL NEONATAL HEARING SCREENING AND CHILDREN WITH HEARING IMPAIRMENT

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Universal Neonatal Hearing Screening (UNHS) program was formally approved by Emilia Romagna Region with the decree n.694 of 23 st May 2011, so since January, 2012 UNHS was carried out in the 31 birth point on the whole neonatal population in an effort to achieve early identification and rehabilitation of newborns affected with congenital hearing loss . About 35000 babies are born every year . The particularity of this regional planning is to integrate the neonatal audiological screening to the therapeutic treatment path, ensuring a continuity care of the newborn with deafness and encourage the pursuit of uniformity and fairness of access for all children with hearing impaired to right care in the right times. If UNHS programs have already been demonstrated to be efficient with a high level of coverage already after the first years (99,7% in 2015, 99,6% in 2016) , it was more difficult to ensure that every child with suspicion of hearing loss had the same chance to access the diagnosis and treatment services. In order to provide continuous, coordinated support and monitor the activity of all centers, a regional multidisciplinary team was put together in so called "Panel of auditory disabilities". Annually a local medical coordination of each birth point , audiology department , rehabilitation team and pediatric neuropsychiatric unit sent a special questionnaire on the regional data base to report their activities. A regional monitoring activity by the group of "Panel of auditory disabilities", on these data base, allows access to the knowledge of the prevalence and quality of the UNHS of each center, their critical points and consequently to promote ,with precise indications, homogeneity in timely identification, diagnostic testing, start of auditory stimulation and early rehabilitative intervention thus managing not to nullify the work of the hearing screening that led to an early identification.

P.08.5

NEW-BORN HEARING SCREENING AND COCHLEAR IMPLANTATION IN UZBEKISTAN: MEDICAL AND ECONOMICAL EFFECTIVENESS

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Cochlear implantation and hearing screening are very closely interrelated and represent a practically complex and complementary algorithm for the preparation of children for this surgery. As we know, the earlier the CI is done, the more effective the rehabilitation. The most effective way to detect deafness in children is NHS. In Uzbekistan CI era has started since 2014 and this year was starting pilot project on NHS.

Material and methods. During for the period 2015- 2016 years, there are 177742 newborns passed through hearing screening accordance to state pilot project. NHS includes OAE and DPOAE. The NHS was performed in perinatal centres by all regions of Uzbekistan.

Results. There were revealed 252 children with deafness, so this statistic data is evaluated 2,8 : 1000 newborns. One of the indirect criteria for the effectiveness of primary audiological screening is the fact of preparing and selecting children for CI. If in 2014 year the majority children with CI were the so-called "speechless" children, who were diagnosed deaf in connection with the absence of speech, at the age of 3-5 years. But in 2015 cochlear implantation were carried out for younger children (till 1 year – 8 children, 1-2 old years 16 children) whom hearing loss was detected by early intervention thanks to activity of NHS.

The cost of a boarding school for children with hearing impairment for food alone is (according to data for 2013 - for 1 child per year 2 million 7,500 soums), disability payments for 1 child 3 million and 48 thousand soums. Total costs of the minimum amounted to 5 million 55 thousand soums (not including special education, disability benefits) per child - by 126 (identified children with hearing impairment by audio scoring), the costs will be at a minimum of 636 million 930 thousand UZS. The costs of the grant study for 2015 amounted to only 120 million 26 thousand soums. Thus, 516 million 904 thousand soums will be saved annually in case of full-fledged rehabilitation of children with a pathology of hearing.

P.08.6

NEWBORN HEARING SCREENING: 2 YEARS' RESULTS

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CHLC ~ Lisboa ~ Portugal

Introduction: Hearing is one of the most important skills for children development - it contributes for their relationship and communication with people around the world.

We know that, in 1000 healthy babies, 1 to 3 have hearing loss but this incidence increases to 20 to 40 if we consider high-risk indicators newborns.

This is the reason why we consider newborn hearing screening very important: to detect all the babies with hearing loss ≥ 35 dB, allowing an early detection (before 3 months of age) and an adequate intervention / rehabilitation before 6 months of age, if an hearing loss is present.

Objective: The purpose of this work is to characterize the newborns population, in a portuguese central hospital (Centro Hospitalar Lisboa Central-CHLC) between 01-01-2016 and 31-12-2017.

Methods: Considering the risk indicators defined by the Joint Committee on Infant Hearing (2007), we screen the risk babies with Otoacoustic Emissions (OEA) and Automated Auditory Brainstem Response (aABR) at the first phase and non-risk babies with only OEA. If, in any phase, the screening result is refer, we repeat the test 2 weeks later or, if the baby is old enough, we do diagnosis tests such as 1000 Hz tympanometry, ABR and behavioural audiometry.

Results: In the last 2 years, there were born 7500 babies on CHLC maternity and we had screened 96,5% of them.

14,1% of those babies had to repeat the screening on a second phase and 2,3% referred again for a third phase. Only 0,8% of those babies needed to do diagnostic tests to confirm an hearing loss.

At the moment, we have 14 children with confirmed hearing loss, but only 7 of them revealed risk indicators for hearing loss.

7 children have bilateral hearing loss and 7 have unilateral hearing loss.

7 of them are already using hearing aids for auditory brain stimulation.

Conclusion: At the present date, there are some children results that are not yet concluded but, in 2 years of hearing screening, we reached the effectiveness level (>95%) for a newborn hearing screening program.

P.08.7

THE USE OF SIMULATION WITH ACTORS IN THE TEACHING-LEARNING PROCESS IN THE AUDIOLOGY COURSE

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Objective: To analyze the content from the filming of undergraduate students of the last year of the Audiology course, during the simulation with actors, of a care in the context of the audiological clinic. **Methods:** Twenty-seven undergraduate students, female, aged between 21 and 24, participated in this study. The total number of participants in the simulation were three students who interacted with three actors; the other students participated as a group of observation and discussion and a teacher led the simulation assuming role of mediator and facilitator of the process. A qualitative study used the content analysis transcripts of these two simulations in a text document (Word format) and which were collected by the software NVivo10 to determine the registration units (words) and context (sentences) and, from thus establishing the thematic categories. **Results:** The most recurrent categories during the simulations were Doubts, Feelings, Expectations, Communicative Skills, Awareness for Change and Difficulties. At the end of the simulations, it was clear that there were changes in student behavior and that this learning will be taken from the simulation to the therapy rooms. **Conclusion:** The workshop evidences that teaching / learning technical skills must be integrated with the interpersonal skills in the care relationship. For this, the curriculum of the Audiology courses should adopt the use of simulations in the various disciplinary contents.

P.08.8

ETHICAL ASPECTS IN UNIVERSAL NEWBORN HEARING SCREENING

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Every pregnant mother expects and longs to give birth to a healthy baby and to leave the hospital with the assurance that all is well, especially when there are no apparent complications at delivery.

Routine neonatal examination by health professionals has therefore become an accepted practice for detecting potentially serious conditions in apparently healthy newborns before hospital discharge (Olusanya et. al, 2006)

According to the World Health Organization (WHO,1971) screening is a "medical investigation that does not arise from a patient's request for advice for specific complains. The term covers all types of examination and does not refer to their speed or accuracy."

Similarly Harford et al. (1978) states, "screening is a process by which individuals are identified who may have disease or disorders that are otherwise undetected" and which many have "findings of asymptomatic cases" (Haggard & Hughes, 1991). Ethic

Balancing benefits and risks in medical care is a moral and ethical duty and a frequent challenge for clinicians and other health professionals.

Screening criteria from a well- cited paper by Wilson&Jungner (1968) recommend the following ten basic and ethical principles that screening program should observe:

1. "The condition to be screened for should be an important health problem
2. There should be an accepted treatment for cases identified
3. Facilities for diagnosis and treatment should be available
4. There should be a recognizable latent (early, asymptomatic) stage in the condition
5. There should be a suitable test to employ in screening
6. The test should be acceptable to the population

7. The natural history of the condition should be understood
8. There should be an agreed policy on whom to treat as patients
9. The cost of case-finding (including diagnosis and treatment of those diagnosed) should be non-wastefully balanced in relation to expenditure on medical care as a whole
10. Case-finding should be an ongoing process and not a 'one-off' project."

Permanent congenital or early-onset hearing impairment (PCEHI)

is one of the most common abnormalities in children, which is detectable shortly after birth.

In the last decade Universal Newborn Hearing screening (UNHS) has emerged as an essential element of neonatal care in developed countries following favorable outcomes from early intervention in the critical period for optimal speech and language development (Olusanya et. al, 2006).

Due to different economical, geographical and financial conditions diverging screening programs and protocols have been developed and implemented. Overall they aim for ethical principals like the one recommended by the American Speech-Language-Hearing Association (ASHA) 2013:

- 1st month after birth: Newborn Hearing Screening to be completed
- 3rd month after birth: for those newborns who fail the newborn hearing screening an Audiologic Diagnostic - should be completed
- 6th month after birth: Newborns diagnosed with hearing loss who need intervention should have hearing technology fitted within 1 month of the diagnosis and be enrolled in an early intervention program no later than at 6 months of age

Beside careful and sustainable planning of financial resources, organization, taking care of geographic topics and training programs ethical issues need to be considered also detailing audiological and technical parameters, like:

- UNHS or targeted screening (for risk- group children)?
- hospital & clinical based screening?
- how to take care home delivery?
- uni- or bilateral hearing screening ?
- retrocochlear HL in well baby population?
- test technique: TEOAE, DPOAE, AABR ?
- test sequences: OAE&OAE, OAE&ABR ?
- define valuable PASS criteria for level and frequencies
- define targets for sensitivity and specificity
- how to screen for late onset HL ?
- when to screen kindergarten or school age?
- audiometric test or speech test?

Remember:

If screening for hearing in newborns is currently mandated in most parts of the developed countries, where only about 10% of children with PCEHI worldwide are found, then distributive justice on a global level suggests that this vital public health programs should be offered also in the developing countries where most of the potential beneficiaries reside (Olusanya et. al, 2006).

P.09 - SCREENING: PRESCHOOL, SCHOOL AGE

P.09.1

AUDITORY PROCESSING SCREENING AND A SELF-REPORT QUESTIONNAIRE IN CHILDREN WITH AND WITHOUT SCHOLAR DIFFICULTIES

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Objective and rationale: Early identification and early assessment of children at risk for Auditory Processing Disorder (APD) has been a challenge in Audiology. It is a consensus that a proper central auditory screening battery should consist in simple and rapid procedures that can be applied to a large number of children with the aim of early identification of those with a high probability of presenting APD that should be referred for a complete diagnostic assessment. Thus, hearing screening contributes to the minimization of the child's losses in relation to learning and school performance. This study aimed to evaluate, compare and correlate the performance of children with and without scholar difficulties in a simple screening battery with diotic tasks and a auditory self-report questionnaire.

Design: cross sectional comparative and descriptive study carries approval from the Research Ethics Committee of State University of Campinas, under number 1.538.278 and performed at a Public Elementary School in the city of Campinas.

Methods: Sixty seven school-age children were divided into 2 groups: Group I (GI) consisted of 40 children with normal development and good academic achievement (age range 8.08 to 11.17 years, median 9.56 + 1.04; 17 boys) and Group II (GII) consisted of 27 children with scholar difficulties (age range 8 to 11,5 years, median 9.61 +1.11; 15 boys). Academic performance was reported by responsible teacher through a specific questionnaire. After parental consent, children with normal otoscopy and tympanometry exam at the time of assessment, completed the screening battery, composed by a self-report questionnaire- Scale Auditory Behavior- SAB (12 questions) and three diotic tasks – sound localization in five directions and temporal ordering with verbal (syllables) and non verbal (musical instruments) materials, battery called of "Simplified central auditory screening" – ASPA. If the children presented abnormal results in any of the three tasks compared to standardization values, the result of ASPA were considered "fail". The maximum possible score on the questionnaire is 60 points and a score above 45 points on SAB was considered "risk for APD".

Results: Groups were homogeneous in gender ($p=0.294$) and age ($p=0.862$). In GI, only two children (5%) presented normal results on ASPA and in GII, 14 children (51.9%) failed on ASPA and had a statistical worse performance when compared to GI ($p<0.001$). There were no result differences on the performance of sound localization ($p=0.179$) and non-verbal temporal ordering ($p=0.600$), but GII presented a significant worse performance on verbal temporal ordering ($p<0.001$). Significant differences ($P<0.001$) were seen between the points average for GI 46.78 (+6.44) and for GII 36.93(+7.67), ($p<0.001$). No correlation was found between the scores of the self report questionnaire and performance on auditory tasks ($p> 0.005$)

Conclusions: ASPA and SAB were able to distinguish children between GI and GII. However, no correlation was observed between ASPA and the questionnaire. Temporal ordering for verbal sounds was the most significant task from the screening battery applied. The use of self-reported questionnaire combined to a screening procedure contributes to an early and assertive referral for a diagnostic evaluation.

P.09.2

THE FIRST STEP TOWARDS AN AUDITORY PROCESSING DISORDER SCREENING TEST FOR CANADIAN FRENCH-SPEAKING CHILDREN

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INTRODUCTION. Children with auditory processing disorder (APD) and normal hearing sensitivity have difficulties in several daily activities and participation, especially in non-optimal communication situations. So far, these children are diagnosed with APD after school entry. Early intervention is postponed by the fact that children are not usually seen for an APD assessment before the age of 7, as suggested [1,2]. Screening for APD at an earlier stage could help to apply intervention programs to children younger than 7 years of age. Several studies have attempted to predict APD evaluation results based on APD screening questionnaires' answers. Results from one study showed that only the Fisher's Auditory Problems Checklist can do so [3]. However, in the aforementioned study, APD criterion was based on abnormal results for one test which does not comply with the ASHA (2005)'s recommendations [2].

Regarding the screening tests, a few studies assessed their sensitivity and specificity. The Multiple Auditory Processing Assessment test battery showed a sensitivity of 90% and a specificity of 100% with three tests [4]. Also, Yathiraj et al. (2014) [5] assessed the Screening Test for Auditory Processing [6]. Results revealed that the sensitivity and specificity were 84% and 76%, respectively when test results were combined with results of the Screening Checklist of Auditory Processing questionnaire. Also, the Screening Test for Auditory Processing Disorders – SCAN-3 for children [7] comprises eight subtests and the sensitivity and specificity "range from 25% to 88%, depending on the cut score chosen" [8, p. 6].

OBJECTIVE. The aim of the study is to create and assess a pediatric APD screening test in French which is not available at the present time. The study is divided into a retrospective and a prospective part. This presentation will focus on the retrospective part. The main objective of this part is to create a brief questionnaire to be used in the prospective part of the study.

METHODS. Files from 125 7-13-year-old children referred for an APD (77 boys, 48 girls) were reviewed. File selection was based on the following inclusive criteria: (1) children with hearing sensitivity with within 0 to 15 dBHL from 250 Hz to 8 kHz in both ears; (2) an APD questionnaire completed by the parents and teachers available in the files, and (3) children with results from a completed APD test battery. The exclusion criteria comprised: (1) children with a known neurological disorder (e.g. epilepsy, head trauma); (2) non-medicamented children with attention deficit, and (3) children with intellectual disabilities.

DATA ANALYSES. Data analyses were done in two steps: (1) correlation analyses to investigate the relation between questions from several sections of the parents and the teacher's questionnaires, and results from each diagnostic test; (2) Questionnaire sections showing a significant relation with some APD tests were then further analyzed to examine predictive effect of questions of these sections on APD diagnosis by logistic regression analyses.

RESULTS. Significant correlations between specific sections of the parents and teachers' questionnaires, and between two specific APD tests were found. Results from the logistic regression model revealed that two questions for the teachers' questionnaire and three from the parents' questionnaire predicted the APD diagnosis.

CONCLUSION. Based on these results, five questions have been chosen to be included in a screening questionnaire for APD that will be used in the second part of this study.

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P.09.3

PREVALENCE OF HEARING DISORDERS IN WESTERN POLAND – ANALYSIS OF 95.411 SCHOOL-AGE CHILDREN

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Introduction In 2008 The Institute Physiology and Pathology of Hearing in collaboration with KRUS (Polish Agricultural Social Insurance Fund) elaborated and implemented of hearing screening programme in school-age children, which starting in eastern Poland and during this programme 92,876 children were examined. Positive assessment of this programme was a main determination to started the same procedure in western Poland.

The aim of this poster was to presented the prevalence of hearing disorders in group of school-age children in western Poland.

Material & Method Hearing screening was performed in group of 95.411 from 9 voivodships in western Poland. Number of schools participated in HS program was 4.041. The most numerous group were children in 7 years old - 77.2% of tested pupils. There were more girls 51.4% than boys 48.6%. Prior to testing, the children's parents were informed of the testing procedures and wrote the consent.

Screening is planned only in the month in which the risk of infection is reduced – they began in the first week of March and finished on June. Screening was performed using the Platform for Sensory Organs Examinations on the basic of audiometric procedure of measuring the hearing threshold. Additionally, subjective assessment was carried out on the basis of parents' questionnaires. Threshold for air conductive were determined in the range of 0.5 - 8 kHz. Positive result of HS was defined for value for 25 dB HL at least at one frequency in either ear.

In addition, during examination the DDT (Dichotic Digital Test) was performed in order to assess symptoms and difficulties of central auditory processing disorders.

Results Approximately 77% represented by seven years old children. The highest of positive results were noted in grade 0 about 23.9%, and the lowest in grade 6 was about 14%. Regions with the highest of positive results was in Zachodniopomorskie (17.2%) and the lowest were in Lubuskie's region (12.7%) and in Lodzkie (12.4%).

Questionnaire results showed of lack of awareness of parents or take-carer of their child has a hearing problems. About 58,8% did not notice this problem. It needs to be highlighted that in group of children who have a positive results, 41% were not under specialist care. In 27% of cases with positive results, it was the first hearing examination except neonatal hearing screening.

Conclusion The results of hearing screening programme demonstrated higher prevalence of hearing problems in group of primary school pupils. In this group of children educational difficulties also were observed. The training for parents, teacher and school nurses are recommended in order to gain the knowledge about early detection of hearing problems and also acquisition skills conducting a hearing test such as pure tone audiometry use tools which would not be time-efficient, inexpensive and easy to implement.

P.09.4

FAMILY PEDIATRICIAN ROLE IN AUDITORY SURVEILLANCE PROGRAM IN THE FRIULI VENEZIA GIULIA REGION, ITALY

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The prevalence of confirmed childhood profound hearing loss increases with age and concerns have been expressed about hearing impaired children not picked up by the newborn screening programs.

In Friuli Venezia Giulia region childhood hearing surveillance (CHS) is performed by monitoring of Audiologic High Risks Registry (JCIH 2007) during the defined periodic health visits (at 1,3,6,9,12,18,24,36 months of age) done by the family paediatrician (FP) .

In order to explore the validity of the audiological surveillance program we evaluated 600 children referred by FPs and subsequently studied for their audiological characteristics. 3-5,5% of children referred by CHS program were identified as having a permanent hearing loss.

Postneonatal routes of identification are today considered essential. While being aware of their current ineffectiveness, they need to be maintained and improvements investigated in order to obtain an operative policy for detection and an early management for children not identified by the Universal Newborn Hearing Screening (UNHS) program. The Italian National Health System recognizes the FP as a key figure for childhood health and CHS. The FP ascertains the UNHS results and the following delivery steps. The regular visits to the FP place the professional in an optimal position to monitor auditory capacity of the growing child.

New audiologic tools for FP CHS activities should be developed and designed. The FP should be included in interdisciplinary education and training. It is indeed necessary to implement a public health system in parallel to the UNHS that can more effectively empower early referral and identification of hearing impaired children not identified by newborn screening.

P.09.5

DESIGNING INTERACTIVE PLAY AUDIOMETRY WITH TANGIBLE AND NATURE-BASED USER INTERFACE FOR PRESCHOOL HEARING SCREENING

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The timely diagnosis of hearing loss in the pediatric population has significant implications for a child's development. It is important to assess this population using a hearing test which can measure only the auditory capacity of a child without the confounding influence of the child's ability to understand the test instructions or of the child's cognitive status, motivation, ability to sustain attention and so on. Pure-tone audiometry is challenging to perform for children with hearing impairment, communication disorders or delayed cognitive development. Developmentally appropriate conditioned play audiometry (CPA), is used to evaluate hearing in children. Current CPA utilizes activities such as placing blocks or balls in a basket game or tablet-based games to replace the subject feedback button in the traditional pure-tone audiometer. However, the tasks in the conditioning and screening phases of the traditional CPA procedures may still be abstract or may lack confluent and consistent meaning for the children to follow. Some children described as having deficient play skills, particularly in the symbolic domain, may find these CPA activities difficult or uninteresting. In addition, younger children may be less tolerant of earphones, resulting in lower completion rate of ear-specific hearing tests.

The purpose of this study is to develop a novel interactive play audiometry for preschool children. The design tried to make the test equipment, conditioning activities, and screening activities into integral parts of an interesting task in real life. The test equipment was modified and the user interfaces in all activities were tangible and made use of nature-based objectives that were age appropriate, gender neutral and motivational. For example, the real-life task is to feed dolphins at the aquarium when they are hungry. The sounds of hungry dolphins are the hearing test stimuli. In the conditioning phase, the screener acts as an aquarium diver and wears a diving mask which is modified by attachment to a headphone. A non-insulating putty dolphin with LED eyes is connected to a Makey Makey device, which translates any diver's touch on the dolphin into a keyboard message input to a tiny computer (Raspberry Pi), in which the software program developed by us for this interactive hearing test is installed. The screener uses the keys on the Makey Makey device to change frequency and volume of the test sound or to play the test signal. In the conditioning phase, the test signal is transmitted to both the diving mask and Bluetooth speaker, thereby enabling the child to hear the hungry dolphin's sound. The screener may ask the child to feed putty fish to the dolphin when the hunger-associated sounds are heard, and consequently, the dolphin's eyes will blink as a reinforcement feedback. In the screening phase, the child is asked to act as the diver and wear the diving mask. The child is encouraged to feed the dolphin as quickly as possible while trying to maintain the correct judgment by monitoring the blinking eyes. Currently, four different real-life tasks have been developed and the preliminary test results revealed that most of the children who were not able to cooperate in the traditional CPA procedures could complete the tasks developed in this study. Further studies regarding the incompleteness rate, test duration and other

validity and feasibility issues of using this portable system to conduct the preschool hearing screening program are underway.

P.09.6

DEVELOPMENT OF A NATIONAL QUALIFICATION FOR NEWBORN HEARING SCREENER

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Across England, newborn hearing screening is delivered within the National Health Service organisations. The programme aims to screen babies born or resident in England within four to five weeks of birth. Screening can take place in the maternity hospital, outpatient clinic, or at home. There are clear care pathways for the screening and referral process with different protocols for well babies, and for those who have spent over 48 hours in a neonatal unit setting.

Screening is usually undertaken by non-professionally qualified staff. Since implementation of the programme across England, when the national programme team provided an in house training programme, responsibility for the training of screening staff rests with the local service lead and consists of on the job experience. This is combined with a bespoke e-learning resource and an observed structured clinical examination (OSCE), provided by the national programme.

It has long been recognised that whilst meeting the needs of the programme, in order to fit with the direction of education in healthcare it was necessary to create a recognised qualification for staff delivering the hearing screen.

Together with the other two national screening programmes that also use non-professionally qualified staff (Abdominal Aortic Aneurism (AAA) and Diabetic Eye Screening (DES)) a national qualification for screeners has been developed.

The Level 3 Diploma for Health Screeners is nationally recognised in England and provides a pathway for screeners to support potential career progression and opportunities in health care. It was created in collaboration with Health Education England and Skills for Health to provide a national screener qualification via an accessible work based training programme.

It has been designed to reflect work based learning and compliment previous methods of training. Learners are expected to provide further evidence and formalisation of additional learning outcomes for units that cover the competencies required to work within a health care setting.

Since April 2016, the diploma is now the recommended national training programme for new NHSP screeners and successful completion is required to assure the provider of the screeners' competence to undertake screening safely, independently and in line with programme standards

Together with a description of the current training structure for newborn hearing teams in England, this poster presents information about the design and content of the new qualification as well as describing the development process.

P.09.7

MAKING SCREENING PROGRAMME INFORMATION ACCESSIBLE TO PUBLIC AND PROFESSIONALS

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Since April 2013, the newborn hearing screening programme (NHSP) in England has been led by Public Health England (PHE) an executive agency sponsored by the Department of Health and Social Care. The organisational change led to stricter guidance and controls on what type of, and where, information can be published. Initially, the majority of programme information was only available on access restricted sites and was not in the public domain.

To improve this situation, the national NHSP programme team has undertaken a major review of the wealth of guidance and information provided to support local screening programmes and commissioners. Information that was available across a wide range of documents and locations has been collated,

reviewed and rewritten in a coherent way using a Hypertext Markup Language (HTML) format in accordance with government publication guidelines.

On the 1st November 2016 the NHSP "Operational Guidance for Newborn Hearing Screening Programmes" was published on GOV.UK the website of all government departments and public bodies at <https://www.gov.uk/government/publications/newborn-hearing-screening-programme-nhsp-operational-guidance>

The target audience for the information are primarily staff in local screening programmes, audiology and the commissioners of services. However the information is freely available to all, including the public, both in and outside England

Presenting data in this format is an innovative approach for the screening programmes in England and so to ensure the user needs are being met a survey has been undertaken to inform modifications and any future initiatives.

This poster outlines the development process along with examples of the information that is now available in the new format, together with the results of the recent survey and data on the frequency with which the guidance is accessed both from within and outside England.

P.09.8

EIGHTEEN YEAR QUALITY ASSURANCE OF NEWBORN HEARING SCREENING IN DUTCH NEONATAL INTENSIVE CARE UNITS

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Objective: To evaluate 18-year quality assurance of newborn hearing screening (NHS) in Dutch neonatal intensive care units (NICU).

Study design: Results of the two-stage automated auditory brainstem response (AABR) screening and diagnostic examination in NICU graduates were centrally registered between October 1998 and December 2016. This registration facilitates screening, tracking and follow-up after abnormal screening results. Outcome measures are referral rates, prevalence rate of hearing loss and (trends of) coverage rates and timeliness of follow-up.

Results: Sixty-three thousand one hundred and forty infants have been screened. Referral rates were 11.9% at the first and 23.1% at the second stage. Hearing loss was diagnosed in 1631 infants (2.5%). Of these infants, 1213 (1.9%) had a bilateral hearing loss and 418 infants (0.7%) an unilateral hearing loss. Coverage rates were 98.9% at the first, 94.9% at the second stage and 93.9% for the diagnostic examination. After correction for gestational age, 95.8% of the infants had their first AABR<1 month, 84.0% of the referred infants had their second AABR<6 weeks and 72.6% were diagnosed<3 months. The positive predictive value of hearing loss after AABR screening was 69%. Coverage rates increased over time (first stage >99% from year 2011 onwards, second stage >95% from year 2010 onwards).

Conclusions: The NHS in Dutch NICU's is effective. Coverage rates are improving over time.

P.09.9

DO TEACHERS FIND DIFFERENCE IN LANGUAGE DEVELOPMENT OF CHILDREN WITH COHLEAR IMPLANTS ACCORDING THE TIME OF DYAGNOSIS AND IMPLANTATION?

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This research is focused both on theoretical and practical issues of the importance of the early diagnosis of hearing disorder, how this is critical for the language development of the child and the input of parents and teachers in his/her smooth integration into academic community.

We present the difference that occurs or not in terms of linguistic development of pre-school and school-age children who have cochlear implants in connection with the age of diagnosis of the problem and the age of implantation.

The research is conducted from the perspective of the teachers and through a questionnaire distributed to them.

The content of the applied questionnaire deals with teachers' understanding of what happens when the hearing problem is diagnosed, what are the next steps, whether parents are sitting directly to find solutions. Some questions are focused on understanding parents' cooperation with the teachers, how they get the idea about the critical differences in children who had early diagnosis and treatment, and how this is reflected in their linguistic development than those who were late to diagnose and proceed to the following steps.

P.09.10

HEARING IMPAIRMENT AND OTOLOGIC CONDITIONS IN PRESCHOOL CHILDREN IN RURAL LIMPOPO PROVINCE (SOUTH AFRICA)

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Disabling hearing impairment is one of the highest contributors to the burden of disabilities in the world. Hearing impairment, especially in children, can cause developmental delays in the development of speech and language as well as cognition. These delays may in turn lead to educational disadvantages and social isolation. The prevalence of self-reported hearing impairment obtained during the national population census often underestimates the problem. There is limited evidence-based data available on the prevalence of HI and otologic conditions in preschool children in South Africa, especially in rural areas. Due to the lack of evidence-based information, the government is unable to implement appropriate ear and hearing health services, especially at primary health care level.

The aim of the study was thus to describe the prevalence of hearing loss and otologic conditions in preschool children aged three to seven years in Elandsdoorn, a rural area in the Limpopo Province of South Africa.

A retrospective record review of 823 hearing screening records was conducted. The mean age of participants was 5.81 years (± 1.09 ; range 3 - 7).

The presentation will highlight the findings of the record review and focus on the implications for the initiation of comprehensive ear and hearing health care services for the school-aged population in under resourced areas.

P.09.11

WORKING WITH HEARING LOSS: THE CASE OF TWO SIBLINGS

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Il Manto S.C.S. ~ Como ~ Italy

This poster is about the school and educational project proposed to two siblings suffering from bilateral deep hearing loss, G. and T.

Each of them has an acoustic prosthesis, a bilateral cochlear implant, G. since he was 4 years old, T. since she was 6 months old.

The family turned to "Il Manto", a Social cooperative in Como, in 2015, to ask for the presence of an educator supporting the children during the school hours, in synergy with the teacher's aid. G. attended his last year of primary school and T. her last year of kindergarten.

Each child is assigned to an educator. During the work with the family, with the school and with the specialists, it has become clear that the children's needs in education and learning, despite the diversity of their functioning profile, mainly concern mediation and, where strictly necessary, compensation of the understanding processes of those contents that are conveyed verbally, both orally and written. The educational work with children also concerns aspects of relationship and socialization, which sometimes need to be facilitated and promoted by adults. This contribution analyzes the didactic and educational modalities proposed to the children during their three school years, the observed changes, and the future paths of work.

P.10 - DEVELOPMENTS IN TESTING

P.10.1

GUIDELINES FOR ECOCHG RECORDING AND MEASUREMENT PROTOCOLS

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Electrocochleography (ECoChG) has been an effective tool in the diagnosis, assessment and monitoring of Meniere's disease (MD)/endolymphatic hydrops (ELH) for over two decades, and more recently, superior semicircular canal dehiscence (SCCD). However, the various protocols used to perform and measure ECoChG continue to vary considerably among clinicians who include this procedure in their diagnostic test battery for MD/ELH/SCCD. This lack of standardization makes it difficult to compare/share results across clinics/clinicians and most certainly has affected the outcomes of several studies related to the effectiveness of ECoChG as a clinical tool. Thus, the objectives of this study are to: 1) present a set of standardized patient preparation, recording and measurement protocols for performing ECoChG for the purpose of helping to diagnose MD/ELH/SCCD, and 2) facilitate/improve the use of an important clinical tool for patients suspected of having MD/ELH/SCCD.

Standardization guidelines for ECoChG recording and measurement protocols were determined via the consensus of three clinicians/clinical scientists who have used this diagnostic tool in the clinic and have conducted research in this area for several years. All three individuals perform non-invasive ECoChG, using the lateral surface of the tympanic membrane (TM) as the primary recording site. Standards for recording TM ECoChG are recommended to include: TM electrode selection and placement procedures, and ECoChG recording parameters. Guidelines to identify and measure the cochlear summing potential (SP) and cochlear nerve action potential (AP) and interpreting the electrocochleogram also are presented.

P.10.2

HEARING THRESHOLD ESTIMATION USING LONG LATENCY AUDITORY STEADY STATE RESPONSES

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The aim of the project reported is to develop an automated electrical response audiometry (ERA) system using cortical auditory long-latency evoked responses (LLR) analyzed objectively in a steady-state condition. Test methods that dominate clinical application of ERA today, such as auditory brainstem response (ABR) and auditory steady state response (ASSR), permit only indirect inferences about hearing sensitivity and cannot provide a comprehensive view of the auditory pathway, as can be achieved with cortical responses. Maturation, level-of-arousal issues, and variation of LLR results have previously limited the widespread implementation of LLR in clinical audiological evaluation, particularly in pediatric populations. Recent publications report work demonstrating that an objective analysis approach can be successfully applied to the LLR using modulation rates below 20 Hz. Our work to-date has demonstrated success in measuring valid Long-Latency Auditory Steady State Responses (LLASSR) in adults and school-aged children and efficacy in infants. Pediatric application is a planned focus for the current work, as this is the age group most challenging for both testing by conventional audiometry and assessment of cortical responses. The LLASSR approach provides an interface with automated response detection, audiogram generation and real-time Signal-to-Noise (SNR) and Residual Noise (RN) measures. Both continuous steady state and the corresponding transient LLR responses can be utilized, allowing analysis using either an automated spectral method or, conventional LLR validation via a time-domain peak identification method. All single sweep recordings are automatically stored for offline and statistical

analysis of signal and noise components. The data reported, obtained from a group of adults with normal hearing using a rate of 0.78 Hz, compares LCLASSR and LLR intensity series to behavioral thresholds. SNR and RN measures are analyzed at the fundamental and harmonic components. [Work supported by NIH-NIDCD SBIR 1R44DC015920-01A1]

P.10.3

COMBINED NEWBORN HEARING AND AUTISM SPECTRUM DISORDER SCREENING SYSTEM

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A system is proposed for incorporating neurological assessment of newborns during routine newborn hearing screening using high stimulation rates and Continuous Loop Averaging Deconvolution (CLAD) [1]. Autism Spectrum Disorder (ASD) is a neurological disorder characterized by impaired social interaction and communication and stereotypical behavior such as adverse response to specific sounds. The prevalence of ASD is estimated at 1 in 68 children and the median age of behavioral diagnosis is 4.1 years. Early detection and intervention is associated with improved outcomes and is encouraged by the American Academy of Pediatrics, Healthy People 2020, and other agencies.

Recent studies have shown prolonged Auditory Brainstem Response (ABR) peak latencies in small groups of premature infants later diagnosed with ASD. In a pilot study, we retrospectively examined ABR newborn (0-6 days) hearing screening records performed between 2009-2014 by MEDNAX® at 35-decibels above normal hearing level using the SmartScreener-Plus2. We found 8,511 records for newborns who passed the hearing test during their first week of life, 21 of which were later diagnosed with ASD according to the University of Miami-Center for Autism & Related Disabilities database. The ABR wave V latency for left and right ears was compared between the ASD group and the remaining newborns, which served as controls. Mean group differences were examined with a t-test. The ASD group consisted of 24% females, while the control group had 50% females. Wave V latency was significantly prolonged in ASD compared to controls in the left ear (ASD: mean= 8.94 milliseconds (ms), SD= 0.9; Control= 8.41 (ms), SD=0.7; Cohen's d=0.69, t = 2.6, p=0.018) but not in the right ear [2]. Further replication on larger samples is needed to examine the potential of prolonged ABR as a biomarker for ASD risk.

The proposed incorporation of a higher intensity, fast rate ABR recording into standard newborn hearing screening protocols has the potential to provide significant information as to an infant's neurological wellbeing and to facilitate early detection and intervention for disorders such as ASD, with very little additional cost. Using high rate stimulation is effective in the evaluation of neural pathways. In the case of ASD, increasing the stimulation rate (from 19 to 61/sec) has been previously shown to further increase the latency of ABR peak V as compared to a control group [3]. Incorporating CLAD ABR recording into the screening protocol allows for stimulating at very high rates (>100/sec) as overlapping responses can be deconvolved. This technique is combined with an automated ABR peak recognition algorithm [4] for neurological evaluation of peak latencies. The proposed system components and protocol are outlined.

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P.10.4

OCTAVE-BAND CE-CHIRP AUDITORY BRAINSTEM RESPONSES LATENCY NORMS IN NEWBORNS AND INFANTS

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Currently there are no published auditory brainstem response (ABR) latency data to octave-band CE-Chirps in the youngest group of newborns and infants with the TDH39 headphone. ABRs from newborns and infants were previously recorded using octave band CE-Chirps at center frequencies of 0.5 kHz, 1 kHz, 2 kHz and 4 kHz and made available for analysis for this project. Data were collected using the Interacoustics Eclipse EP25 ABR system®. The population were recruited after being referred by the newborn hearing screening as part of their referral for threshold estimation ABR. Only newborns and infants meeting the discharge criterion (≤ 30 dB eHL at 4 kHz) were included in the data analysis. ABRs were recorded at four different octave-band CE-Chirp center frequencies from 30 ears at 0.5 kHz, 59 ears at 1.0 kHz, 31 ears at 2.0 kHz and 63 ears at 4.0 kHz. Wave V latencies were determined by an experienced evaluator who followed the English National Health Service guidelines. Mean latencies in newborns and infants were longer than normative adult latencies. This finding is in agreement with previous studies reporting latency norms for other stimuli. The longer latency is a result of a not fully matured auditory system and it is therefore important to have age-specific normative ABR latency data for the octave-band CE-Chirps.

P.10.5

CORTICAL AUTOMATIC THRESHOLD ESTIMATION: AN ALTERNATIVE HEARING TEST FOR OLDER ADULTS WITH DEMENTIA LIVING IN RESIDENTIAL AGED CARE

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BACKGROUND: The ability of adults with dementia to complete the traditional hearing test, pure tone audiometry (PTA), is questionable. A study conducted on 307 older adults living in residential aged care facilities who were identified as having dementia like behaviours, found only 32% of participants could reliably complete PTA (1). Given that over 60% of older adults with dementia also have a hearing impairment (2), the feasibility of alternative hearing tests should be explored. Auditory evoked potential testing, namely auditory steady state response, has been shown to be highly correlated to behavioural hearing thresholds in adults with dementia (3). Cortical Automatic Threshold Estimation (CATE) measures auditory evoked potentials via an automated system and is a non-behavioural hearing test. The aim of this study was to investigate the feasibility of CATE for adults with dementia living in residential aged care facilities.

METHODS: A single group cross-sectional study design was employed. Participants were recruited from three residential aged care facilities in Queensland, Australia between August 2017 and April 2018. Participants were included if they met the following criteria: 1) had a confirmed diagnosis of dementia recorded on their medical records; and 2) lived permanently in a residential aged care facility. Participants completed a demographic questionnaire and had dementia severity assessed via the Clinical Dementia Rating Scale (4). Otoscopy was performed and where appropriate participants were referred for cerumen management. Participants then attempted to complete PTA and CATE. To reduce measurement bias, testing order was randomized. Hearing thresholds were measured at 500, 1000, 2000 and 4000Hz. The ability of participants to complete each hearing test and the time taken to complete each hearing test were recorded.

RESULTS: In total, 13 participants consented to the study. The average age of participants was 86.5 years \pm 6.3. One participant withdrew prior to testing due to a decline in health and two participants could not be tested as cerumen was not managed prior to the conclusion of the study. Of the remaining 10 participants, five were diagnosed with severe dementia, four with moderate dementia and one with questionable dementia. Two participants completed both PTA and CATE, two participants completed PTA only, five participants completed CATE only, and one participant was unable to complete either hearing

test. The average testing time for PTA was 13 minutes and 56 minutes for CATE.

CONCLUSIONS: Preliminary results are mixed and the feasibility of CATE as an alternative hearing test for older adults living with dementia in residential aged care facilities is unclear. Although more participants were able to complete CATE than PTA, the time taken to complete CATE is potentially too long for audiologists to adopt into clinical practice. Despite this, family members and aged care staff valued being provided with evidence on the hearing status of the individual with dementia.

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P.10.6

FREQUENCY-DEPENDENT PRESSURIZED DPOAES IN NORMAL-HEARING ADULT SUBJECTS

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Evoked Otoacoustic Emissions (OAEs) are a vital tool to assess the hearing ability of infants and younger children who cannot yet participate in objective measurements such as pure tone audiometry. When recording OAEs, both the evoking sound stimulus and the OAE responses are transmitted through the middle ear (ME). In cases of children with a negative middle ear pressure (NMEP), the sound transmission in both directions can be attenuated and lead to reduced or non-detectable OAEs even with normal inner-ear function.

A NMEP is common in infants and children, but OAE levels have been shown to be somewhat restored by pressurizing the ear canal to the tympanometric peak pressure (TPP). Recent advances in clinical instrumentation enable the fast and accurate measurement of the wideband tympanogram (WBT), allowing a detailed analysis of the absorbance of the ME as a function of both frequency and pressure. Thus allowing the possibility of frequency specific pressurization to peaks in ME absorbance. The objective of this study was to investigate if the WBT could be used to guide frequency specific pressurization to achieve even greater increased distortion-product otoacoustic emission (DPOAE) levels.

Normal-hearing (< 20 dB HL) young adult subjects with no middle ear abnormalities, including normal middle ear pressures (+/- 50 daPa), were tested. DPOAEs were measured where the ear canal static pressure was systematically varied between +150 to -150 daPa. The stimulus frequency (f_2) was varied between 1 to 6 kHz, with a fixed primary ratio of $f_2/f_1 = 1.22$ and a level ratio of $L_1/L_2 = 65/55$ dB SPL. A baseline WBT was obtained prior to the DPOAE measurements and again afterwards to ensure that the status of the ME did not change during the course of the recording session. Subjects demonstrating a TPP shift of more than 25 daPa were excluded from the study.

Maximum DPOAE levels as a function of pressurization and absorbance at specific frequencies is shown not to be simply related. Implications for pressurized clinical DPOAE measurements are discussed.

P.10.7**HEAD-TO-HEAD COMPARISON OF CONCURRENT TINNITUS MATCHING METHODS WITH A FOCUS ON RELIABILITY AND DURATION: TOWARDS OPTIMIZED MOBILE METHODS IN RESEARCH AND INTERVENTION**

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Tinnitus matching still is a challenging endeavor given the heterogeneity of tinnitus percepts and the reliance on subjective ratings. This unsatisfying situation and lack of consensus among researchers limits the reliability and validity of pitch matchings of tinnitus.

Tinnitus pitch matchings are key parameters for interventions like acoustic stimulation or neuromodulation.

Furthermore, reliable mobile matching methods are needed to study tinnitus variability in real life.

The present study aimed at comparing the three most common and current tinnitus pitch matching methods with a focus on reliability and duration.

Beyond that, ease of use and subjective matching accuracy (i.e. subjective correspondence of tinnitus matching and actual tinnitus) was assessed by subjective ratings.

Main outcome variables were the resulting tinnitus frequency and its reliability over five sessions.

The method of adjustment (MOA) makes use of freely-adjustable interface where tinnitus parameters can be self-reliantly adjusted.

The actual pitch matching is performed on a rotary encoder with a 1 Hz resolution over the audible frequency range (40-20000 Hz).

On the contrary, the more algorithm-driven methods of forced-choice double staircase (FCDS, "bracketing") and pitch likeness (LM) present predefined discrete frequencies which are rated by the participants. Concretely, the FCDS method offers two tones from which the one closer to the actual subjectively perceived tinnitus frequency has to be chosen.

The algorithm then reduces the distance between presented frequencies iteratively until a final frequency is approximated.

The LM method randomly presents an extended set of standard pure tone audiometry frequencies (11 frequencies, 1000 Hz steps between 1 and 8 kHz) which then are rated on a percent scale regarding their similarity (i.e. "likeness") to the subjective tinnitus percept resulting in a tinnitus spectrum with one dominant frequency match.

All the methods were tested five times consequently with short breaks in between.

Additionally, standard tinnitus case history and distress questionnaires, musicality, and pure tone audiometry was assessed. 59 healthy subjects with subjective, tonal tinnitus were recruited for this single session study and randomly assigned to three groups (i.e. FCDS, LM, and MOA) matched for age, sex, hearing loss, and musicality.

Results point at a good (FCDS = .88, LM = .83) and excellent (MOA = .91) mean reliability of the matching methods.

In the last of the 5 matching sessions, participants needed 131 seconds (SD = 81) to match their tinnitus with MOA, 161 (SD = 78) with FCDS, and 233 (SD = 72) with LM.

Ease of use (scale: 1 (not at all) to 10 (very easy)) was rated highest for MOA (mean = 9.2, SD = 0.9) followed by LM (mean = 8.9, SD = 1.1) and FCDS (mean = 7.8, SD = 2.1).

Finally, mean subjective accuracy (scale: 1 (not matching) to 10 (perfect match)) was 8.7 (SD = 1.03) for MOA, 8.63 (SD = 1.11) for LM, and 7.9 (SD = 1.37) for FCDS.

Notably, no significant differences were found between the methods except for duration (MOA < LM, $p < .05$). The evaluation and comparison of three established concurrent tinnitus matching methods produced an overall good reliability, ease of use, and subjective accuracy as well as acceptable durations (< 5 minutes) for all methods.

Generally, MOA slightly outperformed the other methods while duration and ease of use should be cautiously interpreted given inherent differences in the procedures.

While, in general, reliability, duration, ease of use and subjective accuracy may be continuously improved, validity is still limited given both the possibly fluctuating nature of the phantom percept as well as the ability of tinnitus sufferers to match in- and external sounds.

Therefore, a proper familiarization to the methods as well as fundamental training in pitch discrimination

is advisable.

Future mobile implementations of tinnitus matchings could profit from the insights of this study in that MOA may be most suitable for fast and reliable matching while between-method reliability of this self-reliant approach could be improved by combining it with the algorithm-driven approaches of LM and FCDS. This combination of methods is novel in its form and, through improving single session reliability, may elegantly reduce the amount of sessions needed for a reliable tinnitus pitch matching.

P.10.8

PROCEDURES USED FOR HEARING SCREENING IN PRIMARY SCHOOL CHILDREN: A COMPARISON OF AUDIOMETRIC AND OBJECTIVE METHODS

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Background Hearing screening (HS) programmes are undertaken to identify hearing loss. Timing of the screen has been tried at two points: newborn and school entry. In newborn HS are used to objective methods based on evoked potentials or otoacoustic emissions. School-based HS methods can be classified into two groups: subjective and objective (electrophysiological) measures. Subjective procedure includes questionnaires and pure tone audiometry. Objective methods such as otoacoustic emission recording and impedance audiometry screening are often used in HS programmes. The main goal of this study was to find an optimal test battery, including a minimum number of tests, which would be recommended for hearing screening programmes among school-age children.

Materials Study group consists of 190 children (103 girls and 87 boys), randomly chosen from Warsaw primary schools. Range age of children, at the moment of examination was from 10.9 to 14.9 years. None of children declared any otolaryngological problems prior to testing. In addition, for each subject parents were asked to sign a consent and fill in audiological questionnaires.

Methods Each students were evaluated with four different testing protocols: conventional tone audiometry performed in frequency range from 250 Hz to 8 kHz; s-test 4f (automated 4-frequency audiometric screening test) performed in frequency 0.5, 1, 2 and 4 kHz; impedance audiometry which including tympanometry and the stapedial reflex was performed with a 226 Hz probe tone and the last examination was automated transient otoacoustic emissions with stimulus level of 70-84 dB SPL.

Results For a single method of a screening procedure, the best performance was reported in the s-test 4f, followed by the tympanometry and the TEOAE-based procedures. Screening effectiveness has been increased by using a combination of automated and impedance audiometry. A s-test 4f join with tympanometry gives a sensitivity of 65%, and the PPV (positive predictive value) of 46%, which are reasonable values, acceptable for practical use. The use of a TEOAE protocol worsens the overall performance of screening.

Conclusion The present study indicates that audiometric and objective methods can be effectively conducted at schools. None of tested screening methods produced a satisfactory sensitivity or PPV. A combination of a s-test 4f and tympanometry (or more) with time requirements equal to 3 minutes per children, provided better results which allows for detection of conductive and sensorineural hearing disorders.

P.10.9

SOUND LOCALIZATION DATA IN CHILDREN AND ADULTS – GENERATED BY THE EXTENDED MODULE OF THE “MAINZER KINDERTISCH”

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Only few data for the physiological development of the auditory system in normal hearing children are available. The data were mostly collected as mere comparative data for studies in children with hearing impairments. There are no standard values given for the auditory development from birth to adolescence. An explicit example is the task of localizing a sound source. Directional hearing is one of the most important aspect in everyday life, e.g. it aids orientation or the communication in noisy environments. It

is a fundamental characteristic of binaural hearing, because the perception of acoustic space is based on two-ear processing. Human with normal hearing can pinpoint and discriminate different sound sources precisely. But, how good is the performance of localization in children and adults? Are there differences in the localization accuracy? And, how much differ the performance of localization in Cochlear Implant (CI) listeners? What's about its development following implantation? Nevertheless this facts and open questions, the directional hearing is not duly taken account of in clinical practice.

In clinical audiology there is no standardized measuring methodology to record the binaural localization performance in the free-field. The statement about the directional hearing is important for diagnostics. Therefore, an upgrade of a common diagnostic setup for audiology in Germany – the so-called "Mainzer Kindertisch" – was done. With this new setup (the so-called ERKI-setup), we measured the localization accuracy of adults and children. The ERKI-Method uses five loudspeakers to generate 32 virtual sound sources that are ordered in front of the semicircle (angular resolution =45 degree between speakers). We generated the virtual sound sources between two adjacent loudspeakers with LoudSpeaker Level Differences (LSLD). Obtaining 37 discriminable reference angles (five real and 32 virtual sound sources) in 5°-steps in the range of $\pm 90^\circ$. Visibility of speakers resulted in a bias localizing virtual sources at one of the adjacent real speakers particularly in young children. To avoid this bias persons are blinded by a semicircular curtain hiding the speaker array. Different stimuli (noise and a speech sample) with a length of 300 ms and a level of 65 dB SPL were used. The patient is looking to the front (0°) while the acoustic stimuli are presented. The responses were recorded by a control dial and a LED-light strip, giving visual feedback.

We measured the localization patterns in normal hearing listeners: children (3-13 year old) and adults (21-38 year old). The results show that the data of children and adults are different. In case of children, the median response data show only a small amount of variance – but the standard deviations are larger. The intraindividual variability decreased in older children and adolescents in comparison to younger children. Therefore a dependence of age in the localization data was identified. The distribution of results in very young children (3-5 years) is partly explained by the stage of development. Sometimes these children have problems to perform tasks on hearing examination (e.g. localization tests) that are dependent on auditory input e.g. in following oral instructions to action or the concentration performance within a measurement.

The extended Mainzer Kindertisch with the ERKI-setup adds information about binaural localization to the diagnostic process. The system is simple and has an automated run. Visual feedback focusses the head at the center towards 0° . Even in children, the time consumption of the measurement is clinically acceptable. Placement of the semicircular curtain and measurement preparations take about 10 minutes, whereas the measurement as such takes only three minutes.

P.10.10

HEARING AID PERFORMANCE CHARACTERIZED BY APPARENT SNR ESTIMATION TO PREDICT SPEECH INTELLIGIBILITY IN NOISE WITH HEARING IMPAIRED LISTENERS

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Speech Reception Threshold in noise (SRT_n) measured with adaptive procedures are commonly used to evaluate performance differences between hearing aids. It is expected that differences in hearing aid signal processing are reflected by SRT_n scores. However, this experimental design is limited by systems with non-linear behavior and when the SRT_n, expressed in signal-to-noise ratio (SNR), are located within an interval where the tested signal processing has no effect. The differences $d(\text{SNR})$ in performance between the conditions as a function of the test SNR can be computed from the fitted individual performance intensity function. The $d(\text{SNR})$ can illustrate differences over a broader SNR range where tested systems might have a different response. Our hypothesis is that the $d(\text{SNR})$ should correlate with the apparent SNR, defined as the combination of the test SNR with the hearing aid output SNR, and the amplified speech level measured at the tympanic membrane. These indicators can be used to evaluate the hearing aids as a black box in a defined test setup and should help to explain speech in noise intelligibility scores.

The hypothesis was tested by comparing the performances of two hearing aids with different chip

architectures. Apparent SNR and speech levels at the tympanic membrane were measured in the same test setup used to evaluate the SRTn. For each of two listening conditions, two adaptive procedures were used to target the SNR for which 50% and 80 % of the words within a sentence were correctly repeated. The performance intensity function was estimated with data obtained from 29 experienced hearing aid users (pure tone average hearing loss ranged from mild to moderately severe) with both hearing aids. The test results were modelled with a mixed-effect regression analysis that shows how the black-box predictors (apparent SNR and speech level) can significantly improve the predicted speech in noise intelligibility scores between the listening conditions. This approach makes comparison and explanation of adaptive SRTn results easier when the technical data of the tested systems' dynamic behavior are not available. The interpretation of the differences is made over a broader SNR range which helps to explain potential changes of speech intelligibility scores.

P.10.11

TINNITUS AND HEARING SURVEY: CULTURAL ADAPTATION TO BRAZILIAN PORTUGUESE

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Introduction: Hearing loss can cause several problems and may be frequently associated with tinnitus. Audiologist and medical professionals are increasingly involved in the search for instruments that improve a patient's quality of life as there is great difficulty in measuring and separating the symptoms of tinnitus from hearing complaints. The Tinnitus and Hearing Survey (THS) was specially developed with the purpose of identifying the main complaint of these patients. Proposition: To translate, culturally adapt and validate the Tinnitus and Hearing Survey (THS) for the Portuguese-Brazilian, evaluate its reproducibility and describe the results of the application of this tool in patients with tinnitus and hearing loss.

Methods: The study was developed at the Speech Therapy Clinic of Bauru, University of São Paulo (USP), with the acceptance of the Research Ethics Committee and patient agreement, confirmed by signing the Informed Consent Term. The patients who were invited to answer the questionnaire, previously passed the battery of audiological diagnostic exams and were divided into 4 groups: normal hearing without tinnitus, normal hearing with tinnitus, hearing loss without tinnitus and hearing loss with tinnitus. The cultural adaptation of the Tinnitus and Hearing Survey (THS) followed the steps indicated by Guillemín et al. (1993), and also, the inter-researchers' reproducibility evaluation of this questionnaire.

Results: No changes were required to the questionnaire. Instead it was adapted to the Brazilian context. The Cronbach's α test and Kappa's coefficient were considered almost perfect, indicating good reliability and reproducibility.

Conclusion: The Tinnitus and Hearing Survey was culturally adapted to Brazilian Portuguese, and the data of internal consistency, reproducibility and validation showed that this questionnaire is a useful tool to help professionals differentiate the main complaint of the individual, allowing the choice of a more appropriate intervention.

P.10.12

A MULTI-INTERFACE TRACKING SYSTEM FOR NEWBORN-, PRESCHOOL- AND SCHOOL HEARING SCREENING

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Tracking solutions are essential for all types of screening programs in public health. Screening programs without a concomitant implementation of a tracking system will lead to a negative outcome of the program. For ongoing evaluation of the quality of care and the effectiveness of the program a database system is strongly required.

Based on experience from a former tracking system, which was implemented in 2004 in some federal states of Germany, the tracking software was re-developed to a new tracking system, called "pathTrack". Multiple instruments or clients can connect to the system. Data exchange can be performed in one- or bi-directional way. Especially in regions with limited medical infrastructure the system saves time and travel costs and reduces the loss to follow-up-rate. It enables telemedicine consultation and remote operating of instruments.

Besides tracking activities the tracking software enables a constant quality control of the user's test performance, patient documentation and completeness of the screening benchmarks. It integrates a module for statistical data as well as a constant monitoring of data transfer. Data transfer can be done by "out of the box" solutions from each location and in a worldwide available service.

The tracking software is divided in two parts. One part is communicating with connected instruments and clients for incoming and outgoing data transfers. It can easily be connected to already existing tracking systems via multiple data exchange protocols.

The other part is an intuitive tracking module for Hearing Screening or School Screening of all ages. It provides pre-sorted access to all transmitted cases and guides the tracking staff to all stages of a tracking process from primary screening to full patient diagnosis. It enables a close and accurate monitoring of all patients until end of diagnosis or the patient's start of therapy. The system communicates via multiple interfaces with hospitals, resident physicians, follow-up-sites and further reporting sites. It integrates data exchange with third-party databases such as National Health Registers. The new tracking system has been implemented in a number of countries such as Chile, Mongolia, Ukraine, Iran or Germany. All countries are having different challenges in order to their partly low-resource settings, long distances, and limited infrastructure or to elicit very detailed statistical data.

The presentation is demonstrating the cooperative teamwork of instruments and tracking software as well as the smooth interactivity from patient's first registration on a measuring device up to its diagnosis or therapy, submitted either by an expert center or even by a remotely located doctor's practice far away. The presentation will show the generation evidenced based data with a modern tracking system as well as the practical advantages in developing countries.

P.11 - USE OF HEARING AIDS

P.11.1

MULTICENTER FIRST ADHEAR ® EXPERIENCE IN ADULT AND CHILDREN: NOT ONLY FOR SLIGHT CONDUCTION HEARING LOSS?

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ADHEAR system (AD) represents a non-surgical option recently introduced for unilateral or bilateral conductive hearing loss (bone conduction between 5-25 dB) or for single-sided deafness with normal hearing on the contralateral side.

With its adhesive retroauricular adapter and the small audio processor, it appears to be a comfortable and cosmetically appealing solution also for children.

Clinical data has not yet been published in the literature.

Despite all the limits due to a restricted sample size in which it has been tested and a limited follow-up, AD appears to be not inferior to the traditional bone conduction solutions on a headband or a bone conduction implant, with even better high frequency outcomes compared to the first and with the advantage of a non-surgical, infectious risk-free approach.

The mean functional gain varies between 18 to 21 dB with a natural sound quality perception.

Compared to a CROS hearing aid in the same user, AD provides significant improvement in sound localization and a positive trend for speech perception in noise, with a 67% of user satisfaction.

We have tested AD in 7 children aged between 4 and 14 years (6 with atresia auris and 1 after surgery for cholesteatoma), in which the mean bone conduction was between 30-40 dB. We have registered a mean functional gain of 25-30 dB with AD, evaluated with free field audiometry.

Six adults with a monolateral moderate-to-severe conductive hearing loss have used AD, with a mean functional gain of 30 dB evaluated with free field audiometry.

Hence, in our experience, AD represents a valuable and winsome treatment option in patients with a conductive hearing loss and we suggest that it might be applied also if the hearing loss presents a bone conduction below the limit of 25 dB proposed by Medel, with an acceptable level of patients satisfaction.

P.11.2

INDIVIDUAL FACTORS INFLUENCING MUSIC LISTENING WITH HEARING AIDS

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Most commercially available hearing aids offer a program specifically designed for music listening. Recent investigations indicate that relatively few hearing aid (HA) users have a music program or know whether they have a music program in their hearing aids. Also, self-reported problems of HA wearers when listening to music with the music program do not seem to differ significantly from listening to music with the standard HA program.

One possible approach towards understanding this situation is to examine the music program preference/indifference in relation to the style of music, assuming that the music program may work better for one musical style than for another. A second approach is to consider the hearing impaired person in more detail, assuming that different listening experiences and listening capabilities influence the ability to perceive sound quality differences brought about by a dedicated music program.

In a recent study, 26 experienced HA wearers rated the sound quality of excerpts of different music styles, recorded from different brands of hearing aids using their standard programs and music programs. The music examples comprised five different music styles: jazz, classical, pop, folk and a 'favorite' excerpt chosen personally by the subject. The listeners also performed a short questionnaire assessing factors previously identified as important for HA satisfaction. These factors included age, experience with the HA, the pure tone audiogram, music listening habits, self-reported speech in noise

problems, motivation for using the HA, sensitivity to loud environments and tonal working memory. Details about musical education and musical activities were also collected. The sound quality ratings were then analyzed as a function of the hearing aid program and the individual factors of the hearing impaired listener.

We found that the following individual factors influenced the sound quality ratings of the music and standard programs significantly: music education, music listening habits, tonal working memory, self-reported speech in noise problems and sensitivity to loud environments. Differences in sound quality ratings as a function of individual factors and different musical styles will be presented.

P.11.3

STAGES AND BIOPSYCHOSOCIAL CORRELATES OF HEARING HEALTH-SEEKING IN ADULTS AGED OVER 50 IN ENGLAND

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Objectives. Hearing aids are the primary treatment for hearing impairment. But less than 25% of individuals with a hearing impairment own a hearing aid and up to 40% of hearing aid owners do not use their hearing aid regularly. People delay seeking help by an average of seven to ten years after first recognising hearing difficulties. Referral to audiology by general medical practitioners has previously been reported to be inconsistent. We aimed to a) report numbers of people at various stages of hearing health seeking, in order to identify particularly problematic stages, and (b) model biopsychosocial correlates of those who reported being at stage, in order to identify interventions to promote hearing health seeking.

Design. Cross-sectional analysis of participants aged 50 - 89 years old from a representative sample of adults aged 50 years and over living in England (the English Longitudinal Study of Aging). A subset of participants (n = 2845) with a hearing impairment determined by the HearCheck Screener (indicating a hearing threshold of >20 dB HL at 1 kHz, or >35 dB HL at 3k Hz) were included. Stages of hearing health seeking were recorded from participant self-report according to i) recognising hearing problems, ii) asking a healthcare professional for help, iii) being referred to audiological services, iv) being offered and v) accepting a hearing aid and vi) using a hearing aid regularly. Demographic and biopsychosocial correlates of each stage including sex, age, educational level, wealth, hearing level (total tones heard for the better ear based on HearCheck Screener), living situation and attitudes to aging were examined using multiple regression statistical models.

Results. 57.5% of those with a hearing impairment reported hearing difficulties. 69.3% of people who reported hearing difficulties told a health professional about hearing difficulties. Of those who had told a health professional, 85.5% were referred for a hearing assessment and 86.8% of these people were recommended a hearing aid. Of those who were recommended an aid, 97.3% obtained a hearing aid. 80.4% of people who obtained a hearing aid used it regularly. Poorer hearing level was positively correlated with all six stages. Men, those with more positive attitude to aging and those with better cognitive function were more likely to reporting hearing problems. Older adults were more likely to tell a healthcare professional about hearing difficulties. Being referred for a hearing assessment was correlated with participation in a greater number of social activities.

Discussion. Recognising hearing difficulties and telling a healthcare professional were the most problematic stages of hearing health seeking behaviour. Targeting these stages via hearing screening linked to referral to services may lead to an increase in hearing health seeking. In order to facilitate recognition of hearing difficulties, negative attitudes towards aging, and the stigma associated with hearing impairment should be addressed.

P.12 - C.I. OUTCOMES IN CHILDREN

P.12.1

A REVIEW OF COCHLEAR IMPLANTATION IN CHILDREN WITH PARTIAL HEARING AND SIGNIFICANT RESIDUAL LOW FREQUENCY HEARING

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Introduction: 'Soft' or 'Atraumatic' cochlear implant (CI) surgery is now normal practice in many CI centres. This surgical technique, used along with specially designed electrode arrays, can result in the preservation of hearing for children who have partial hearing (PH). Successful hearing preservation (HP) of the low frequencies allows a child to use a hearing aid and a CI together in the same ear. This is known as electric-acoustic stimulation (EAS). A hearing aid acoustically amplifies low frequencies, while the CI electrically stimulates the high frequencies. Where hearing cannot be preserved, or where it deteriorates over time, it is possible to increase electrical input into the lower frequencies as required, up to full electrical stimulation with no acoustic component.

During the CI assessment, children with PH whose hearing thresholds are ≤ 65 dBHL at low/mid frequencies are considered for EAS fitting following CI surgery. The families are carefully counselled that preservation of hearing is not always possible. Post-implantation, hearing responses are recorded and the child is fitted with an acoustic component as appropriate. The reasons for not fitting an EAS device or changing to electrical stimulation over time are explored.

Methods: Since October 2014, the Midlands Hearing Implant Programme – Children's Service and the St Thomas' Hearing Implant Centre have worked collaboratively to review of the outcomes of partially hearing children who have received CIs. Children with PH who received their CIs between 2008 and 2017 were included in the review. A comprehensive analysis of the data will be presented, including (1) overall rates of hearing preservation for the PH cohort, (2) numbers of children fitted with EAS, post-operatively, (3) numbers of children who are (a) continuing to use EAS and (b) who have changed to electrical stimulation only, (4) reasons for not using EAS or changing to electrical stimulation over time.

Results: This poster will illustrate the challenges involved in predicting, fitting and maintaining the optimal hearing device (EAS or electrical stimulation only). It will also illustrate the need for close monitoring of the child's hearing, their perceived preferences and issues with middle ear involvement.

Conclusion: Families should be carefully counselled on the possibility of CI and EAS. It is essential they are aware that hearing may not be preserved. It is equally important for them to understand that for a child receiving an implant at a young age, CIs outperform the child's hearing aids even where there is minimal preservation or complete loss of hearing.

P.12.2

ASSESSMENT OF ABILITY TO DEFINE MEANINGS OF WORDS IN CHILDREN WITH COCHLEAR IMPLANTS

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Introduction: Learning the meaning of a word or the emergence of a term is a period that takes a long time for children which use cochlear implants (CI). During this process, children acquire communication experience and connect the specific word with content based on personal experiences. By simply experiencing more, the number of perceived and observed characteristics of certain words multiplies. One of the goals of the rehabilitation program is to train these children to be able to logically define a meaning of a word, besides enriching and expanding their vocabulary. To actually be able to define a

meaning of a word, to be able create conclusions and think abstractly, at the highest level, is required.

Aim: The aim of this study was to examine the ability to define meanings of words of cochlear implanted (CIs) children and to determine whether there are differences in relation to their hearing peers.

Method: Sample group was consisted of 25 children with CI and 25 hearing children, ages 4 to 7. To test the ability to define a meaning of a word, the „Test for assessing the level of speech development“ was used. Children had the task of defining the five most frequent nouns (mother, house, man, sun, life) appearing in the children's dictionary. The results of CI children were compared with the results of hearing children.

Results: The results show that both the CI children and hearing children have most correctly defined the word sun, then house, mother, man, with the word life being most incorrectly defined. Statistically significant differences in the group of CI children occurred in relation to hearing age, age when implantation occurred and the duration of rehabilitation, but not to chronological age. Also, statistically significant differences appeared between CI and hearing children.

Conclusion: CI children show poorer results in defining meanings of the words, especially abstract ones, in relation to their hearing peers. It can also be concluded that the age of implantation, hearing age and duration of rehabilitation affect the understanding of meanings of words.

Key words: cochlear implant, meaning of words, children.

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P.12.3

GESTURE FREQUENCY IN COMMUNICATION OF COCHLEAR IMPLANTED CHILDREN*

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This study is observing both natural and learned gestures as a part of communication in hearing impaired children with cochlear implant and/or hearing aids, accompanying certain action or verbal statement.

The objective of the study was to observe the frequency of gesture use in deaf and hard of hearing children with different types of amplification. Various impact factors affecting frequency of gesture use, such as gender, chronological age, onset of rehabilitation and educational settings were taken into consideration as well.

The sample consisted of 40 children with severe to profound sensorineural hearing loss divided in two groups according to amplification type. Younger group consisted of children aged 5 to 10 years and older group 11 to 15 years. The cochlear implant group consisted of 18 children and hearing aid group of 22. The pairs of children with adjusted age and type of amplification have been filmed during play in the "shop" with ten objects or age appropriate toys. The videos were analyzed afterwards and communication has been classified as verbal, total or gestural. Word list has been based on video records.

The results have shown statistically significant advantage of boys regarding oral use of verbs ($t(14) = 2,569$, $p < 0,0$) and early rehabilitated children (oral use of verbs $t(14) = 2,575$, $p < 0,05$ and pronouns $t(14) = 2,763$, $p < 0,05$). Gesture use is more frequent in older children with conventional hearing aids. Younger children tend to use more words than gestures. Cochlear implanted children use considerably less gestures. Overall number of words and gestures used in communication increases over time..

Key words: cochlear implant, gesture, hearing aid, children

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P.12.4

COCHLEAR IMPLANTATION IN UZBEKISTAN: HEARING-SPEECH MONITORING RESULTS AND PERSPECTIVES

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In 2014 there was started the State Program in Uzbekistan "The introduction of a complex of rehabilitation measures in children with severe form of hearing loss and deafness» which has aimed to increase the rate of invalidation caused by deafness. So, since this period has beginning CI Era in our country.

Material and methods. The integrated program includes audiological screening and cochlear implantation. There are 365 children were implanted (CI- Concerto, SP- OPUS 2, SONNET, Med-El/Austria). Rehabilitation monitoring has performed by the MAIS questionnaire.

Results. The 3 years monitoring system has had positive results: speech - auditory rehabilitation has showed the results of 97, 2% of the speech sphere and 86.1% in a good hearing perception. So, in 2016 there are 42 children went to the general secondary school at the age of 7 years and 38 children under 6 years old. The rest of them are attended the preschool institutions and have lessons with speech-therapeutics.

Conclusion. CI program large-scale allows integrating the children with deafness to general schools, to adapt them in social environment and reveals for them the opportunity to realize themselves in life.

P.12.5

SPEECH PERCEPTION ASSESMENT IN CHILDREN WITH COCHLER IMPLANT IN FREE HEARING FIELD

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Speech audiometry, as one of the methods for hearing examination has been applied in our country. Compared to tonal audiometry, it provides us with the information how an individual hears and understand speech. It is practiced with adults and children. In our practical work, this method has proved useful for following results of re/habilitation of hearing and speech in children. The aim of this work is to examine speech perception of children with cochlear implant in free hearing field. Work method: the sample consisted of twenty children with cochlear implant, they were of average intellectual abilities, without other impairments, of both sexes, of chronological age between 5 to 9 and they were included into re/habilitation treatment for at least a year. With speech audiometry in free hearing field we estimated the ability to perceive one syllable and two syllable words. The word list was taken from Triage Articulation Test (Vladisavljevic, Kostic) which was standardized for our speech - language area, and consists of 30 words. The examiner presented a list of words presented by the microphone without the ability to read and see words from face and lips.

Results present that two thirds of examined children had more than 80% correctly repeated words, that they perceived two syllable words and to those that had high tone sounds.

Understanding one syllable words greatly lowered no matter what the sound structure is.

Key words: hearing impairment (deafness), cochlear implant, speech audiometry

P.12.6

BIMODAL HEARING FOR COCHLEAR IMPLANT RECIPIENTS: CAPTURING EXPERIENCES

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Introduction All bilaterally profoundly deaf children now have the opportunity to benefit from two cochlear implants (CIs). However, not all children receive bilateral implants and instead have a unilateral implant. Reasons for this include clinical or recipient choice, asymmetric hearing levels, social needs or anatomical abnormalities such as absent nerves. Whilst unilateral cochlear implantation can enable children to understand speech and develop spoken language, bilateral cochlear implantation allows the potential for binaural hearing: the ability to localize sounds and improvements in speech understanding in noise. This can lead to better speech production, improved educational outcomes, enhanced appreciation of music and improved quality of life. Wearing a hearing aid in the contralateral ear allows improved access to low frequency information and access to some of the benefits of binaural hearing. The Naida Bimodal Hearing Solution from Advanced Bionics allows the the Phonak Naida Link hearing aid to connect to the Naida CI (Q70 or Q90) sound processor to optimise binaural hearing. The Naida Link hearing aid is intended for unilateral AB recipients with aidable residual hearing in the non-implanted ear. For those recipients with no hearing in the contralateral ear, the Naida Link CROS aid is available. The Naida Link CROS picks up signals presented to the "non-hearing" ear and instantaneously transmits them to the Naida CI sound processor on the "hearing ear." This helps to improve speech understanding in quiet and noise and a better overall hearing experience.

Method 4 children fitted with the Naida Link hearing aid and 4 children fitted with the Naida Link CROS aid will be included in the review. A sound quality ratings questionnaire will be administered to parents and carers of the children fitted with the devices asking them to rate their experiences before and after fitting.

Results The ratings questionnaire will capture the listening experiences and challenges of unilateral recipients in different environments, such as listening in quiet and noisy situations, listening on the 'deaf' side, and the amount of listening effort involved with unilateral recipients.

Conclusion

Listening with one ear presents great challenges for communication. For individuals relying on a single CI, the Naida Link hearing aid and the Naida Link CROS offer a great opportunity to provide a better overall hearing experience.

P.13 – C.I. ACROSS THE AGES

P.13.1

QUANTIFICATION OF LINGUISTIC CONTEXT EFFECTS IN SPEECH RECOGNITION FOR CHILDREN, ADULTS WITH ACQUIRED HEARING LOSS, AND EARLY-DEAFENED ADULTS

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Introduction: For adults with normal language development, the use of lexical, syntactic, and semantic context is crucial in everyday communication, particularly when hearing loss, noise, or distortion reduce the acoustic information available. Boothroyd and Nittrouer (1988) described a mathematical treatment of contextual effects in speech recognition. The goal of this study was to apply these ideas to results for cochlear implant (CI) recipients, compare to normal listeners, and contrast the effects across adults with acquired hearing loss, early-deafened adults, and children.

Method: Speech recognition results were obtained for 700 adult CI users with acquired hearing loss, 200 adults with prelingual loss, and 400 children. Non-linear regression provided functions that related phoneme scores within monosyllables to whole word scores (lexical context), and word scores to words-in-sentences scores (semantic and syntactic context).

Results: The curvilinear relationships found were consistent with those for normal participants. A parameter dubbed the "j factor" quantifies how many phonemes need to be recognized within a 3-phoneme monosyllable to identify the word. The "j factor" was 2.3-2.4 for adults with acquired losses, 2.6-2.7 for early-deafened adults and 3.0 for children

Conclusions: This study highlights the importance of language ability in everyday communication. Audiologists optimize the auditory input for those with a hearing loss, but the potential benefits of improving linguistic abilities and associated cognitive skills should not be underestimated. The results suggest that children have virtually no ability to use this linguistic information making the quality of their auditory input of crucial importance.

P.13.2

IMPACT OF AGE AT IMPLANTATION ON THE DEVELOPMENT OF SPEECH DISCRIMINATION WITH COCHLEAR IMPLANT

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Background: The purpose of this study was to compare the development of speech discrimination after cochlear implantation in patients across different age groups. Higher age has been shown to be negatively correlated with the degree of improvement in speech recognition scores [1]. Our aim was to determine the extent of differences in postoperative performance between different ages.

Patients and methods: In this retrospective study, we selected a cohort of 102 postlingually deaf patients. The 102 patients were divided into three groups. Group I, 10 to 35 years (n=15; mean 25.0, SD 7.2), group II 36 to 70 years (n=58, mean 55.5, SD 8.1) and group III 71 years and older (n=29, mean 77.0, SD 3.8). Speech discrimination was tested with the standard German Freiburg monosyllabic and two-digit numbers speech intelligibility test at the time Points of 1, 3, 6 and 12 months after implantation. The test was performed at 50, 65 and 80 dB speech levels.

Results: In group I, the average speech recognition of monosyllables at 65 dB was 40 % (Q1 20.0, Q3 42.5) at 1 month and rose to 57.5 % (Q1 31.3, Q3 67.5) at 6 months and 50 % (Q1 32.5, Q3 72.5) at 12 months. Group II increased from 30 % (Q1 10.0, Q3 50.0) at 1 month to 40.0 % (Q1 to 21.3 %, Q3 63.8) at 6 months to 42.5 % (Q1 26.3, Q3 63.8) at 12 months. In group III, the speech recognition of monosyllables improved from 15.0 % (Q1 0.0, Q3 25.0) at 1 month to 32.5 % (Q1 12.5 %, Q3 55%) at 6 months to 35.0 % (Q1 3.8, Q3 50) at 12 months. In all three groups, the progress in performance was higher during the first 6 months post implantation compared to the 6-12 months interval. The test of speech recognition of two-digit numbers at 65 dB showed a ceiling effect. At 3 months, the median of patients in groups I and II was 100 %, whereas group 3 reached 90 %.

Conclusion: The improvement in speech recognition depends on age of cochlea implantation in post-lingual deafness: descriptively evaluated patients at age 10 to 35 years show higher improvement while patients being 71 years and older lower than the other groups. Compared to the median performance of the younger patients, the upper 3rd quartile in group III was also able to reach 55 % speech intelligibility. Furthermore, we found that the majority of improvement in performance takes place during the first 6 months after cochlea implantation. Speech recognition of two digit numbers at 65 dB showed a strong ceiling effect while speech recognition of monosyllables at 65 dB did allow for patient Performance discrimination. Careful patient selection is necessary to implant successfully in the elderly.

1. Lin, FR, Chien, WW, Li, L, Clarrett, DM, Niparko, JK, Francis, HW: Cochlear implantation in older adults. *Medicine*, 91: 229-241, 2012.

P.13.3

DEVELOPMENT OF AUDITORY VERBAL SKILLS AND MAXIMIZING OUTCOME IN ADULT COCHLEAR IMPLANT USERS - A CURRENT ADULT REHABILITATION PROJECT AT THE COCHLEAR IMPLANT CENTER IN EASTERN DENMARK

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Objectives: The project aims at establishing, describing and documenting the effects of an auditory verbal rehabilitation intervention for adult Cochlear Implant (CI) users.

Methods: A prospective comparative rehabilitation study with 17 adult CI users compares 10 adults CI user's and a control group's outcome after 6 month of rehabilitation. The 10 patients participated in the Auditory Verbal Skills Training (AVST). The CI center developed AVST for adult CI users, and it is an AVT inspired and goal based auditory verbal training for CI users and their close relatives.

The intervention group participates in 10 AVST sessions during 6 months at the CI center after they first got their CI. Both the intervention group and control group also received standard rehabilitation at their local rehabilitation centers in the same period.

Outcome measures in the two groups are focused on speech intelligibility (Dantale I and HINT) and Quality of Life (Nijmegen CI Questionnaire).

Results: Preliminary results prior to publication will be presented comparing the intervention group and the control group on speech intelligibility measures and Quality of Life measures.

Also, the framework and content of the AVST intervention will be presented. Examples of AVST activities will be available.

P.14 - eHEALTH

P.14.1

AFFORDABLE AND ACCESSIBLE E-HEALTH IN HEARING CARE SUPPORTING PRIMARY HEALTH CARE

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Adequate hearing health care services are often not available in development countries and primary care plays a central role in health care system. The e-Health offers an effective means for improving communication between primary care practitioners and specialists in reference centres, facilitating access to diagnostic tests and enhancing health care quality at under-served communities, besides being a tool of continued education. The aim of this work was to study the demand and supply of hearing health activities using the tools of the Brazilian Telehealth Network in a state of the southeastern region of Brazil as well as to evaluate the impact of the resolutibility of the cases. A search was made based on the database of the Telehealth Program of Federal University of Espirito Santo regarding activities carried out from 2013-2017, related to hearing health aiming 78 counties of the state. Continuing education activities and teleconsultation requests were counted, as well as the impact of the answers sent by specialists to primary care professionals regarding the need for referral to the reference centers. There were 12 web conferences activities with 126 professionals who attended online sessions and 3366 off-line participation (courses available on the platform), 6 counselling groups for new hearing aids users involved 40 hearing impaired patients living in remote areas. Out the total of 3625 teleconsultations requests recorded in general health issues, 45 teleconsultations were specific in hearing health and the specialists responses avoided 60% of referrals with problem resolution locally. The other cases were necessary to refer to centers of reference in hearing health because they were possible permanent hearing loss, identified and forwarded to intervention. The professionals profile that sought asynchronous information regarding hearing health were predominantly nurses, physician and community agents. Teleconsultation, like other forms of e-health, has several problems related to its adoption by users and incorporation in daily practice of health practitioners. Although it is still necessary to encourage the use of e-health tools, it demonstrated significant potentiality in areas such as education and training. By implementing the use of information and communication technology in hearing health care represents an excellent strategy for addressing access to care hearing issues timely.

P.14.2

DEVELOPMENT OF HEARING REHABILITATION FOR OLDER ADULTS (HERO) USING SMARTPHONE APPLICATION

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Background and Purpose: Along with hearing aid fitting, hearing aid orientation, informational and/or educational counseling, effective auditory training should be regarded as one of key components for aural rehabilitation of individuals who have hearing loss, especially for the old adults. Nevertheless, the auditory training of hearing-impaired old adults is currently limited due to its time consuming and high cost, resulting in little chance to improve their speech perception ability. The purpose of the current study was to develop an auditory rehabilitation program of Android basis, namely 'Hearing Rehabilitation for Older Adults (HeRO)' in which designed to help old adults suffer from age-related hearing loss and then to evaluate its practicality and efficacy.

Methods: The HeRO program was consisted of a questionnaire, called Self-assessment of Hearing Screening of the Elderly (SHSE, Kim et al., 2016), seven training modules (e.g., syllable discrimination training with closed- and open-set, syllable identification training with closed- and open-set, sentence recognition training with high- and low-predictability, sentence recognition training under fast-rated speech, training for working memory ability, sentence recognition training under reverberation, and sentence recognition training with selective stress, and result sections which are summarized by both total score for each training and error pattern and will be finally sent to user's audiologist as evidence-based information for accurate hearing aid fitting.

Results: The developed HeRO program was summarized as followed. For syllable discrimination and

identification trainings, no noise (quiet) and two levels of white noises (+ 6 and + 3 dB SNR) were provided as easy, moderate, and hard training conditions, respectively, whereas multi-talker babble noise was used for sentence recognition training as same noise levels to the syllable training. For sentence recognition training under fast-rated speech, three compressed times (i.e., 10, 30, and 50%) were applied. In the training for working memory ability, the user listened to a string of various digits and asked to change them order from the lowest to the highest number. The sentence recognition training under reverberation provided three reverberation times such as 500, 1000, and 1500 ms. Sentence recognition training with selective stress was asked to concentrate the stressed word of each sentence and guess a whole sentence, in order to overall improve his/her speech perceptual ability. As preliminary data, five old adults (age range: 65 to 84 years) controlled the developed HeRO program whether any possibility of malfunction of application or not. Also, they were asked to evaluate the HeRO program in terms of visual display, audio condition, instruction, and satisfaction, while using 12 questions with 5-point scales. There was no technical error and they reported that most functions were suitable.

Conclusions: Although preliminary data was run by five subjects to fully confirm any component for malfunction of the application, no problem was found. If applying further clinical study with a large size of old adults with hearing loss, we expect that the application will be very helpful for the old users to identify, prevent, and manage their hearing status.

P.14.3

PILOT HEARING SCREENING PROGRAM AMONG SCHOOL-AGE CHILDREN IN TAJIKISTAN – A TELEMEDICINE MODEL

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Introduction Telemedicine allows to monitor many groups, especially children. It gives also the possibility to conduct mass population examinations in this age group as an instrument of national health policy and decrease the costs of healthcare system. It has been a keynote event concluding the activities implements during Poland's EU Council Presidency with regard to ensuring the equal opportunities for children with communication disorders, in integral part of the priority in the field of public health. Therefore, one of the priority activities of the IFPS (Institute of Physiology and Pathology of Hearing) in Kajetany is a hearing screening program for school-age children. Moreover, as a result of consensus agreement EFAS (European Federation of Audiology Societies) in 2011 and under the auspices of the IFPS, a number of pilot HS (hearing screening) programs were started in various countries. The major aim of HS program is promoting hearing loss detection and detect a disease at a stage when treatment can be effective in reducing long-term complications and also reduced communication disorders in young school-age children.

Material HS was conducted in a group of randomly selected 143 children from two primary schools in the capital of Tajikistan – Dushanbe. The pilot study included students in aged 7-8 years. In a one of the schools the teaching language was Tajik and in the second Russian.

Method Screening was performed using the Platform for Sensory Organs Examinations on the basis of audiometric procedure of measuring the hearing threshold. Positive results of HS was defined as equal or more than 25 dB at least at one frequency in either ear. Additionally subjective assessment was carried out on the basis of parents' questionnaires. In addition, all results were performed using SZOK system. Use of a system to assist patients with remote diagnosis and to transfer audiological screening results to the IFPS in Kajetany. Integrating patient data into the "SZOK" ® system, will allow for quick service and thus shorten patient waiting times for visits to IFPS or other specialized facilities and as a comprehensive patient medical base. It is a unique solution in the field of telemedicine.

Results Positive results of HS, according to defined criteria, were obtained 23.7% of tested children with a 50% ratio between uni- and bilateral losses. 73.5% of all cases of hearing dysfunctions were sent for additional tests. Among pupils with positive results of HS 31.4% presented low-frequency hearing loss, 25.5% high-frequency hearing loss and the remaining 43.1% presented hearing impairments involving all tested frequencies. Results of questionnaires showed that only 37% of all children needed additional tests and 32% pupils with recommended prophylaxis had previously undergone hearing tests.

Conclusion Many children in school-age have hearing disorders, but often the problem stays unnoticed by parent or caregivers. Our present study suggest that it is possible to use telemedicine model to HS and provided s long-distance medical care. Moreover, this HS validated screening procedures and data collections within IT system (SZOK) in different language conditions.

P.14.4

LEARNING OBJECTS ALLIED TO HEARING HEALTH EDUCATION PROGRAMS

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Promoting health requires reflection on adequate standards of food, housing and sanitation, as well as good working conditions, access to education, a clean physical environment, social support for families and individuals, and a responsible lifestyle involving community and the environment in its physical, social, political, economic and cultural dimensions.

Education and health are spaces for the production of knowledge for human development. The concepts of Health Promotion went through evolutionary processes, focusing on health actions with the objective of transforming habits and lifestyles of individuals, reaching the family environment, the cultural and social aspects of the individual.

According to World Health Organization (2011), in Brazil, 28 million people have some hearing problems, 5% of hearing losses are caused by exposure to high sound pressure levels, leisure activities, inappropriate use of headphones, which means approximately 1.5 million young people.

In prevention programs, the dynamics of youth involvement is extremely important. Specifically in Audiology, there is great concern related to people's awareness in hearing protection and care. Thus, they are emerging programs, such as Young Doctor of Audiology, Dangerous Decibels®, Dangerous Decibels Brazil.

The Young Doctor Project dynamics aims to empower students and encourage them to undertake work to promote better health and quality of life in communities. The Dangerous Decibels® dynamic aims to prevent and / or reduce hearing loss induced by high sound pressure levels, aiming at altering behaviors and habits of adolescents and adults in the community regarding exposure to "loud sound".

The development of new information and communication technologies has been an important ally of education. Interaction in a virtual learning environment helps students to organize their ideas and share their knowledge.

New educational proposals address the use of important tools and / or educational platforms. In this context, there are different learning environments for technology-mediated teaching at the choice of educator, according to the proposed goal. The Young Doctor project uses educational learning platforms, where the student interacts with the knowledge and from there creates materials to multiply the knowledge with the community. In the speech and language pathology department of the School of Dentistry of Bauru / USP (FOB/USP), several projects involving the hearing health theme combined with the Young Doctor dynamics were performed using different strategies of knowledge multiplication.

The programs use interactive educational materials that address problems of risk of exposure to noise, consequences of exposure to sounds that can cause hearing damage, and awareness of the importance of hearing protection.

Among educational materials, we can mention the serious game in hearing health, where young people experience everyday situations for different levels of exposure to noise, through the stages of the game. This game was created by researchers of the Doctoral Program in Speech Therapy at FOB / USP, using the strategies of the dynamics of the program Dangerous Decibels®, and aims to make the young person reflect on what is a "dangerous sound".

Another object used as a learning strategy is the puppet that measures the sound pressure levels of individual sound equipment. The puppet helps the researcher to demonstrate to young people the importance of protecting themselves from dangerous sounds.

As a result of the activities proposed by the programs, through social actions, young people multiplied the knowledge acquired through educational platforms or other interactive educational objects, more than 10 thousand people in the community, thus creating a productive chain of hearing health.

P.15 - HEARING AND AGING

P.15.1

THE EFFORT REQUIRED TO COMPREHEND A SHORT DOCUMENTARY IN NOISE

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Several investigators have used a dual-task experimental paradigm to investigate listening effort (Gagné, et al., 2017; McGarrigle et al., 2014). In almost all cases the speech tests used in those investigations have been either a word or sentence-recognition task (see: Gagné et al., 2017). Using a sentence-recognition task performed in a background of noise as the primary task, investigators have shown that generally older adults (even those with normal-hearing detection thresholds) expend more listening effort than young normal-hearing adults (e.g., Anderson-Gosselin & Gagné, 2011; Anderson-Gosselin et al., 2011). In the present investigation an audiovisual speech comprehension task was used to measure listening effort among three groups of participants: 1- young normal-hearing adults, 2- young adults listening to the speech stimuli through a 3-KHz low-pass filter and, 3- older adults with normal hearing detection thresholds (n=18 participants/group). The primary task consisted of a 12 minute documentary on a neutral topic (e.g., the ring, the telephone, microwave oven, the automobile). The speech signal was heard at 63 dBA in a free field at 0o azimuth on the horizontal plane. A video recording of a female talker (a frontal view of her upper body and face) was shown on a 53.34 cm computer monitor positioned at 1 meter directly in front of the participant. An 8-talker speech babble signal was presented at 180o azimuth on the horizontal plane. Hence, the speech task was administered at a SNR of -6dB. The participants had to answer a series of 15 questions (in a closed set format) about the content of the documentary. The same questions were answered twice: before and after viewing the documentary. Speech comprehension was defined as the percent correct difference in performance between the score obtained during the post-viewing test and the pre-viewing test. The secondary task consisted of a tactile detection task of a 200ms pure-tone of 250 Hz that was presented randomly over a 12 minute period (approx. 8 presentations/minute; the shortest and the longest duration of time between stimulus presentation was 3 and 15 seconds, respectively). Each participant completed the primary task alone, the secondary task alone and both tasks concurrently. The results revealed that the older participants obtained a lower speech comprehension score on the primary task and a longer response time (RT) on the secondary task than the two groups of younger adults under both the single and the dual task conditions. Listening effort was defined as the pDTC (single task – dual task)/single task X 100). There were no differences in pDTC among the three groups for the primary (speech comprehension) task. The younger participants who listened to the documentaries via a low-pass filtered condition displayed a greater pDTC on the secondary task (the tactile detection task) than the other two groups. The results revealed that the speech comprehension task was more difficult (in terms of performance) for the group of older adults than for the 2 groups of younger adults, the older participants. However, under the experimental conditions used the older participants did not expend more listening effort than the 2 other groups. Mainly, the experiment revealed that it is possible to use a dual-task paradigm to investigate listening effort for a speech comprehension task. Further work using this experimental paradigm is currently being conducted in our laboratory.

P.15.2

STUDY ON THE RELIABILITY AND VALIDITY OF THE WHISPER TEST (IDENTIFICATION OF WHISPERED PARONYMS) FOR THE RAPID DETECTION OF PRESBYCUSIS IN HEALTH CENTERS

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Presbycusis is hearing loss caused by the process of auditory aging which affects, at first, the highest frequencies and that brings problems when following a conversation in situations where speech is degraded (noisy and reverberant acoustics, speaking very fast, poor diction...). The idea that the sooner presbycusis is detected, the greater the possibilities are to intervene positively in the course of this disorder and thus curb the possible cognitive, social, and emotional impairment that is usually associated with it is becoming increasingly more widespread. ASHA recommended carrying out programs to detect hearing problems every three years beginning at age 50. However, in many countries, including Spain, general medicine departments tend not to incorporate any kind of evidence that, applied on a regular basis from a certain age, facilitates their detection. When the problem is already quite advanced and its effects are virtually irreversible, the affected person's family tend to be the ones to express concern about the hearing problems.

Audiometry is the gold standard method for hearing assessment. However, it requires other methods that are simple, fast and also effective to provide the first detection of presbycusis. The aim of this paper is to determine the validity and reliability of the Whisper Test (Identification of whispered paronyms) applied to the detection of presbycusis in a primary health care center. Through a cross-sectional and double blind study, our target population was composed of 156 individuals, 74 men and 82 women, with the average age of the entire sample being 73.17 years.

Through the Whisper Test, 90 people were detected with presbycusis, data that correlates significantly with those obtained by audiometry [$r = .844$ ($p > .001$)]. The optimal cut point of the Whisper Test to see if the scanned patient may have presbycusis was established at 8 points out of a maximum of 10. The sensitivity and specificity of the test was established at 61.9% and 94.6%, respectively. Hearing loss is very common in older adults. The Whisper Voice Test could establish itself as a first test for the detection of presbycusis in primary health care services. The results indicated that the Whispered Voice Test has been useful and sensitive to the detection of the mild and moderate binaural hearing loss affecting the understanding of speech.

P.16 - CITOMEGALOVIRUS

P.16.1

VALGANCICLOVIR TREATMENT OF CONGENITAL CYTOMEGALOVIRUS INFECTION INDUCED HEARING LOSS

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The most common environmental cause of hearing loss in the newborn child and in young children is congenital cytomegalovirus CMV infection. The virus can cause unilateral, bilateral, and progressive and fluctuating hearing loss, and any degree of hearing loss can develop. The virus is present in the endolymph for many years after birth and can cause gradual damage to both hearing and to the vestibular function. Now the antiviral drug Valganciclovir is available for treatment of the viral infection, which can prevent progressive hearing loss to a certain degree. In asymptomatic infected children, the only sign of an infection is hearing loss. When a child fails the newborn hearing screening there is only limited time to confirm the diagnosis with serology from the child, i.e. blood sample, urine or saliva. 21 days after birth, the child becomes contaminated with antibodies from the mother, and hereafter the only way to confirm the congenital infection is to examine the dried blood spot from a Guthrie card. On this poster, we describe a child who received treatment with Valganciclovir for six months in order to try to prevent further hearing loss. The child had failed the newborn hearing screening and an early Auditory Steady State Response, ASSR, and Auditory Brainstem Response, ABR, measurement confirmed a mild sensorineural hearing loss in the left ear. At five months of age, the hearing loss had developed to a moderate to severe sensorineural hearing loss. A thorough work up was undertaken to find the cause of the hearing loss, and serology proved positive for CMV antibodies IgG and IgM. The Guthrie Card was positive of a congenital CMV infection, and in a urine sample 76.000 copies of CMV was found by PCR. The latter being a strong predictor of increased risk of progressive hearing loss and deafness. An MRI scan of the brain revealed white matter lesions and intracerebral calcifications. At seven months of age, treatment with Valganciclovir was initiated. The treatment was given for six months. Hearing testing after the treatment had ended showed, that the hearing loss in the left ear had progressed to a severe hearing loss, and in the right ear, the hearing threshold had worsened to a mild hearing loss. As the hearing loss was severe in the left ear, the child was implanted with a cochlear implant. Unfortunately, the Valganciclovir treatment did not seem to have the wanted effect on the hearing loss, as the hearing loss progressed both in the ear, with a hearing loss, but also in the ear with normal hearing.

P.16.2

HEARING LOSS IN CHILDREN WITH CONGENITAL CYTOMEGALOVIRUS INFECTION: RESULTS AFTER THE IMPLEMENTATION OF THE UNIVERSAL NEWBORN HEARING SCREENING

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Hearing loss is the most prevalent developmental abnormality present at birth, with an incidence calculated in 1-3- per 1000 live births and represents a significant public health issue. Different causes can be listed: genetic, bacterial, malformative, etc. Nowadays, congenital CMV (cCMV) infection is considered the leading cause of non-hereditary congenital sensorineural hearing loss (SNHL), with reported prevalence from 2% to 18% in retrospective studies on deaf children populations.

In 80-90% of the cases cCMV infection is asymptomatic at birth, but 10-15% of these infants develop late sequelae, more commonly hearing, visual, or neurodevelopmental impairment. The remaining 10-

20% of infants can present with preterm delivery, intrauterine growth retardation, sensorineural hearing loss, microcephaly, cerebral malformations, or others.

Hearing loss is the most common sequela: children with cCMV develop a sensorineural hearing loss, 35-65% among symptomatic newborns and 7-15% among asymptomatic ones. Most have a stable hearing loss over time, but 30% of children with hearing loss has a fluctuating threshold.

cCMV is due to the virus transmission to the fetus through the placental blood, during the delivery by contact with infected secretions or after birth through breast milk or through blood transfusions. The risk of transmitting CMV infection from mother to child is respectively 30-40% and 0.5-2% for primary (acquired by the mother during pregnancy) or secondary infection respectively. As most newborns are asymptomatic at birth and there is not a specific screening, the impact of cCMV is still not completely defined.

In cases of cCMV infection, following a full clinical evaluation and biochemical evidence, it is necessary to determine whether the baby with cCMV infection is symptomatic or asymptomatic. This decision affects the protocol of treatment and follow-up, as current guidelines recommend to undertake the therapy only in symptomatic infants (during the first 30 days of life) presenting central nervous system disorders or in case of focal or severe organ diseases. Because of the lack of an effective prenatal therapy, of a vaccine or because most cCMV recover spontaneously, a universal screening program for cCMV is currently not recommended in most countries, although it is a matter of debate.

The aim of our work was to evaluate the prevalence of hearing loss in children with cCMV infection in Modena county and in consequence, to discuss the necessity and the sustainability of a universal screening program of cCMV infection.

This retrospective study has been approved by the Ethics Committee of Modena county.

P.17 - IMPROVING HEARING CARE AND FAMILY PERSPECTIVES

P.17.1

COMPLEMENTARY CLINIC INSTRUMENT IN SPEECH AND HEARING EVALUATION OF CHILDREN AND TEENAGERS WITH HEARING LOSS BASED UPON THE INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH.

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INTRODUCTION: International Classification of Functioning, Disability and Health (ICF) was proposed by the World Health Organization (WHO) as an international pattern to describe and measure health and disability on an individual and populational scale. Accepted as one of the social classifications of the United Nations, as part of the standardized rules to equal opportunities of people with disabilities. Nevertheless, its application still represents a challenge for being considered extensive and complex, difficult to incorporate in clinical practice. AIM: Elaborate a complementary clinical instrument to the speech and hearing evaluation of children and teenagers with hearing loss, using the ICF version for children and young (ICF-CY) as reference, and verify its applicability in that population. METHODS: Took part in the study five speech pathologists, with specialization in deafness, who act on hearing rehabilitation, and eight children and eight teenagers with hearing loss that are in speech and hearing rehabilitation care. Patients presenting diagnostic of syndromes or disturbances that might influence significantly the functionality of the study were excluded from it. To the elaboration of the clinical instrument, a literature review on the subject was performed and the international core set of ICF for hearing loss - Comprehensive ICF Core Set For Hearing Loss – and the aspects evaluated in the practice of hearing rehabilitation therapies, based on the selection of categories and descriptors of the ICF-CY relevant in this contexts were considered. After consensus among the researches involved, over the pre-selection of categories, the initial version of the instrument was concluded and instructions for its application were elaborated, together with a questionnaire for its evaluation by the speech pathologists, judges of the research. The instrument was entitled ICF-CY Documentation Form for hearing loss and it was tested by being applied to the study's participants. The judges evaluated and applied the instrument, apart from answering the questionnaire on the elaboration phases and after its application. The considerations made by the judges were analyzed and the needed alterations made. RESULTS: As a result, an instrument with 46 categories of functions and structures of the body, 55 categories of activity and participation and 19 categories of environmental factors were obtained, totaling 120 categories for the description of health and functionality of children and young people with hearing loss. The developed Form presented efficacy to characterize the profile of the participants in each aspect analyzed and demonstrated applicability by the high level of concordance and reliability among the answers of the evaluators. CONCLUSION: ICF-CY Documentation Form for hearing loss can be used as a complement to the existing evaluations in the speech and hearing field and, with so, enhance the acceptance of ICF and its use by professionals in practical clinic. Besides, it contributes to the practices in therapies, in orientation to the caretaker, in presenting a broader and wider view of the users of the health service to the professionals assisting in the decisions, register the progress of the aspects of development of children and teenagers with hearing loss, considering compensations, adaptations and contextual factors that enhance or difficult communication.

P.17.2

DEVELOPMENT OF THE GERMAN ACE: AN ACTIVE COMMUNICATION EDUCATION TRAINING PROGRAM

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Introduction: In Germany there are a lack of evidence-based communication training programs for persons with hearing loss. Having been diagnosed with hearing loss, hearing aid fitting, if indicated, tends

to be the only healthcare service offered to outpatients. However, hearing loss has a negative impact on the everyday life communication of Persons with Hearing Loss (PHL) and their Significant Others (SO). Communication difficulties caused by the hearing loss can crucially be influenced by the use of effective communication strategies. Both, the lack of German communication training programs and the importance of communication strategy use, underline the relevance of developing a German version of the ACE program (Hickson et al., 2015) for rehabilitation of hearing loss.

Study objective: The overall objective of the study was to develop a final German version of the Active Communication Education (ACE) program which meets the needs of German study participants.

Intervention: A preliminary ACE version that was closely translated from the original ACE version of Hickson et al. (2015). The ACE program consisted of 5, weekly group sessions, containing 6 to 10 participants.

Methods: An intervention study (pre-post-design) was conducted with 49 participants (N = 49, SO = 19, PHL = 30), aged from 54-78 (SO) and 59-79 (PHL) years. Outcomes were self-reported measures collected before initiation of the program (pre-program) and 2 weeks and 6 months after attending the ACE program (post-program). Pre-post measures for PHL referred to communication strategy use, acceptance of hearing loss, activity and participation, health-related quality of life, anxiety and depression. SO pre-post measures referred to 3rd party disability, health-related quality of life, anxiety, and depression. Additionally post measures were used for PHL and SO to measure the degree of change of individual communication goals and usage of learnt communication strategies. Qualitative data were collected from feedback sheets for each session and the whole program.

Categories of individual communication goals and feedback sheets were analysed using the summarising qualitative content analysis of Mayring (Mayring, 2010). Within-group comparisons and effect sizes (Cohens-d) were calculated for the pre-post measures; post-measures were descriptively analysed.

Results of the outcome measures, and the structure of the final German version of the communication training "ZAKS" (Zusammen Aktiv Kommunizieren Schulung), will be presented and discussed.

P.17.3

USING THE LITTLE EARS AUDITORY QUESTIONNAIRE TO PROMOTE PARENTAL CONFIDENCE IN THE ASSESSMENT PROCESS: CAPTURING EXPERIENCES

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Introduction Children with cochlear implants are often assessed using a range of measures at regular intervals post-implant. This process can result in increased parental anxiety, lack of confidence and frustration that the assessment tool is not reflecting what they are observing / experiencing at home. The assessment is a snap-shot in time, a one-off moment where the carers can perceive they or their child is failing. Every one of the assessment appointments needs to be managed carefully by the therapist to maintain parental confidence and reflect parental perspectives.

Method 50 children were assessed at different intervals between 6 and 24 months post-implant. All children and their families are seen for regular therapy by the therapist performing the assessment and all are reported to have a positive therapeutic relationship with the therapist. A combination of assessment tools including the MED-EL Little Ears Auditory Questionnaire, the Pre School Language Scales (UK 5) (PLS) and therapist rating scales CAP, SIR and CEP were used. At the end of the assessment appointment, parents and carers were asked to complete a questionnaire focusing on how the assessment made them feel.

Results This presentation will illustrate the challenges in assessing children's progress after cochlear implantation and managing parent's thoughts and feelings to make this a positive, rather than anxiety-inducing experience.

Conclusion The Little Ears Auditory Questionnaire is a useful tool to use with families during the post implant journey to report and acknowledge progress alongside traditional assessment tools that require the child to participate and perform. In the early post-implant stages, parents experiences of the Little Ears Auditory Questionnaire is generally more positive than formal assessments such as the PLS.

P.17.4**AN ANALYSIS OF THE LANGUAGE ENVIRONMENT OF AT THE HOME OF BRAZILIAN TODDLERS WITH HEARING IMPAIRMENT USING THE LANGUAGE ENVIRONMENT ANALYSIS SYSTEM**Miriam Ferreira^[1], Ulrika Löfkvist^[1], Cilmara Levy*^[2]^[1]2 University of Oslo ~ Norway ~ Norway, ^[2]FCMSCSP ~ São Paulo ~ Brazil

This study is part of a research project which investigated the audio and language environment of Brazilian Portuguese-speaking (BP) homes using the Language ENvironment Analysis system (LENA). Results from the first part of this project deemed LENA sensitive to BP. Therefore, the aim of the present study was to analyze the language environment of 11 families of children with normal hearing (NH) and hearing impairment (HI) living in São Paulo Metro area. A total of 14 children were selected, 7 children with NH and the other 7 with HI. Children age ranged between 11 and 43-month-old. Participants were matched in number, age, gender, hearing condition, and SES. Their language and audio environment were recorded with the Digital Language Processor (DLP), which was inserted in the pocket of a specially designed vest. The recording lasted for about 12 hours, and it took place on the families' home.

For this study, the whole 12-hour recording of the 7 children with NH was taken into consideration. A Spearman correlation was calculated for investigating the correlation among the LENA variables. Results indicated a strong correlation between child age and the number of CT, CV, and AE-meaningful language. It suggested that children were increasingly more (1) exposed to AE-meaningful language, (2) engaged in joint-conversation, and (3) made more vocalization in relation to their age. The same analysis was conducted with the whole cohort (n=14). Results suggested a strong correlation between AE-meaningful language and CT, CV, and AW. It means that there was an increase in the number of CT and CV as children were more exposed to AE-meaningful language. In addition, there was an increase in meaningful language as adults spoke more. Such result stress the relevance of dyadic relations or joint interaction on children language development (Bronfenbrenner, 1979).

A comparative analysis of the language environment of children with NH and children with HI was conducted. Analysis focused on means, median and range of CVC, AWC, CTC, AE, AVA, and Developmental snapshot (DevSnap) for each group. Although the independent t-test demonstrated no significant difference between means, great variability in range was found among the variables. The great variability in range among variables was associated with (1) the varied degree of hearing loss and (2) the age of fitting of hearing aids among participants with HI.

The LENA system yielded detailed analysis of the audio and language environment of the participating families. Replicating this study with a larger cohort would provide us a more consistent and detailed insight on what the audio and language environment of Brazilian families is. Therefore, having the LENA system standardized for BP would equip researchers and speech pathologists with an analytical tool, which would support them on the elaboration of family-centered intervention programs. These family-centered intervention programs would support families with strategies for boosting the language development of children at risk of language delay. Consequently, the impact of the delay in language development would diminish whilst stimulating a child's communicative, cognitive, and social development.

P.17.5**WORDS MAKE A DIFFERENCE – A POPULATION-BASED RESEARCH PROGRAM FOR 0-48 MONTHS OLD CHILDREN WITH HEARING IMPAIRMENT AND CONTROLS WITH NORMAL HEARING**Ulrika Löfkvist*^[1], Sandra Nilsson^[2], Yvonne Thalen^[3], Elisabet Östlund^[4], Hanna Mared^[4], Gabriella Tisjö^[4], Lena Anmyr^[5], Eva Karltorp^[5]^[1]Department of Special Needs Education, University of Oslo ~ Oslo ~ Norway, ^[2]Assistive Technology Center, County Council of Dalarna LD Hjälpmedel ~ Falun ~ Sweden, ^[3]County Council of Värmland, Department of Otorhinolaryngology, Central Hospital, Karlstad ~ Karlstad ~ Sweden, ^[4]Karolinska University Hospital ~ Stockholm ~ Sweden, ^[5]Karolinska Institutet ~ Stockholm ~ Sweden

"Words make a difference" is a population-based Swedish research program, with international partners. The aim of the program is to explore how different environmental factors like listening environment and

spoken language stimulation from caregivers are associated to early language development and psychosocial wellbeing. This is examined in different sociocultural and linguistic contexts, in young children with hearing impairment (HI) and compared to age-matched controls with normal hearing (NH).

The Swedish national program consists of four separate studies:

1: A population-based validation study of the Language Environmental Analysis (LENA) system in children with NH and typical development aged 0-48 months, including 30 % children with multilingual development. Pre-validation results have so far shown high interrater agreement between different human raters and moderate agreement between the human transcripts and Swedish LENA audio samples for adult word counts (AWC) and somewhat lower for child vocalisations (CV) (Nilsson & Olsson, 2015; Jonsson & Pettersson, 2017; Mosten & Stenberg, 2018).

2: Longitudinal cohort study aiming to investigate young children's listening and language environment (measured with LENA) from around 6 months until 4 years of age, in relation to their spoken language development (measured with traditional language tests) and psychosocial development (parent questionnaires), in children with pre-lingual HI, who either use hearing aids (HA) and/or cochlear implants (CI), including 30 % children with multilingual background, and compared to age- and language-matched controls with NH.

3: Development of a new family-centered intervention program; Prevention Education Program for Parents (PEPP) for caregivers of children who recently have been diagnosed with any degree of HI. The PEPP program is conducted individually by an experienced SLP or teacher of the deaf at the clinic. PEPP aims to reduce initial parental stress and increase parental engagement and empowerment as early as possible. The content of the PEPP is based on current evidence-based recommendations, and includes regular evaluation with LENA- and video recordings for diagnostic reasons and more specific guidance of caregivers. Examples of intervention goals is to promote early full-time use of the child's HA:s, to encourage audio-verbal communication from day one, decreased screen time (if necessary) and in parallel promote adequate prosocial skills in infants. The 3-months long program is initially conducted as a case study with single-subject design (ABA) and with a follow-up in focus groups after 6 months. When the initial pilot study has been evaluated and PEPP has been revised, we plan to conduct a comparative RCT study, for future newborns who have recently been diagnosed with HI.

4: A cohort study that aims to explore the impact of remote microphone use at home and in daycare centers in young children with HI, who use HA and/or CI, aged 2-4 years, and evaluated with the LENA technology. The aim is to learn in which situations remote microphone is especially beneficial for verbal communication and to develop new strategies and pedagogical recommendations for caregivers and pre-school professionals.

Preliminary results will be shared and discussed in the presentation.

P.17.6

DIFFERENCES IN GROWTH TRAJECTORIES OF FATHERS' AND MOTHERS' SKILLS IN IMPLEMENTING AUDITORY VERBAL THERAPY PRACTICES FOR CHILDREN WITH HEARING LOSS

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Background: The Auditory Verbal Therapy (AVT) is a family-centered intervention for children with hearing loss that focuses on coaching parents to act as their child's own linguistic stimulator. Hence, facilitating parental engagement in the early intervention is crucial as parent-child interactions are directly related to a child's language development. Nowadays fathers' participation in AVT intervention service has increased but little research is known about the growth trajectories of AVT implementation skills in fathers and mothers. Therefore, the aim of the study was to compare fathers and mothers' competence patterns in applying AVT instructions and to further investigate how fathers' and mothers' behaviors changed in interacting with their children over time.

Method: Five pairs of hearing parents (5 fathers and 5 mothers) were matched with respect to their child's characteristics on chronological age (Mean=55.2 months) and length of enrollment in AVT (Mean=12 months). Two multidimensional 5-point Likert scales were used. One is Parental Teaching Skill, which

is consisted of 17 items in three subscales of language usage, instructional goal setting, and behavioral management. The other one is Parental Behavioral Skill Scale, which is consisted of 10 items in three subscales of parent-child interaction, emotional behavior, and parenting behavior. All scales were rated by AVT therapists and were assessed at three follow-up periods with intervals of every three months. Both scales were found to be reliable with supporting evidence for its construct validity. Profile analysis and generalized estimating equation (GEE) approach were conducted and compared to fit the time trend in repeated measurements.

Results: The results of parallelism and level tests in profile analysis indicated that there were no effect of group (scales scores of fathers and mothers) and no interaction between group and 3 time points on all subscales, which suggested that mothers did not receive higher scores by AVT therapists when compared to fathers from time 1 to time 3. Furthermore, the results of the flatness test showed the profiles of all subscales over 3 time points were relatively flat, indicating that subscales' mean scores of fathers' and mothers' at 3 time segments did not differ significantly from one another. However, the results here might be attributed to small sample size that would undermine the time effect on different subscales between fathers and mothers. Thus, GEE method with unstructured correlation and robust standard error was further applied to examine outcomes that were determined by changes in parental teaching and behavioral skills between fathers and mothers over time. Results obtained from GEE showed that there was a significant interaction between group and time points, indicating that fathers received higher scores than mothers with regards to differences in the dimensions of language usage skill (Wald $\chi^2=3.658$, $p=.056$) , instructional goal-settings skill(Wald $\chi^2=4.116$, $p=.042$), emotional and behavioral skills(Wald $\chi^2=6.532$, $p=.011$), and parenting skill (Wald $\chi^2=3.894$, $p=.048$) after 6 months training of AVT.

Conclusion: In overall time trend, fathers and mothers were not differed significantly in parent-child interaction and parental behavioral skills, however, in terms of growth trajectories obtained from GEE analysis, fathers were detected on trajectory for increased levels across four specific domains after enrolling in AVT for 6 months. Results suggested that fathers, like mothers, would also be suited to be their child's own language facilitator as length of training session increased over time. This finding provides early intervention professionals with greater understanding of gender role differences when working to optimize parental engagement for children who are deaf and hard of hearing.

P.17.7

ASSESSING AND IMPROVING PARENTS' IMPLEMENTATION OF AUDIOLOGICAL MANAGEMENT FOR CHILDREN WITH HEARING LOSS: FROM PARENTS' AND PROFESSIONALS' PERSPECTIVE

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Audiological management lays an important foundation for developing auditory skills and pursuing spoken language outcome for children with hearing loss. A clinical assessment tool was developed to assess parents' implementation of audiological management. In addition, a follow-up assessment was administered to investigate the improvement after audiologists' counseling based on the initial assessment results. In addition, the study explored the differences between parents' self-evaluation and professionals' evaluation. Audiological Management Checklist (AMC) was developed to assess parents' implementation of audiological management for children with hearing loss. The AMC is composed of 20 items, which can be divided into three dimensions: audiometric status understanding, hearing technology handling, and audiological monitoring. A rating of 0, 1, or 2 was assigned to each item, where a higher rating indicates a parent's higher degree of understanding or implementation. The maximum rating is 40. The auditory-verbal therapists (AVTs) and parents of 95 children (40 females) were recruited in the study. Parents' implementation of audiological management was evaluated using AMC by both the AVTs and the parents themselves. These children and their parents enrolled into the auditory-verbal therapy program less than one year prior to the initial assessment. At initial assessment, the mean age of the children was 34.6 months (range: 19 to 99 months). Based on the initial assessment results, pediatric audiologists counseled the parents to improve on the items receiving low ratings. Follow-up assessments

were administered in six months.

After receiving pediatric audiologists' counseling, parents' implementation of audiological management improved from the initial to the follow-up assessments based on both parents' and AVTs' perspectives. Most (87% based on parents' self-evaluation; 89% based on AVTs' evaluation) parents' implementation improved during the six months between initial and follow-up assessments. The mean rating increased from 33.78 (out of 40; 84.47%) to 37.19 (92.97%) based on parents' self-evaluation; the average rating grew from 26.29 (65.74%) to 32.62 (81.55%) from AVTs' perspectives. There was a strong positive correlation between parents' and AVTs' ratings in both initial ($r=0.81$, $p < 0.0001$) and follow-up assessments ($r=0.76$, $p < 0.0001$). A two-way ANOVA revealed a significant main effect for evaluator (parents or AVTs) ($F(1, 94)= 207.06$, $p<0.001$) and for time (initial or follow-up) ($F(1, 94)= 159.09$, $p<0.001$), with a significant interaction ($F(1, 94)= 15.17$, $p<0.001$). Compared with AVTs' evaluation, parents' self-evaluation generated significantly higher score at both assessments; ratings at follow-up were significantly higher than initial assessment based on both evaluators' view. In addition, the interaction resulted from a smaller difference between parents' and AVTs' ratings at follow-up compared to initial assessment.

At both initial and follow-up assessment from both parents' and AVTs' view, the worst implemented dimension was consistently "audiological monitoring" and the worst implemented item was consistently "keeps records of home monitoring using the speech sound test." Interestingly, this worst implemented item, belonging to the "audiological monitoring" dimension, was also the most improved item after audiologists' counseling. However, the best implemented dimension and item varied with evaluators and assessment time.

This study suggested that the counseling provided by audiologists, based on the initial assessment using AMC, is effective. Parents' implementation of audiological management significantly improved based on their own evaluation as well as from professionals' perspective. However, the results suggested that professionals should take parents' self-report on audiological management with caution because parents may overestimate their implementation. However, parents' self-evaluation may provide valuable information for professionals when advising parents to improve their implementation. AMC is a practical tool to assess parents' implementation of audiological management. With this tool, more systematic and precise instruction can be provided to help parents acquire knowledge and develop skills on audiological management.

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