Abstract Proof Report

List: Control Number, Complete Status, Abstract Title, Author Block, Abstract Body

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records: 1 - 265 of 265

Control Number: 2022-A-13-ACI

Complete Status: Complete

Presentation Number: CS10-1.1

Publishing Title: Cochlear Implantation in A Patient with Bilateral Mastoid Segment Facial Nerve Diverticula

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Abstract Body: Introduction: Facial nerve (FN) anomalies are rarely discovered during workup for cochlear implantation (CI) and are even more infrequently identified intraoperatively if overlooked or not apparent on preoperative imaging. We present a case of bilateral, incidentally found diverticula of the mastoid segment of the FN, which complicated CI through a traditional facial recess approach.

Case Description: A 70-year-old male with bilateral sensorineural hearing loss presented for left CI. He had previously undergone right CI 7 years prior and was found intraoperatively to have a stimulable 3-4mm soft tissue diverticulum based off the anterolateral proximal mastoid segment of FN, which was not evident on preoperative computed tomography (CT) imaging, nor identifiable on subsequent magnetic resonance (MR) imaging with gadolinium. While this prohibited implantation through the facial recess, even after sacrifice of the chorda tympani nerve (CTN), implantation was ultimately successful via a transcana l approach. Repeat CT prior to contralateral implantation did not show obvious FN anomalies and appeared similar to his past imaging, with a normal appearing facial recess on the unoperated left side. He was counseled extensively as to the rare outcome of a similar diverticulum being found,
despite negative imaging. He underwent a left mastoidectomy and was again found to have a similarly positioned 3-4mm soft tissue outpouching within the facial recess. Attempts to extend the facial recess inferiorly resulted in significant FN stimulation, and the procedure was aborted. He elected to proceed with a second attempt, and successful round window implantation was achieved after extending the facial recess inferiorly and drilling down the bony annulus to allow anterior displacement of the tympanic membrane and canal skin. Function of the FN was intact post-operatively in both cases.

Discussion: Intratemporal FN abnormalities or masses are rare, and include schwannomas, fibromas, hemangiomas, and epineurial pseudocysts. Although no histologic diagnosis was available on our patient, given the appearance of the lesions, it is likely these represented schwannomas or epineurial pseudocysts. Schwannomas can be found along any segment of FN, grow at variable rates over time, enhance with MRI contrast, and commonly span multiple segments. Symptoms are based on size, rate of growth, and proximity of the tumor to adjacent structures, and commonly include facial palsy, tinnitus, vertigo, and hearing loss, although many patients remain asymptomatic. Epineurial pseudocysts are found almost exclusively at the mastoid segment of the FN, are usually bony covered, remain stable over time, tend to be found in well aerated mastoid bones, do not enhance with MRI contrast, and are almost always asymptomatic. Unlike schwannomas, in which reports of bilaterality are incredibly rare, epineurial pseudocysts have been reported to be bilateral in up to 50% of cases. While FN masses are usually detected preoperatively on CT or MR imaging, small or subtle diverticula may be overlooked or dismissed as simple air cell opacification. When FN diverticula are found within the facial recess, alternative approaches for CI may be required.

Conclusions: Preoperative CT imaging for CI should be reviewed carefully for possible FN diverticula that would obscure a facial recess approach. If suspected, alternative surgical approaches should be considered if adequate access to the middle ear cannot be obtained.
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Introduction: Due to the increasing importance of residual hearing in cochlear implantations, a reliable instrument for monitoring residual hearing and for detecting possible critical steps during implantation would be helpful. There are various electrocochlear measuring methods, including extracochlear electrocochleography (ECochG). The aim was to establish a possible correlation between the audiometric hearing threshold and the electro-cochleographic stimulus response threshold.

Methods: 121 patients with residual preoperative hearing were included in the retrospective study. In a total of 107 patients, an extracochlear ECochG measurement was carried out before and after the insertion. In an additional 70 patients, the amplitude profile of the stimulus responses was monitored during the insertion of the electrode.

Results: The evaluation of the course of the residual hearing showed a significant drop in the threshold. The ECochG response thresholds before and after the insertion correlated significantly with one another. A positive, significant correlation between tone audiometry and ECochG could only be demonstrated in one frequency between postinsertional ECochG and postoperative tone audiometry at the time of the first fitting. The monitoring of the amplitude curve during the insertion of the electrode did not show a complete loss of the signal in any case. Thus, the structures could presumably be preserved in all cases, but the course was very heterogeneous and a connection between the course of the amplitude and the later development of the residual audiometric hearing could not be demonstrated.

Conclusion: It turns out that ECochG is a very sensitive measuring instrument for detecting intracochlear damage. However, further studies are necessary to determine to what extent ECochG and its intraoperative changes can predict possible residual hearing loss.

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Control Number: 2022-A-15-ACI
Complete Status: Complete
Presentation Number: 020
Publishing Title: Musical Ear Syndrome and Cochlear Explantation: Case Report and Proposal for a Theoretical Framework
Introduction: Patients who suffer from musical ear syndrome, sometimes also called musical hallucinations, hear music where none is present. In several case reports it has been shown that the syndrome can start after a cochlear implantation (CI). It seems to be generally accepted that auditory deprivation is a precondition for musical ear syndrome, but it remains unclear, why CI should trigger this condition and how it can be treated.

Methods: We report an unusual case of musical ear syndrome, and we propose a theoretical framework for this condition, merging information from the presented case and data from former reports of a total of 65 other cases. A written report has been accepted for publication in Otology & Neurotology. In our case, a 67-year-old semi-professional musician underwent cochlear implantation. One day after surgery, she started to experience musical ear syndrome. The perception of music never went away and could not be influenced with any programming of the CI, or with the use or abstinence of the CI-processor. Despite an otherwise successful rehabilitation, the patient insisted to have her CI removed. It was explanted 17 months later. The musical hallucinations stopped immediately after explanation, but reappeared 3 months later.

Results: From the presented case and in cases described previously in the literature we found that several types of factors seem to determine whether a musical ear syndrome is present or not. On this basis we propose a framework which differentiates between triggers, modifiers, and conditions, which determine a base vulnerability. Vulnerability seems to be increased by auditory deprivation and by habitual retrieval of music from memory. Cochlear implantation or explantation seem to act as triggers.

Conclusion: The proposed framework may help to stimulate reporting of more potentially relevant factors in future case reports on musical ear syndrome, and ultimately to help to understand this condition better. It may also help patients and professionals to understand that, e.g., cochlear implantation is probably neither the sole nor the main reason for musical ear syndrome, but more likely a trigger in an overall situation, which already favors its onset.
Title: Cochlear Implantation in a Patient with CHARGE Syndrome: Case Report of an Extraordinarily Nice Result

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Introduction: CHARGE is a mnemonic term for: Coloboma, heart defects, choanal atresia, retarded growth and development, genital abnormalities, and ear anomalies. CHARGE syndrome is one of the leading causes of congenital deafness and blindness in children. Reports of the outcomes of cochlear implantation in patients with CHARGE syndrome are that minimal communicative benefits are achieved. This is a case report of a 27-year-old female who has dealt with multiple congenital problems including severe hearing loss, for which a cochlear implant was placed at age 5 years in her first ear and her second ear at 24 years.

Methods: The patient was identified with bilateral severe sensorineural hearing loss and Charge Syndrome at birth. She was fit with hearing aids at a very young age and her parents enrolled her in Auditory-Verbal therapy. Her left ear was implanted at 5 years of age, and she was bimodal for almost 20 years. In 2019, her right ear was implanted and her left was re-implanted in 2020.

Results: Despite the less than stellar published outcomes for children with Charge Syndrome, our patient has been a very successful user (Ahn, et. al., 2013 and Lanson, et. al, 2013). We believe that the combination of early identification and remediation, her very dedicated parents, the auditory-verbal method of intense therapy in session and at home contributed to this young adult’s achievement.

Conclusion: We will review the family’s journey to raising a listening and spoken language child with special needs, her outcomes, and the decision to implant her second ear as an adult.

REFERENCES

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Control Number: 2022-A-24-ACI

Complete Status: Complete
Introduction: Verbal working memory delays are well documented in the population of children and adolescents with cochlear implants, but little is known about the underlying processes contributing to those delays. Prior work with rote-sequential verbal short-term memory tests (e.g., digit span) has demonstrated that speed of verbal rehearsal of words in memory predicts memory span. However, no research has examined response speed for memory items in a more demanding verbal working memory task requiring both processing and rote rehearsal. In this study, we examined processing speed during a demanding verbal working memory task in order to better understand how speed and efficiency of processing and retrieval influence speech, language, and working memory outcomes in children and adolescents with cochlear implants.

Methods: 25 early-implanted (<=3 years) children and adolescents (age 8-17 years) and 25 same-age normal hearing peers completed the WISC-V Letter-Number Sequencing (LNS) test, a challenging measure of working memory that presents a series of random letters and digits; subjects must recall the digits first in ascending order and then the letters in alphabetical order. Two processing speed measures were derived from correct LNS responses to sequences of 2 items (one letter and one digit) or 4 items (2 letters and 2 digits): response latency (time from the end of the stimulus to the beginning of the subject’s spoken response) and pause duration (average time between recalled digits or letters). Response latency reflects speed of active processing of memory contents, during which numbers and letters are mentally reordered for spoken recall. Pause duration reflects speed of rehearsal and production of spoken items during recall. Participants also completed measures of word recognition, rapid automatized naming, vocabulary, and working memory.

Results: For cochlear implant users, shorter latencies for 2 item sequences were associated with better verbal short-term memory, verbal working memory, word recognition, and rapid automatized picture naming. In contrast, latencies for 4-item sequences were not associated with any memory or language measures in the cochlear implant sample but were associated with all memory and language measures in the normal-hearing sample. Pause durations were associated with working memory, rapid automatized picture naming, and vocabulary in the cochlear implant sample only.

Conclusion: Faster speed during active memory processing (latencies) and recall (pause durations) was associated with stronger speech recognition, language, and verbal short-term/working memory in cochlear implant users more than in normal hearing peers.
Results of this study indicate that speed of information processing during working memory is an underrecognized influence on speech, language and neurocognitive outcomes following cochlear implantation.

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**Control Number:** 2022-A-25-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS8-1.1  
**Publishing Title:** Word Generation Fluency in Children and Adolescents with Cochlear Implants

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**Introduction:** Many children and adolescents with cochlear implants show delays in verbal fluency, the ability to rapidly/automatically generate words within semantic or phonological categories. Because the ability to fluently generate words is required for effective verbal communication, understanding verbal fluency delays is critically important for improving functional language-related outcomes in youth following cochlear implantation. This study compared verbal fluency, language, and neurocognitive outcomes in youth with cochlear implants to normal-hearing peers.

**Methods:** 28 children and adolescents (age 9-17 years) with cochlear implants (deafness onset age 6 months or younger; implanted at age 3 years or younger) and 33 normal-hearing peers completed measures of semantic verbal fluency (e.g., names of animals) and phonological verbal fluency (e.g., words starting with F). Participants also completed measures of sentence recognition, vocabulary, working memory, and inhibition-concentration skills. Three scores were derived for phonological and semantic verbal fluency: (1) number of words generated in each 5-second interval during a 1 minute period (words generated); (2) time delay until generating the first word (latency scores); and (3) number of words grouped in clusters (cluster scores) - phonological (words with the same beginning and ending phonemes, such as fast and fist) or semantic (words from the same semantic subcategory, such as types of fish, within the larger semantic category of animals).

**Results:** For semantic verbal fluency, differences between the samples were minimal, but
for phonological verbal fluency, the cochlear implant sample generated fewer words, had longer latency times, and had fewer words in clusters than the normal hearing sample. In both samples, better verbal fluency scores were associated with stronger sentence recognition, vocabulary, verbal working memory, and inhibition-concentration skills. However, cluster scores (grouping words into meaningful phonological or semantic clusters) were associated with sentence recognition and working memory only for CI users.

**Conclusion:** Children and adolescents with cochlear implants show delays in phonological verbal fluency compared to normal-hearing peers, but differences in semantic verbal fluency are minimal, suggesting that word generation based on semantic meaning is more efficient in cochlear implant users than word generation based on sounds/phonology. Associations of verbal fluency with spoken language and executive functioning outcomes demonstrate the close connections between speed/efficiency of word generation and broader language/neurocognitive functioning. Novel therapies focusing on speed/efficiency of generating and retrieving words from the mental lexicon may offer the potential to improve language, communication, and cognitive outcomes after cochlear implantation.
benefits provided by these devices can deteriorate over time due to the progression of the disease or its treatment. The objectives of this study are twofold: 1) to review the experience in hearing rehabilitation of patients with NF2 managed at one of the leading cochlear implant center in Canada, and 2) to describe the auditory outcomes of both CI and ABI in this specific population.

**Methods:** We performed a retrospective case series including all patients diagnosed with NF2 who were treated at the Centre québecois d’expertise en implant cochléaire (CHU de Québec-Université Laval, Québec City, Canada) between 2000 and 2021. The following data were collected: patients’ demographic information; surgery, radiotherapy and/or chemotherapy (e.g., bevacizumab) history; hearing evolution; hearing rehabilitation methods; implant details (CI and/or ABI); and auditory outcomes following implantation (short-term and long-term).

**Results:** A total of 12 patients were included in the trial: 3 males and 9 females. The mean age at implantation was 43.2 years (range: 17-74 years). Seven patients had a CI, and 5 patients had an ABI. Among patients who received a CI, 2 patients had an untreated and non-growing VS, 1 patient underwent a cochlear nerve preserving surgery through a retrosigmoid approach and 4 patients received radiotherapy treatments. Six patients (85.7%) became regular users of their device. Pure-tone average (PTA) dropped from 105dB preoperatively to 21.5dB postoperatively. The mean open-set sentence recognition scores without lip-reading were: 2% preoperatively (range: 0%-7%), 55.8% at 9 to 12 months postoperatively (range: 0%-83%) and 56.2% on the most recent audiological evaluation (range: 0%-98%). Among those who received an ABI, 3 patients used their device regularly, while 1 patient was an occasional user and 1 was a nonuser. All patients with an ABI were implanted concomitantly with VS surgical excision and 3 of them also received radiotherapy treatments. The mean open-set sentence recognition scores without lip-reading were: 7% preoperatively (range: 0%-18%), 23% at 9 to 12 months postoperatively (range: 0%-44%), and 14% on the most recent evaluation (range: 0%-42%).

**Conclusion:** Despite major technological advances in the field of auditory implantation, it remains challenging to rehabilitate hearing in patients with NF2. While ABI have been specifically designed to address hearing loss following surgical excision of a VS, long-term auditory outcomes remain deceiving with less than 12% of patients getting access to open-set speech recognition. Considering the evolving trend toward conservative management of VS, the increased role of hearing preservation surgery and the overall improvement in postoperative auditory performances with CI compared to ABI, cochlear implantation standouts as a viable option that should be considered as the primary mean of hearing rehabilitation in patients with NF2.
Cochlear Implantation in Children with Single-Sided Deafness: Case Reports

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Introduction: This multiple case study report will attempt to characterize important differences in children with single-sided deafness who receive a cochlear implant and how those differences can play a role in their outcomes. Cochlear implantation for children with single-sided deafness can result in improved hearing in noise, localization, tinnitus suppression, and stereo hearing. However, there can be significant variability in patient outcomes for speech perception with the cochlear implant alone.

Abstract Body:

Methods: Several case reports

Results:

Conclusion: This report describes some potential predictors for success in children of various ages, durations of deafness, etiology of hearing loss, and social backgrounds. We also describe recommendations for aural rehabilitation post-implant activation that we believe have significant effects on not only patient outcomes, but the child’s acceptance of the implant and overall satisfaction with the device.
Introduction: Superficial Siderosis (SS) is a rare progressive disorder caused by recurrent hemorrhage in the subarachnoid space. The hemorrhaging leads to dissemination of heme by circulating cerebrospinal fluid and subsequent deposition of hemosiderin and other iron-containing pigments in the central nervous system. These deposits propel lipid peroxidation which ultimately leads to localized cell and tissue necrosis. SS is typically treated symptomatically with the classic triad being progressive bilateral sensorineural hearing loss (present in 95% of patients), cerebellar ataxia, and myelopathy. In these patients, hearing rehabilitation is initially through hearing aids. However, once patients have bilateral severe to profound hearing loss and exhibit poor speech perception capacity, the next step in auditory rehabilitation in various studies has included vibrotactile stimulation, cochlear implantation (CI), and auditory brainstem implantation. Even though patients with SS are indistinguishable from standard CI patients based on pure-tone audiometry alone and speech perception, CI should be considered with caution due to the predominantly retro-cochlear nature of the damage, but potential iron deposited within the cochlear may also affect the spread of excitation within the cochlear. Previous systematic reviews (SR) have reported clear sustained benefit and that early implantation could be more beneficial, and outcomes are dependent upon the site of lesion, neural deterioration and degree of cochlear nerve functionality. The aim of this SR is to pool all available data via a rigorous SR methodology and to provide clinicians with best evidence to date and advice on the use of CI in patients with confirmed SS.

Methods: Systematic review. Databases searched: Medline, EMBASE, Web of Science COCHRANE and ClinicalTrials.gov. No limits placed on language or year of publication. Review conducted in accordance with the PRISMA statement.

Results: Of a total of 46 studies, 19 studies met inclusion criteria reporting outcomes in 38 patients. Of the 44 implants, 22 implants (50%) achieved good hearing outcomes at last follow-up, 9 (20.45%) initially benefited but then performance deteriorated (4 of whom were re-implanted) and 13 (29.55%) never benefited from them. All studies were grade four using the Oxford Centre for Evidence Based Medicine grading system, being retrospective in nature and consisting of case reports and non-controlled case series with small numbers of patients.

Conclusion: 31 out of 44 implants (70.45%) showed improved hearing outcomes following CI in SS at some point in time, of which 22 (50%) implants showed sustained benefit at last follow-up (average follow-up being 21.97m). It is difficult to predict the longevity of benefit, due to the progressive nature of the disease, or for which patients it may be beneficial as pre-operative investigations inadequately predict benefit. Pre/post-implantation counselling with the patient and family regarding the potential limited
Introduction: Motivating young children to participate in audiometric, speech perception testing, and mapping session takes a specially trained audiologist who can get information from an often unwilling participant. Positive reinforcement and sometimes even bribery are viewed as a way to encourage cooperation. There is some research that indicates we are erring in our assumptions that positive reinforcement and praise increases good behavior (Kohn, A. 2001). This presentation will outline why praise and positive reinforcement doesn’t always work and alternative ways to encourage children to cooperate in audiometric testing and CI mapping.

Methods: In most graduate pediatric audiology courses, the techniques for testing infants and young children include the practice of consistent and repetitive reinforcement in the form of exclaiming "good job" after every head turn or toy dropped in a bucket. As pediatric audiologists, we are encouraged to use behavior changing methodology such as positive and negative reinforcement as a means for cooperation and motivation during audiologic testing and cochlear implant mapping (Peck, 2007). Although there are books and articles that advise us against relying on punishment or bribery, there is little to discourage us from relying on what may be euphemistically called positive reinforcement (Kohn, 2001).

Results: The unintended detriment of praise is that is loses its effect and does not increase the intended behavior. Alternatives that can work for sustained interest, motivation, and cooperation will be discussed.

Conclusion: There is support for the use of alternative methods to encourage and facilitate cooperation in audiometric testing and cochlear implant mapping.

Kohn, A. (2001). Five reasons to stop saying "Good job!" Young Children, 56(5).
responses for individual subscales. Specifically, the patterns of responses did not change significantly after the 1-year visit for the UHL group; however, the AHL reported continued improvements for the SSQ Qualities of Hearing subscale and the APHAB Reverberation subscale.

**Conclusion:** Adult CI recipients with AHL and UHL report an early reduction in tinnitus severity and improvement in quality of life with CI use that are maintained with long-term device use. The AHL group continued to report improvements in subjective benefit with long-term CI use, which may reflect an ability to fuse the signals from the CI and contralateral hearing aid over time. Questionnaires such as the SSQ, THI, and APHAB may contribute to a more holistic assessment of the durability of benefits of cochlear implantation in this population.

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**Control Number:** 2022-A-37-ACI

**Complete Status:** Complete

**Presentation Number:** 177

**Publishing Title:** Building Cochlear Spiral Ganglion on a Chip Bioelectric Model

**Author Block:** Ilkem Sevgili, PhD student, Iwan Roberts, PhD, Manohar Bance, MD, PhD; Clinical Neurosciences, Univ. of Cambridge, CAMBRIDGE, United Kingdom.

**Abstract Body:**

**Introduction:** A key limitation of cochlear implant (CI) performance is the electrical interface with spiral ganglion neurons (SGNs). There is a pressing clinical need for a reliable model for testing strategies for electrical stimulation of SGNs. Current in vivo clinical measures are very limited and animal models do not replicate the anatomical structure of the human cochlea. Therefore, we propose the development of an in-vitro Spiral Ganglion-on-a-Chip model that combines 3D replication of the anatomy and core structures of the cochlea, along with embedded SGNs and microelectrode arrays (MEAs) to record neural responses. This combines electrical stimulation using real implants generating realistic electrical fields, with detailed probing of neural responses in order to generate a more complete picture of the implant-neural interface. This testbed enables the evaluation and optimisation of both current and future CI stimulation strategies and treatments, to answer key questions in the field and directly improve patient outcomes.

**Methods:** Spiral Ganglion-on-a-Chip aims to replicate in vivo neural electrical responses expected in humans in a controlled and measurable in vitro system. The model consists of 3 main elements: 1) Rat SGNs and human induced pluripotent stem cell (hiPSC)-
derived SGNs (in separate models) 2) Custom microelectrode arrays (MEAs) to measure cellular electrical activity and 3) Custom-designed 3D printed microfluidic chips to replicate the structure of the human cochlea. Currently, we have been focusing on developing both the cellular and device aspects of the Spiral Ganglion-on-a-Chip model separately. Several versions of the PDMS microfluidic device design have been iteratively optimised in order to ensure: 1) accurate anatomical and electrical conductivity representation of the scala tympani (where CIs sit in the cochlea), 2) reproducible 3D printing and subsequent casting of the precise features of the casted model, and 3) reliable fluid input into the device, needed for ionic current spread and cell growth.

**Results:** A casted PDMS device from a 3D-printed mould demonstrated good casting of all required microfeatures. Rat SGNs and glial cells were seeded in initial Cochlea-on-a-Chip prototypes and survived in the SGN channel for over a month. SGNs extended neurites through the microchannels toward the CI channel. We also developed human auditory neuron-like cells from human induced pluripotent stem cells (hiPSCs) derived from human fibroblasts. These hiPSC-derived SGNs displayed both a similar morphology to rat SGNs and express a neuronal marker TUJ1. We were also able to culture these neurons onto commercial MEAs and measure both their spontaneous ability to develop action potentials, and their response to electrical stimulation, and show that the action potential profiles are very similar to rat SGNs also grown on MEAs.

**Conclusion:** The Spiral Ganglion-on-a-Chip model will enable the rapid evaluation of existing technologies and the development of new CIs and hearing loss treatment strategies.

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**Control Number:** 2022-A-44-ACI

**Complete Status:** Complete

**Presentation Number:** 089

**Publishing Title:** Electric-Acoustic Cochlear Implant Fitting: an alternative approach

**Author Block:** Jennifer Torres, Doctor of Audiology Denver Ear Associates, Englewood, CO.

**Abstract #** 2022-A-44-ACI

**Abstract Body:** Introduction Presented today are case studies of patients with cochlear implants who have maintained residual hearing. Since the benefits of acoustic-electric fitting for cochlear implant recipients are well-proven, we attempted traditional fitting of the
addition of the acoustic receiver to the electrical stimulation of the cochlear implant. These patients were unsatisfied with the traditional fitting and an alternative was sought.

Methods The patients presented today had experience with the traditional fitting method for months or years prior to being refit. The integrated acoustic-electric fitting system was compared to the non-traditional fitting system on speech measures as well as quality of life questionnaires.

Results in both cases the patients had expressed frustration with aspects of the previous traditional fitting of the acoustic-electrically coupled cochlear implant. Patients were then fit with separated hearing aid and cochlear implant systems in the same ear. Since being fit with the decoupled systems as a non-traditional alternative, they express satisfaction with the fit of the devices as well as the data support their reports of hearing improvements. Objective data as well as subjective quality of life questionnaires will be presented.

Conclusion Non-traditional fitting of decoupled, individual devices fit within the same ear should be considered for any implant patient with residual hearing who has barriers to wearing the traditional acoustic-electric device or who expresses frustration with their hearing performance.

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Control Number: 2022-A-46-ACI

Complete Status: Complete

Presentation Number: 004

Publishing Title: Cochlear Implantation in Noonan Syndrome: A Case Report and Systematic Review

Author Block: Daniel Blumenthal, MD1, Braeden Lovett, BA2, James Leonard, MD1, Sixian Wang, BA2, Melissa Blumgart, AuD1, Michael Hoa, MD1;

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Abstract Body: introduction: Noonan Syndrome with Multiple Lentigines (NSML), previously known as LEOPARD syndrome, is an autosomal dominant disorder most commonly caused by a mutation in the tyrosine phosphatase non-receptor type 11 gene (PTPN11). This gene is also involved in Noonan Syndrome (NS). NSML and NS possess high phenotypic variability and share a broad range of clinical findings. There are a number of studies reporting hearing loss (HL) in both NS and NSML patients. These case series report that SNHL occurs anywhere between 3-20%. Other studies demonstrate various temporal bone
abnormalities in the middle and inner ear of patients with NS/NSML. Despite the prevalence of HL in both NS and NSML patients, outcomes after cochlear implantation (CI) remain poorly characterized.

Methods: We compare our patient’s results after bilateral CI to the literature via a PRISMA systemic review. We specifically focus on audiometric testing, evaluations, clinical features and developmental milestone attainment.

Results: A male infant born at term presented with notable speech and language delay at age 15 months despite passing his newborn hearing screening. During his first year of life, he was diagnosed with pulmonary valve stenosis, otitis media with effusion, and bilateral nephrosis. Audiologic evaluation revealed type B tympanograms bilaterally, and mild-to-moderate bilateral HL at 500-1000 and 4000 Hz. Minimal improvement was achieved with myringotomy, tympanostomy tube placement and a 6-week trial with bilateral hearing aids. ABR was performed, revealing bilateral severe-to-profound SNHL from 500-4000 Hz. Meanwhile, the patient underwent genetic testing, revealing a heterozygous PTPN11 gene with a c.1529A>G variant, seen in both NS and NSML. Preoperative MR imaging of the internal auditory canal (IAC) demonstrated normal appearing inner ear structures with no evidence of retrocochlear lesions. At 2.5 years of age, CI was performed successfully in the left ear, but postponed in the right due to poor insertion trajectory. Right ear CI was re-attempted and successfully inserted 2 months later. Full electrode insertions were achieved with each surgery. Audiogram at 7 months after activation of his left CI and 5 months after activation of right CI revealed an SAT of 40 dB HL on the right, left, and bilaterally. The patient is now able to consistently discern speech and sounds. However, the patient continues to predominantly communicate through sign.

Conclusion: Given the heterogeneity of NS/NSML, a multidisciplinary approach is needed for optimal outcomes. Although there is limited data on CIs in NS/NSML patients, this intervention should be discussed with parents as a viable treatment modality to improve audiologic and speech development. However, otolaryngologists should emphasize that objective audiometric outcomes may improve, but speech progression can be limited by cognitive deficits. Early genetic testing in patients with SNHL and multi-visceral abnormalities is critical for diagnosis, patient education, prognosis and joint decision-making. Identifying the specific mutation remains an underutilized modality and should be incorporated into practice better counsel patients on their audiologic and speech improvements after CI placement. Future studies that stratify cognitive deficits based on specific mutations will enhance our understanding of the pathophysiology behind NS/NSML and improve clinical decision-making when predicting CI outcomes in these patients.
Introduction: Noise-induced hearing loss (NIHL) is a global health burden resulting from the pathophysiological impact of noise overexposure, afflicting approximately 16% of the worldwide population. NIHL is the second most common form of sensorineural hearing loss and is increasingly recognized as a unique cause of inner ear trauma. At present, cochlear implants (CIs) are often the treatment for profound sensorineural hearing loss with more recently developed electroacoustic stimulation CIs (EAS-CIs) aimed at patients with residual low frequency hearing. However, CI surgery also results in a significant trauma to the inner ear that damages residual hearing (including a delayed loss of residual hearing). While effects of NIHL and CI trauma have been characterized separately, phenotypes and mechanisms underlying CI trauma in patients with prior noise related damage to the peripheral auditory system remain to be detailed. Here, we developed a preclinical rodent model of the accumulated pathophysiology of the cochleae with high-level noise exposures that subsequently undergo CI surgeries. Our overall goal is to test the efficacy of mild therapeutic hypothermia (mTH) during CI surgery in this ‘double-insult model’ for the protection of residual hair cells, synaptic elements, and spiral ganglion neurons.

Methods: Twenty juvenile Brown Norway rats were exposed to high level noise (110-120 dB, 1-2 hours, broadband noise). CIs were implanted one month after the noise trauma. Half the animals received CI under normothermic conditions while the other half received CI with mTH treatment. mTH treatment was applied with a one-hour cooling protocol using a patented probe and Peltier device during CI insertion. Auditory brainstem responses (ABR) were recorded prior to the noise exposure, post-noise exposure for one month, and post-CI at multiple time points up to one month. Histology was performed at the conclusion of experimentation. Statistical analysis of ABR analysis and histologic findings was performed comparing control and experimental groups.

Results: Different levels of noise trauma generated temporary and permanent threshold shifts up to 28 days. Hearing threshold shifts, damage to hair cells, synaptic elements, and SGN counts allowed for characterization of the ‘double-insult’ group and efficacy and safety of the hypothermia treatment.
Conclusion: Functional and anatomical outcomes in this model can generate new knowledge underlying pathology and mechanisms in patients and develop novel potential therapeutic interventions to preserve residual hearing.

Control Number: 2022-A-48-ACI
Complete Status: Complete
Presentation Number: CS7-1.4
Publishing Title: The Case for Intra-Operative X-Ray Imaging in Cochlear Implantation: Three Illustrative Cases and Literature Review
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Introduction: Evolving surgical techniques, programming software, and electrode arrays have all enabled improved performance in patients with cochlear implantation. Yet despite decreasing complication rates, suboptimal electrode misplacement remaining a common occurrence. Although the importance of proper electrode positioning is thoroughly acknowledged, utilization of all intraoperative tools (both radiologic and electrophysiologic) is not universal. Given such, the purpose of this article is to review the benefits and techniques of intraoperative X-ray (IOXR) via three illustrative cases - highlighting its importance, even in cases of normal electrophysiologic testing.

Methods: Three cases of electrode malposition, each performed by an experienced CI surgeon and detected only by X-ray, are discussed. Literature review was performed on the use of intraoperative imaging, focusing on plain film radiography.

Results: Case 1 describes resistance-free electrode insertion in a patient with normal pre-operative imaging. Intraoperative impedances and neural response telemetry (NRT) was normal, however, IOXR revealed tip fold-over prompting repositioning of the array. Case 2 describes resistance-free electrode insertion in a patient with normal pre-operative imaging. Intraoperative impedances and neural response telemetry (NRT) was normal with the exception of elevated (though normal) impedance on a single electrode. IOXR revealed tip fold-over prompting repositioning of the array. Case 3 describes an elective replacement of a soft-failing device. Resistance was encountered during array insertion, with IOXR demonstrating incomplete insertion compared with prior imaging. The array position was revised to achieve pre-revision insertion depth, demonstrating the added utility of prior IOXR in revision cases. Literature review of IOXR is discussed.
Conclusion: Appropriate placement of the electrode array is arguably the most essential component to successful cochlear implantation outcomes. These cases illustrate IOXR as a safe and effective method to ensure optimal placement even in cases of normal electrophysiologic testing. As such, plain film X-rays should be utilized routinely by even the most seasoned of surgeons.
matched normal hearing peers who had also completed the surveys at the same time points.

**Results:** Findings demonstrated a decrease in CI users’ overall QOL from pre-COVID to during-COVID. This decrease in overall QOL was particularly driven by lower social, entertainment, and emotional subdomain scores from the CIQOL-35 survey. The CI users also reported a decrease in real-world communication abilities during the COVID-19 pandemic. Lastly, CI users reported less social isolation during-COVID compared to pre-COVID.

**Conclusion:** These preliminary data suggest that the COVID-19 pandemic affected three aspects of CI-users’ real-world functioning, but in varying ways. CI users reported a decrease in self-perceived social isolation during-COVID. One possible explanation could be that pre-COVID CI users may have been missing out on friend and family interaction in public. With the onset of the pandemic and more friends and family remaining at home, CI users may have experienced more social interaction but within more controlled listening environments. In contrast, QOL and communication abilities decreased for CI users during-COVID. These findings suggest that despite an improvement in social isolation during-COVID, CI users were still negatively affected in real-world QOL and communication abilities. The ability to compare self-reported real world functioning outcomes in the same CI-user in both pre-COVID and during-COVID times provided a unique glimpse into the impact of the COVID-19 pandemic on CI users. Further research into the impact that environmental changes can have on CI users’ real-world hearing functioning and QOL will help clinicians and researchers better understand individual differences in outcomes among CI users.

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**Control Number:** 2022-A-51-ACI

**Complete Status:** Complete

**Presentation Number:** 042

**Publishing Title:** Does Intraoperative Monitoring Correlate with Speech Perception in Children with Auditory Neuropathy Undergoing Cochlear Implantation?

**Author Block:** Jackie Yang, BS, Emily Kay-Rivest, MD, Susan B. Waltzman, PhD, John T. Roland, Jr., MD; Department of Otolaryngology—Head & Neck Surgery, New York Univ. Sch. of Med., New York City, NY.

**Abstract Body:** **Introduction:** Patients with auditory neuropathy spectrum disorder (ANSD) often exhibit difficulties in speech perception out of proportion to severity of hearing loss as measured
by audiometry. Increasing numbers of these patients are undergoing cochlear implantation (CI) and outcomes are varied. Intraoperatively, electrically evoked compound action potentials (ECAP) are routinely assessed, but the relationship between ECAP and post-CI outcomes is not fully understood. The objective of this investigation is to assess whether intraoperative monitoring during CI is predictive of outcomes in a cohort of patients with ANSD.

**Methods:** A retrospective analysis of children with ANDS undergoing CI between 2009 and 2021 was performed. Demographic data, birth and developmental history, preoperative audiologic testing and neuroimaging, intraoperative monitoring results, and age-appropriate postoperative speech perception scores were collected. The primary outcome of this study was postoperative speech perception scores.

**Results:** Thirteen patients were included, with a median age at implantation of 2 years and a duration of follow-up from one to 12 years. Only two patients in the cohort had significant neurodevelopmental delays. Six patients had abnormal imaging of the brain or inner ear, although all had evidence of a cochlear nerve. Intraoperative ECAP were available for all patients and only two patients had absent responses. One of these patients had a known diagnosis of NF1 and MRI showing multiple areas of abnormal signal involving the cerebellum, periaqueductal region, and midbrain structures consistent with NF1-related myelin vacuolization. Inner ear structures were unremarkable. Six months postoperatively, the patient detects all Ling sounds but identifies only 2 of 5 sounds. The child is beginning to demonstrate closed-set identification of words. The second child with abnormal ECAP was known for a controlled seizure disorder and otherwise developmentally normal, with normal neuroimaging. This patient had improved ECAP responses by one-month post-implant and scored 88% on Multisyllabic Lexical neighborhood Test postoperatively. In this cohort, performance was associated with developmental abnormalities and abnormal neuroimaging and not with intraoperative ECAP.

**Conclusion:** In the absence of significant neurodevelopmental and neuroimaging abnormalities, ECAP measured during cochlear implantation do not correlate with speech perception outcomes in our experience with ANSD patients. In patients who have neuroimaging abnormalities, however, abnormal or absent intraoperative ECAP may signify underlying structural factors that hamper post-CI improvement.
Introduction: Children who receive cochlear implants at a young age often demonstrate speech perception skills on par with their peers. In recent years, advances in technology and early implantation have led to many children reaching ceiling scores (≥90% correct) on tests of speech perception before they are linguistically ready to proceed to a more challenging test, making it difficult to assess progress accurately and quantify performance over time. Furthermore, no good clinical guidance exists regarding appropriate age ranges for each test when considering high-performing, early implanted children.

Methods: In this retrospective study, we examined longitudinal speech perception scores (words and sentences) for over 160 children implanted between 2005 and 2014, including over 900 data points. All children were implanted by age 4. To account for different test material overtime, scores were converted to rankings using the PROSPER method. Individual speech perception tests were examined for their propensity to produce ceiling effects.

Results: Longitudinal data using PROSPER scores show that children tend to plateau at ceiling on a test for several years before they are linguistically ready for more difficult test materials. In our data sample, the mean age to hit ceiling on PBK words was 6.76 years, while the average age for the transition to a more difficult test (CNC words) was 10.97 years. Additionally, over 80% of children hit ceiling on the PBK test at least once. Older children or those with more CI experience tended to hit ceiling more often. Other test materials (e.g., LNT, HINT-C, Pediatric and Adult AzBio sentences), even when presented in noise, showed similar results.

Conclusion: Ceiling effects are present across a wide array of pediatric speech perception materials, which may hamper our ability to accurately assess a child’s performance over time. Our data examine which demographic factors are more likely to lead to ceiling hits, which may help clinicians with choosing which test to administer and realistically interpret the findings. For children who are at ceiling level performance, clinicians should consider measuring performance in other auditory areas, such as spectral or temporal resolution, or in other domains, such as academically or socially.
Active transcutaneous bone conduction implant and adhesive bone conduction devices: A one year follow up on audiological performance and subjective satisfaction

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Abstract Body:

Introduction In 2014 it was implemented a bone conduction implants program at the national Chilean reference center for genetic syndromes and cranium facial malformations in children. Since then, 56 pediatric patients with agenesis of external auditory canal had been implanted with active bone conduction implants. It was already reviewed the surgical and audiological outcomes, but not the quality-of-life results. Other issue was the need to compare the audiological results with users of not implanted devises (adhesive bone conduction devises). Objective To assess the audiological performance and subjective satisfaction of children implanted with active bone conduction implants and compare it with adhesive bone conduction devices results.

Methodology Prospective, multicentric study (Argentina and Chile). Performance and subjective satisfaction were evaluated at 1-, 6- and 12-months post implant activation. Tests: sound field audiometry, sound field speech in quiet, sound field speech in noise, hearing questionnaires (MUSS, MAISS, KIDSCREEN) and audio processor specific questionnaire. We compare the audiological results with a previous study in a similar group of children with congenital aural atresia (6 unilateral / 4 bilateral) implanted with an active bone conduction implant. Mean age: 11 ± 2 years (range: 8-15 years). All of them completed the 1 month and 6 months evaluation and 9 out of 10 completed the 12 months evaluation. The average PTA pure tone thresholds are AC 70,3dB; BC 14,7dB. Sound field Audiometry with the implant is close to 20dB for all frequencies and the results are stables on time. Speech in Quiet discrimination improved from 42% to 100%, speech in noise improved from 33% to 95% with noise at 60dB SPL and from 25% to 89% with noise at 65dB SPL. The total score of the audio processor specific questionnaire is 85%, score of MUSS 40, score of MAIS 39 and score of KIDSCREEN 4,4. On the other hand, the results for a similar group of children with conductive hearing loss using adhesive bone conduction devises: Sound field Audiometry close to 35dB for all frequencies, Speech in noise improved from 22% to 80% with noise at 60dB SPL.

Conclusion Considering these are preliminary results, they show a clear benefit of the active bone conduction implant in quality of life and hearing performance. Also, the
audiological performance is better than the results with adhesive bone conduction devices. It is necessary to complete the study to confirm these data.

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**Control Number:** 2022-A-58-ACI

**Complete Status:** Complete

**Presentation Number:** CS6-1.5

**Publishing Title:** Spread Of Excitation: Why It’s Useful and Why You Should Be Measuring It

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**Abstract Body:**

**Introduction:** Growing evidence suggests electrode placement impacts cochlear implant (CI) outcomes (e.g., Chakravorti et al., 2019). However, not all centers have access to imaging information affording perioperative surgical guidance and/or revision. In contrast, every CI center can obtain auditory evoked potentials through the CI software. One measure offering particular promise for providing electrode placement information is spread of excitation (SOE), which measures the width of current spread in the cochlea from a given electrode (Busby et al., 2008; Cohen et al., 2013; Hughes & Abbas, 2006; Hughes & Stille, 2010). However, to date, the clinical utility of SOE to estimate electrode placement and its potential relationship with speech recognition outcomes is not clearly defined. Therefore, this study aims to assess the utility of using SOE width to 1) identify electrode array tip foldover, 2) predict electrode placement factors confirmed via postoperative CT imaging, and 3) investigate whether a relationship exists with postoperative speech recognition in a large clinical sample.

**Methods:** A retrospective chart review was completed and identified 233 ears with a Cochlear Ltd. device, implanted between September 2016 to present, and at least one SOE width obtained. We identified cases of electrode array tip foldover, SOE widths (electrodes 5, 11, & 17), CT imaging data (electrode-to-modiolus distance, angular insertion depth, scalar location), and speech recognition outcomes (CNC words, AzBio sentences in quiet and +5 dB SNR) throughout the first year following activation.

**Results:** 1) SOE identified 100% of tip foldover instances confirmed by imaging. The incidence rate for precurved electrode arrays with a stylet (CI532 & CI632) was 3%,
whereas no instances of tip foldover were found for any other electrode type (CI512, CI522, CI612, & CI622). All instances of tip foldover were corrected intraoperatively via reinsertion. 2) Preliminary correlation analyses revealed a significant relationship between SOE and average electrode-to-modiolus distance \((r = 0.41, p < 0.001)\), and SOE and angular insertion depth \((r = 0.20, p = 0.006)\). However, the relationship between SOE and scalar location was not significant \((r = 0.06, p = 0.45)\). 3) The relationship between SOE and speech recognition outcomes was also not significant for any measure or time point \((p > 0.05\) for all comparisons).

Conclusion: In the absence of intraoperative CT or fluoroscopic imaging, SOE can reliably be used to identify electrode tip foldover, and should be routinely measured intraoperatively, especially for precurved electrode arrays with a stylet. Additionally, SOE was related to electrode-to-modiolus distance and angular insertion depth but was not related to scalar location or speech recognition outcomes.
sentences. Speech comprehension in noise was assessed using AzBio sentences presented in the SSD ear with noise to the contralateral ear at +5 signal to noise ratio (SNR), and Bamford-Kowal-Bench sentence-in-noise (BKB-SIN) testing. Statistical analysis was performed using GraphPad Prism v7. Differences in evaluation scores were analyzed by Student’s t-test with P<0.05 considered statistically significant.

**Results:** Out of 36 SSD patients who received a CI from 2016-2021, 20 patients met the inclusion criteria, with 11 females and 9 males. Mean age at time of CI was 40.6 years (range 22.5-58.6). Mean duration of HL prior to CI was 6.7 years (range 0.3-21.4). CI device profile was Cochlear Nucleus (n=11), Med-El (n=8), and Advanced Bionics (n=1). Etiology of SSD included sudden sensorineural HL (n=13), trauma (n=2), labyrinthitis (n=2), otosclerosis (n=1), congenital HL (n=1) and Meniere’s disease (n=1). Mean pure tone threshold improved from 73.8 dB pre to 34.8 dB post-CI by 3 months (p<0.01). CNC word perception in the SSD ear improved, reaching significance at 12 months. Mean CNC score pre-CI was 11.7%, 32.3% at 3 months, 35.3% at 6 months, and 61.1% at 12 months post-CI (p<0.01). Mean CNC phoneme in the SSD ear improved significantly at 3 months and 12 months (pre-CI: 18.9%; 3 months: 51.7%, p<0.05; 6 months: 51.0%, p>0.05; 12 months: 79.9%, p<0.05). Mean AzBio sentence in the SSD ear improved, reaching significance at 12 months (pre-CI: 24.8%; 3 months: 53.1%, p>0.05; 6 months: 59.7%, p>0.05; 12 months: 77.6%, p<0.05). Speech comprehension in noise did not reach significance (mean pre-CI: 60.9%; 3 months: 78.9%, p=0.18; 6 months: 92.7%, p=0.09; 12 months: 82.0%, p=0.14). BKB-SIN also did not reach significance (mean pre-CI: SNR +5.64; 3 months: +0.96, p=0.13; 6 months: -0.44, p=0.20; 12 months: +2.2, p=0.13). Tinnitus was reported in 15 patients pre-CI, with 14 reporting improvement. Vertigo was reported in 8 patients pre-CI, with 6 reporting improvement.

**Conclusion:** Our study demonstrates CI benefit in SSD patients regardless of the etiology of the hearing loss. Audiologic outcomes continued to improve up to 12 months, suggesting SSD patients require longer CI use given the normal contralateral ear. Most patients who experienced tinnitus or vertigo experienced improvement within 8 months. This data highlights the multifactorial improvements of CI for SSD patients. Given the limited power of this study, larger cohort is needed.

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**Control Number:** 2022-A-60-ACI

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**Presentation Number:** 130
Predictors Of Cochlear Implant Outcomes in Western Province of Saudi Arabia

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Introduction: In order to counsel families pre-operatively about the range of possible outcomes and to plan for post-implantation intervention, accurate prognostic information is required. Prognosis is considered a key component in pediatric cochlear implantation. Parents will only be able to set evidence-based and achievable expectations for their children if they are guided by professionals who are able to discern the factors that will exert an adverse effect on outcomes.

Methods: CI recipients were reviewed retrospectively, and cross-sectional outcome measures were added during an eight month data collection period. All children (≤18 years), implanted between 2000 and 2017 with a minimum of twelve months implant use at the time of data-collection and with data available on at least one outcome measure, were considered as eligible participants for this study. Of the total sample, 50% children were implanted unilaterally and (50%) were implanted bilaterally at the time of data collection. All bilateral implants were performed simultaneously or sequentially, with maximum time window one year between C1 and C2. All children had a fully inserted electrode array. Statistical plan Regression modelling was performed to determine prognostic factors that will influence outcomes in terms of auditory performance (CAP scores), speech production (SIR scores), communication mode and educational placement. Description of variables: Regression modelling was performed to determine prognostic factors that will influence outcomes in terms of auditory performance (CAP scores), speech production (SIR scores), communication mode and educational placement. Outcome variables: Auditory performance. Speech production.

Results: For unilaterally implanted children with a congenital/early onset hearing loss and a history of admittance to the NICU, there was a 42% probability to be a non-oral communicator, with the probability being almost half times less (22%) if children were not admitted to NICU. In contrast, should bilaterally implanted children with a congenital/early onset hearing loss have a history of NICU admittance, the chance to be a non-oral communicator was less (27%). For children with a post-natal onset of hearing loss, those implanted unilaterally had a higher probability (27%) to be non-oral communicators, in contrast to children with bilateral implants (16%). The presence of one or more additional developmental condition was found to be strongly predictive of poorer speech production scores and was associated with a higher probability for non-mainstream education. It is estimated that 30 to 40% of children with profound deafness have additional disabilities.

Conclusion: Outcomes in reality determined by many more single or interacting factors. Better understanding of factors influencing outcomes enables physicians to provide evidence-based information counselling to CI patients and their families.
**Introduction:** Hearing preservation the main target in recent era of cochlear implant. Round window approach is mainly serving this target. In fact, round window viability and accessibility still a challenge able matter. Many radiological trails to predict this issue

**Methods:** We will show the last 9 international publications in the issue of radiological predication of visibility and the accessibility of RW in CI surgery

**Results:** We will discuss in detail during our presentation

**Conclusion:** We conclude the feasibility of predication of visibility and accessibility of RW during CI
Sedey, 2011) compared to hearing peers. Working memory is acknowledged to be critical to the development of spoken language, and positive correlations have been found between working memory and language development in children with CIs (Pisoni & Cleary, 2003).

Early auditory deprivation can have a multitude of effects on brain development and may impact cognitive capacities that extend beyond the auditory system. It has been proposed that hearing loss can be considered a “connectome” disease, with individual differences in response to auditory deprivation accounting for variability in outcomes (Kral et al., 2016).

Working memory is an essential component of many aspects of our daily lives, including socioemotional functioning. If a child is unable to retain and process information or directions, their behavior is likely to change in the home and school environments. The current study hypothesized that working memory capacity would predict socioemotional functioning, with stronger working memory predicting better overall functioning.

**Methods:** This study examined parent and teacher forms of the BASC-3 for preschool (ages 2-5) and childhood (ages 6-11), as well as working memory scores from the WPPSI-IV and WISC-V. These measures were collected as a part of annual evaluations for children who have hearing loss and attended an inclusive education program. Within person analyses were completed with children who had both parent and teacher forms available (N=35). Analyses were conducted using RStudio in R version 3.6.3 (R Core Team, 2020).

**Results:** For teacher report, stronger working memory scores were positively associated with functional communication (r=.37). Working memory was negatively associated with attention (r=-.31), atypicality (r=-.49), hyperactivity (r=-.44) and withdrawal (r=-.42). For parent report, stronger working memory scores were positively associated with adaptability (r=.37) and functional communication (r=.33). Working memory was negatively associated with attention (r=-.46), atypicality (r=-.35), and hyperactivity (r=-.31).

Linear regression analysis indicated that working memory scores significantly predicted functional communication T-scores for parents (β1=.42) and teachers (β1=.58). Working memory scores also predicted teacher report of withdrawal (β1=-.47) and atypicality (β1=-.90).

**Conclusion:** Working memory scores predicted withdrawal and atypicality scores in teacher reports, and functional communication in both parent and teacher reports. It is likely that the items of the BASC-3, when used with children with hearing loss, capture how children present when working memory or auditory processing is challenging (e.g., shutting down, acting odd). Working memory and executive functioning are important factors in differential diagnosis of children with hearing loss.
Acceptance and Benefit of EAS for Pediatric CI Users


Introduction: The potential benefits of combined electric and acoustic stimulation (EAS) for adults with cochlear implants (CIs) have received significant of attention, emphasizing the importance of hearing preservation during surgery. However, it remains unknown if 1. Similar rates of hearing preservation are possible with children when using full-length electrodes and 2. Children benefit from EAS to the same degree as adults. While they may have similar patterns of hearing loss audiometrically, the etiologies and thus likely course of hearing loss progression is different in children when compared to adults. The purpose of this study was to investigate the benefits and acceptance rates of EAS in children.

Methods: Retrospective chart review was conducted on a large population of pediatric patients with a preoperative low-frequency pure tone average (LF-PTA, 250 and 500 Hz) of 75 dB or better. Speech perception scores, audiometric data, and EAS usage were collected preoperatively and up to 7 years post-operatively.

Results: Preliminary results suggest that children have high rates of hearing preservation (defined as thresholds of 75 dB or better at 125 and 250 Hz based on typical fitting post-operative EAS fitting criteria). Despite the ability to preserve this hearing, EAS acceptance was generally poor, primarily due to non-auditory factors such as preference for an off-ear processor or difficulty manipulating equipment. Speech perception scores were excellent for most children, regardless of hearing preservation or EAS status.

Conclusion: Children with residual hearing may have different hearing loss etiologies, hearing preservation rates, and EAS acceptance rates than adults. Thus, the benefits of EAS in this population may be less than in adults. Clinicians should consider non-audiologic factors at least as strongly as hearing thresholds when deciding to fit EAS in children.
Development of living guidelines for cochlear implantation in adults

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Introduction: International guidelines and clearly defined care pathways on adult cochlear implantation (CI) are limited, and country-specific guidelines vary and are associated with disparate levels of access and systemic underuse across the world⁴. In 2020, consensus statements were published⁵ representing the first step toward the development of international guidelines on best practices for CI in adults with severe to profound sensorineural hearing loss (SPNHL).

The standard of care for adults with hearing loss should include treatments that best improve the individual’s quality of life through optimizing hearing function, social participation, and engagement. For adults with SPNHL, the standard of care includes an accurate diagnosis and timely referral to an appropriate specialist centre for assessment and counselling. When it is indicated as the most beneficial treatment option, the patient should be advised by an appropriate healthcare professional about access to cochlear implantation (CI) and aftercare.

Methods: An international group of CI users and experts in the fields of otology, audiology, and hearing care have been brought together to form a Task Force in partnership with the Cochlear Implant International Community of Action (CIICA). The aim of the Task Force is to develop living practice guidelines and guidance that can be adapted and adopted in country, to optimise the care for adults indicated for CI. Member affiliations will extend to national and international organisations and a wide range of stakeholders implementing hearing care solutions within the community and most importantly patient representatives with SPSNHL.

Results: The overall objective of the Task Force is to contribute to and support the effective development and subsequent dissemination and adoption into practice of a set of accurate, consistent, and usable guidance and guidelines. Health Technology Analysts, an independent healthcare consultancy, will coordinate the Task Force and provide technical expertise to bring the guidance and guidelines to fruition. As the guidance and guidelines will need to be updated as new evidence is published, the aim of the Task Force is therefore for continuity and evolution over the long-term.
**Conclusion:** Developing a consistent approach to optimizing the care for hearing impaired adults who may not receive adequate benefit from hearing aids will help raise awareness and better define referral and treatment pathways, so patients can receive information about a treatment option that may help them.


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**Control Number:** 2022-A-68-ACI

**Complete Status:** Complete

**Presentation Number:** 093

**Publishing Title:** Speech Perception After Cochlear Implantation in Children with Partial Deafness

**Author Block:** Marc van der Schroeff, MD PhD MPH, Jantien Vroegop, PhD, Mick Metselaar, MD PhD; Erasmus MC, Rotterdam, Netherlands.

**Introduction:** Although many reports on cochlear implantation in adults with partial deafness are available, very few studies that report on this topic for children can be found. We investigated the effect of the duration of partial deafness in relation to the outcome of speech perception with CI in a number of children and young adults who were implanted at the Rotterdam Cochlear Implant Center, the Netherlands. Hearing preservation and the relation to speech perception was also assessed.

**Methods:** Fourteen children and young adults (age up to 21) with residual hearing at low frequencies who received a cochlear implant at Sophia Children’s Hospital at one or both ears were included. Pure tone audiometry was assessed pre and post operatively. Speech perception in quiet was assessed post operatively.

**Results:** We found that speech perception scores with CI were correlated to the duration of partial deafness. Participants with longer duration of deafness had lower performance with CI compared to the ones who received their implant earlier or at younger age. Also, data on hearing preservation will be presented.

**Conclusion:** Cochlear implantation is beneficial to children with partial deafness. However, the shorter the duration of partial deafness, the better the outcome with CI.
Introduction: Hospitals worldwide use masking to reduce the potential of transmission of infectious diseases by health workers and patients. Due to COVID-19, face mask use is increased. With these surgical masks, speech sounds are attenuated and people cannot see the facial expressions and lip movements. Therefore, surgical masks are suspected to have a negative effect on the communication while, especially in hospitals, effective communication is very important. Some studies investigated the effect of surgical masks on speech understanding for normal hearing adults. All these studies found decreased speech perception scores in background noises when surgical masks were worn. However, the effect for patients with cochlear implants or hearing aids was not investigated yet. The aim of our study was therefore to investigate the effect of surgical masks and face shields on speech intelligibility of adults with mild to severe hearing loss. A second aim of the study was to measure the acoustic effects of the masks and face shields on the speech signal. And third, we investigated the effect of face masks in daily life of the patients.

Methods: This study measured speech tracking scores in quiet for live speech in three different conditions: without a mask, with a surgical mask and with a face shield. Acoustic effects of the masks and face shields on the speech signal were also investigated. The study sample consists of 42 patients with moderate to severe hearing loss, 23 cochlear implant users and 19 hearing aid users. The third part of the study used an online questionnaire about the effects of face masks on daily life communication of adult CI users. We used three sub domains of the Nijmegen Cochlear Implant Questionnaire to assess quality of life. We also developed a face mask questionnaire. 221 CI users participated in this part of the study.

Results: A significant average difference in speech perception scores was found for the use of a surgical mask compared to the listening situation “without mask”. The worse the speech understanding in quiet, the larger the impact of the surgical mask. For the worse performers even the face shield had a negative impact on speech perception. The sound distortion for the face shield compared to the surgical mask was greater. The face mask
questionnaire showed that widespread use of face masks cause considerable problems in daily life communication of 80% of the participants. Also, CI users tend to feel more lonely and all used subdomains of the Nijmegen Cochlear Implant Questionnaire worsened due to the use of face masks in the public domain.

**Conclusion:** This study shows that even for speech perception in quiet, surgical face masks, and face shields to a lesser extent, have a negative effect for patients with moderate to severe hearing loss. Moreover, if face masks are widespread used in the public domain, it greatly complicates the daily life communication of CI users and reduces quality of life.

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**Control Number:** 2022-A-71-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-2.6

**Publishing Title:** Brain correlates of auditory talker segregation in cochlear implant users.

**Author Block:** Andrew Dimitrijevic, PHD, Vincent Lin, MD, Trung Le, MD PHD, Joseph Chen, MD; Otolaryngology, Sunnybrook Res. Inst., Toronto, Canada.

**Abstract Body:**

**Introduction:** Cochlear implant (CI) users vary drastically in both performance and self-reported benefit. Previous work has shown poor correlations between clinical speech perception scores and quality of life measures. Part of this apparent discrepancy may be related to the testing materials used in the clinic. Real-world environments typically include varied types of visual and auditory distractors at numerous spatial locations. We aimed to understand the source of this variability from the auditory streaming/segregation perspective. To this end, we developed behavioral and brain-based tests of multi-talker separation to assess relationships to speech in noise perception and quality of life.

**Methods:** We adapted the Listening in Spatialized Noise (LISN-S) originally formulated as a test for central auditory processing disorders. In free-field, CI users were instructed to attend to a center speaker location (0 degrees azimuth) while distracting/masking talkers at different spatial locations +/- 45 and 90 degrees. Additionally, talker identity was altered by changing by the fundamental and vocal tract length. Thresholds for 50% identification of triplet digits was assessed using an adaptive staircase procedure. In addition to the behavioural test, high-density EEG (electroencephalography) was measured while CI users listening to an audiobook under the same +/- 45 and 90 degree
“Neural speech tracking” was assessed by extracting the audiobook speech envelope and relating this low-pass filtered signal to the brain response.

**Results:** Robust neural responses were recorded using this novel type of stimulus. Neural tracking was reduced, and behavioral thresholds were elevated when maskers were in the same voice as the “to be attended voice” compared to when the attend voice was different than the masking voice. Similar effects were observed when the maskers were +/- 45 degrees compared to +/- 90 degrees. The degree of EEG enhancements to attended speech was also significantly correlated to the spatial domain of the SSQ (Speech, Spatial and Qualities of Hearing Scale).

**Conclusion:** We found that it is possible to record speech neural tracking in CI users and that these measures are related to the ability to segregate voices in a multi-talker environment that mimics real-world soundscapes. Importantly, these measures are related to subjective improvements in quality of life.
presentation looks to expand on those data. Specifically, we will look at the relationship between teletherapy, processor wear-time and patient outcomes. **Methods and Results:** We will review the data from the SSD patient population at our Center, totaling approximately 30 patients. Specifically, we will look at pre- and post-operative test scores, aural rehabilitation attendance, wear-time and patient satisfaction surveys. We will assess the trends and relationships among these aspects. **Conclusions:** Patients with SSD are a unique subgroup of the general cochlear implant population. They require more intensive aural rehabilitation to integrate the new signal with their normal hearing ear. Processor use is also an important factor in cochlear implant benefit, particularly for this population. It is expected that there will be a significant correlation between aural rehabilitation and wear-time on patient outcomes with their cochlear implant.
obvious trigger. The patient received a second cochlear implant within 6 months of the decline. Behavior as well as speech and language skills improved considerably following the second implant. **Conclusions:** Cochlear implantation for children with unilateral hearing loss can provide significant improvement in speech and language development, particularly for children with congenital CMV who are at considerable risk for progressive hearing loss in the contralateral ear. This child had difficulty acclimating to his initial implant; however, he had significant improvement when the contralateral ear declined. The acclimatization period with the second cochlear implant was considerably smoother with more rapid improvement seen. This child is now performing well with both implants, with improvements seen in auditory skills as well as speech and language development. Academic skills and behavior have also improved.

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**Abstract Body:**

**Introduction:** While shorter duration of deafness and younger age are correlated with better cochlear implantation (CI) outcomes, little is known about how specific patient activities influence outcomes. Inquiring as to the common activities of successful CI users, we wanted to understand whether participation in specific activities and perceived social support correlate with speech perception outcomes following CI.

**Methods:** We emailed CI patients 18 years or older at the time of CI, who were implanted after January 2019, inviting them to complete the Functional Social Support Questionnaire (FSSQ) and a modified version of the Victoria Lifestyle Study-Activities Lifestyle Questionnaire (VLS-ALQ). The FSSQ measures perceived social support. The modified VLS-ALQ asks how often patients participated in 81 activities within the past two years. We analyzed how patient demographics, FSSQ score, and individual activities from the VLS-ALQ correlated with and predicted both implanted ear and binaural AzBio scores.

**Results:** Of 154 patients emailed, 53 (34%) completed the survey, of whom 24 had at
least 6 months follow-up with appropriate speech perception testing for analyses. Our cohort was 75.0% white, 70.8% male, and had an average age of 69.0 years. With AzBio testing, implantation improved the implanted ear from a pre-operative average of 25.4% to 68.5% post-operatively (p < 0.005) and binaurally, from 40.4% pre-operatively, to 79.1% post-operatively (p = 0.006). Functional social support did not correlate with either implanted (Pearson’s R = 0.271, p = 0.106) or binaural (R = -0.301, p = 0.159) post-operative AzBio scores. AzBio scores in the implanted ear correlated positively with length of follow-up (R = 0.445, p = 0.029), participation in organized social activities (R = 0.472, p = 0.020), and correlated negatively with travel abroad (R = -0.417, p = 0.043). With regression analysis, social activities (B = 10.165, p < 0.001) and knowledge games (B = 3.988, p = 0.24) positively predicted AzBio scores in the implanted ear, whereas participation in photography (B = -6.698, p = 0.01) negatively predicted AzBio scores. Binaural AzBio scores correlated negatively with on-the-job training (R = -0.655, p = 0.011), informal social interactions (R = -0.658, p = 0.011), jigsaw puzzles (R = -0.792, p = 0.001), and practicing a foreign language (R = -0.659, p = 0.010). Attendance at church/synagogue services positively predicted (B = 10.629, p < 0.001), whereas jigsaw puzzles (B = -17.640, p < 0.001), math (B = -6.321, p = 0.001), card games (B = -1.457, p = 0.014), and eating at restaurants (-3.775, p = 0.027) negatively predicted binaural AzBio scores.

**Conclusion:** Participation in organized social activities is positively associated with post-operative speech recognition scores, while solitary recreation is negatively associated with speech perception testing. Further study with prospective analyses and quality-of-life studies is needed to determine whether these relationships are causal.
**Introduction:** Many pediatric unilateral microtia-atresia patients do not undergo hearing intervention and are monitored for hearing changes instead. It has been shown that when comparing age-matched unilateral microtia-atresia patients without hearing aid devices to control subjects with normal hearing, speech discrimination scores are lower for microtia-atresia patients in conditions of noise. However, previous studies haven’t compared aided and unaided microtia patients to see if there are differences in speech discrimination abilities between cohorts. Among aided microtia patients, previous studies have focused on differences in hearing aid devices for patient comfort and adverse effects but not speech discrimination abilities over time. Comparing hearing outcomes between pediatric microtia patients who received various hearing aid devices, as well as with patients who underwent no hearing intervention, can help to guide future clinical decision-making.

**Methods:** Following IRB approval, patients were identified using ICD-10 codes for Microtia and Atresia (Q17.2, Q16.1, and 82721). For this retrospective study, inclusion criteria were as follows: pediatric patients (<18), diagnoses of congenital microtia and/or atresia and conductive hearing loss, and a minimum of 12 months of audiology evaluation in their chart. The primary predictor variable was whether or not the patient underwent hearing intervention (aided vs. unaided). Secondary predictor variables for aided patients were date of hearing device implantation and type of hearing device. The primary outcome measures of interest were Speech Recognition Threshold (SRT), Speech Awareness Threshold (SAT), and Pure Tone Average (AT-PTA).

**Results:** 29 patients met inclusion criteria, with 30 total affected ears. The mean age at first audiology visit was 5.91 years, and mean follow-up time was 6.9 years with an average of 5 audiology visits (range: 1-15). 71% of the patients had a hemifacial microsomia diagnosis, and 28% had an additional craniofacial syndrome. Of these patients, 13 were aided and 16 were unaided. One patient had bilateral microtia and was in the aided group. Within the aided group, 61.5% had a Softband and 38.5% used a bone-anchored hearing aid (BAHA). In addition, 23% of the aided patients received a second hearing device, all of which were Cochlear implants. The mean time between their first audiology visit and their cochlear implant was 3.4 years. When comparing aided and unaided ears, there was a significant difference in mean baseline speech discrimination scores in the contralateral ear in the unaided group (7.50, SD 5.40) as compared to the aided group (26.67, SD 20.41) (p=0.012). Subset analysis within the aided group showed no statistically significant difference between patients using softband vs. BAHA for their baseline speech discrimination testing scores and their scores at latest follow-up.

**Conclusion:** These findings provide a descriptive analysis of characteristics of unilateral microtia patients. This data reveals a significant difference in speech discrimination testing between aided and unaided unilateral microtia patients. It also shows similar hearing outcomes within the aided cohort between BAHA and softband users. This data provides the basis for further investigation into trends in speech discrimination in this patient population with a larger patient cohort and can ultimately guide clinical decision making on hearing aid use in unilateral microtia patients.
**Abstract Body:**

**Introduction:** The aim of this study was to prospectively assess pain and drug use following otologic surgery comparing two prescription patterns. A prospective nonrandomized consecutive cohort study was carried out.

**Methods:** 125 adult patients undergoing ambulatory otologic surgery were assigned to one of two treatment arms and followed prospectively. The two treatment arm received the following therapies: 1) acetaminophen 500 mg + ibuprofen 400 mg; 2) acetaminophen 500 mg + codeine 30 mg. Pain levels, medication dose, disposal patterns of opioids, and suspected side effects were evaluated in a diary, which patients were asked to fill out on a daily basis for at least two weeks after surgery.

**Results:** All patients reported mild to moderate pain. The highest pain level was on the day of surgery. Pain levels were an average of 0.26 lower on each day than the day before. Sufficient pain control could be achieved with both drug regimens with no significant difference in pain levels between the two. 50% of patients who were prescribed opioids used them. Additionally, the median tablet intake was 3 tablets of codeine while 10 to 20 tablets were prescribed. The majority of patients (97%) did not dispose of these drugs safely.

**Conclusion:** Non-opioid medication leads to comparable pain control rates. If opioids such as codeine (30 mg) are prescribed, the amount should be reduced as low as possible, such as three to five tablets, based on our studied population. In an effort to reduce opioid prescription and use, standard postoperative pain medication should not include opioids for patients undergoing cochlear implantation.
Abstract

Body: 

Introduction: Cochlear implantation (CI) is the most effective treatment for single sided deafness (SSD) and asymmetric hearing loss (AHL) and works by restoring the benefits of binaural hearing, namely speech perception in noise and sound localization. However, little research has been published on optimal methods for rehabilitating SSD-CI. The goal of this systematic review was to evaluate the effectiveness of methods for improving postoperative CI hearing performance in patients with SSD or AHL.

Methods: Systematic review and narrative synthesis. Embase, PubMed, and Scopus were queried for English language articles with search terms pertaining to CI for SSD and rehabilitation. Studies reporting postoperative techniques to maximize hearing outcomes following CI surgery for SSD were included. Speech in noise (SIN) was the primary outcome measure and speech in quiet (SIQ) and sound localization (SL) were secondary outcome measures. 32 studies met criteria for full text review and 8 (n=104) met final inclusion criteria. Due to heterogeneity, meta-analysis was not performed.

Results: Interventions were categorized as follows: auditory rehabilitation, programming techniques, or hardware optimization. Formal auditory rehabilitation with 5 sessions and assigned home listening (n=10) found no objective improvement in hearing outcomes. Programming techniques, such as electrode maps that selectively deactivate electrodes to reduce distortion and improve resolution (n=17), showed significant improvements in spectro-temporal non-speech tasks and SIN tests for some individuals but lost significance between groups. Programmed processor delays to improve synchronization with the acoustic ear demonstrated improved SL but no improvement with SIN (n=12). Gain control matching the contralateral hearing aid to the CI improved SIN and conferred a subjective preference by patients (n=15). Hardware optimization such as adding both multidirectional adaptive (n=29) and remote (n=11) microphones improved SIN and SL. Changing processor type from behind the ear to a single unit was preferred by 8 of 10 patients.

Conclusion: Postoperative programming and hardware interventions were associated
with improved hearing outcomes for SSD and AHL patients with CI. Formal auditory rehabilitation did not improve hearing outcomes, although the sample size was small warranting further study. Focus on creating symmetry between the acoustic and implanted ear, particularly with programming or hardware interventions, may be beneficial in future rehabilitation plans.

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**Control Number:** 2022-A-80-ACI

**Complete Status:** Complete

**Presentation Number:** CS5-1.2

**Publishing Title:** Effect of Cochlear Implant Speech Processor Microphone Position in a Real-World Listening Environment

**Author Block:** Amanda M. Griffin, AuD, PhD, Jennifer M. Harris, AuD, Elizabeth Erickson O’Neill, AuD, Lauralyn M. Chetwynd, AuD, David B. Faller, BA, Greg R. Licameli, MD, MHCM; Otolaryngology and Communication Enhancement, Boston Children's Hosp., Boston, MA.

**Abstract Body:**

**Introduction:** Cochlear implant (CI) recipients often achieve high levels of speech understanding in quiet, but many continue to struggle in adverse listening environments with interfering background noise. Research conducted with adult recipients has demonstrated benefits in noisy situations when the processor microphone is placed close to or in the ear. No studies have evaluated microphone placement in pediatric CI recipients. Today, CI manufacturers offer processors utilizing a variety of microphone placements including in-the-ear (ITE), behind-the-ear (BTE), and off-the-ear (OTE). The goal of this study was to investigate the effect of microphone placement on hearing-in-noise abilities in school-aged CI users using the R-SPACE Sound System.

**Methods:** Bilateral Cochlear and Advanced Bionics CI users 7 to 18 years old who achieved sentence recognition-in-quiet scores ≥80% correct were included in the study. Subjects were seated in the center of an R-SPACE installed in an audiometric booth. Subjects listened to BKB sentences presented from the front loudspeaker at 0 degrees azimuth, while proprietary restaurant noise was presented from the remaining 7 loudspeakers encircling the child (+45, +90, ⋯ +315). A descending presentation level paradigm was used, where the signal-to-noise ratio (SNR) decreased in 3 dB steps with each sentence presentation from +15 to -15 dB SNR. The SNR required for 50% speech understanding (SNR-50) was calculated. Each subject listened in 8 test conditions. The effects of microphone placement (BTE, OTE, ITE) and potential moderating factors microphone directionality (omni vs. directional) and use of remote microphone
technology (e.g., Roger Touchscreen, MiniMic 2+) on SNR-50 scores were evaluated within subjects for each CI manufacturer.

**Results:** Preliminary results suggest subjects achieved lower (better) SNR-50 scores 1) with ITE or BTE microphone placements compared to OTE, 2) in directional microphone modes compared to omnidirectional, and 3) with remote microphone use. SNR-50 scores were best with remote microphone use and poorest with an OTE microphone placement in an omnidirectional mode. Initial findings further suggest the effect of microphone placement lessens as directional microphones and remote microphone technologies are added.

**Conclusion:** Today CI users can benefit from multiple technologies to improve hearing in noisy listening environments. Understanding the extent to which each of these technologies can improve speech perception in adverse listening environments and how they may interact with one another has been challenging to evaluate in pediatric CI users. Results from the current study suggest benefit from a microphone placement closer to or in the ear and directional microphone use when listening in a realistic auditory environment, like dining at a restaurant. The largest benefit, however, was obtained with remote microphone use.

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**Control Number:** 2022-A-81-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-2.4

**Publishing Title:** Health Insurance Coverage of Cochlear Implantation in Single Sided Deafness and Asymmetric Hearing Loss

**Author Block:** Donna Sorkin, MA, Nichole Westin, MA; American Cochlear Implant Alliance, American Cochlear Implant Alliance, McLean, VA.

**Introduction:** There is increasing interest in providing cochlear implants (CI) in single sided deafness (SSD) or asymmetric hearing loss (HL). CI clinics have experienced a range of outcomes when seeking insurance coverage for patients.

**Methods:** A SurveyMonkey® questionnaire was used to collect data from US CI clinicians. Respondents were from all regions of the US and represented a diversity of clinic types including hospitals, university-based clinics, private clinics, and schools. Data was collected during August-October 2021 from 103 respondents regarding their clinic’s experience in gaining health insurance coverage for pediatric and adult patients who had single sided deafness or asymmetric hearing loss. Strategies that had been used for
gaining coverage after an initial denial were explored.

**Results:** Numbers of cochlear implant surgeries for SSD increased in recent years. Prior to 2019, a majority of clinics (59%) indicated that they had performed 10 or fewer SSD or asymmetric HL surgeries. After 2019, clinics in the survey that performed 10 or fewer such surgeries fell to one-third. After 2019, clinics that had completed 30 or more SSD or asymmetric HL CI surgeries nearly doubled from the prior (before 2019) timeframe. Regarding health insurance coverage in the current timeframe, 29% of respondents indicated that they were almost always able to gain insurance coverage and 35% indicated they “often” gained such coverage. A minority of respondents indicated that they gained SSD coverage infrequently (5%) or almost never (8%). Most respondents indicated no difference in success in gaining SSD coverage for children and adults. The survey queried on which insurers were providing coverage and approaches used to overturn an initial denial. Peer to peer review was the most successful approach. When insurance declined to cover, the most common reasons were: not an approved benefit, experimental procedure, not medically necessary, does not have a profound hearing loss in contralateral ear, and policy specifically excludes SSD.

**Conclusion:** There is variability in CI coverage for SSD and asymmetric hearing loss. Some health insurance coverage is available for patients of all ages from a range of insurers including insurers thought to not cover by some respondents (i.e., Medicare Managed Care, United). Some insurers were noted as being particularly difficult and likely to deny pediatric coverage for SSD or asymmetric HL based upon the current FDA guideline applying to children 5 years of age or older. Some clinics were able to gain coverage—at least some of the time—from insurers categorized as “always negative” by other clinics. Future advocacy efforts might best focus on: evidence of benefit of providing a CI for SSD and asymmetric hearing loss, and the collected body of information from this study (and others) demonstrating that many healthcare insurers do recognize these important outcomes and provide SSD coverage.

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**Control Number:** 2022-A-82-ACI

**Complete Status:** Complete

**Presentation Number:** 011

**Publishing Title:** Adhesive versus passive bone conduction implants

**Author Block:** Javier Gavilán, M.D., Fernanda Pedrero, MD, Laura Cavallé, MD, José Manuel Morales, MD, Luis Lasaletta, MD;
Abstract

Body:

**Introduction:** The first adhesive bone conduction device was introduced in 2017. We compare the auditory outcomes and patient satisfaction between adhesive and passive transcutaneous bone-conduction implants.

**Methods:** We include 16 pediatric patients with bone conduction threshold ≤ 25dB who were users of passive transcutaneous implants for at least one year, and gave them an adhesive system for one week. Pure tone thresholds and word recognition with bisyllables at 65dB with and without noise were measured for each of the two devices. A specific satisfaction questionnaire, SSQ life questionnaire and the Kinddle quality of life questionnaire adjusted to the patient’s age were also passed.

**Results:** The age of the patients was between 5 and 16 years. All of them had congenital aural atresia, 9 unilateral and 7 bilateral. The pure tone average in the studied ear recorded a mean threshold of 52 dB unaided. The mean passive transcutaneous-aided threshold was 27 dB and 29 dB with the adhesive-aided. The average word recognition score was 96% for the passive transcutaneous and 95% for the adhesive system in quiet. The word recognition score in noise at 5 dB SNR was 70% for the passive transcutaneous and 77% with the adhesive device and at 0 dB SNR 50% for the passive transcutaneous and 48% with adhesive implant.

**Conclusion:** The new adhesive bone conduction system provides comparable auditory results with passive transcutaneous bone conduction implants in free field, in word discrimination in quiet, and word recognition with background noise. The overall satisfaction of the new adhesive device is good.

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**Control Number:** 2022-A-83-ACI

**Complete Status:** Complete

**Presentation Number:** 012

**Publishing Title:** MARS Sequences: A comparison of two generations of transcutaneous bone conduction implants

**Author Block:** Javier Gavilán, M.D.¹, Cristina Utrilla, MD², José Manuel Morales, MD¹, Pilar García-Rayà, MD², Luis Lassaletta, MD¹; ¹Otorhinolaryngology, La Paz Univ. Hosp., Madrid, Spain, ²Radiology, La Paz Univ. Hosp., Madrid, Spain.
Abstract Body:

**Introduction:** Analysis of head magnetic resonance images (MRI) of patients with active bone conduction implants (BCIs) is challenging. Currently, there are two generations of a transcutaneous system, the main difference between them being the transducer design and thickness. The aim was to compare the effect of transducer placement and artifact reduction sequences on legibility of MRI scans.

**Methods:** Four Thiel-fixed human head specimens were used: first generation implant was positioned in sinodural and middle fossa placement, and second generation in middle fossa and retrosigmoid approach. Images were obtained with a Signa® 1.5T MR. A metal artifact reduction sequence known as MAVRIC (multiacquisition variable-resonance image combination) was used. Each specimen was scanned using standard axial T2 SE and compared with axial MAVRIC artifact reduction sequences.

**Results:** Qualitatively, limits of the artifact produced by the implant were better defined with MAVRIC than with standard T2 sequences. Assessment of contralateral internal auditory canal (IAC) was possible in all cases. Placement of the second generation implant in the middle fossa allowed the view of the ipsilateral IAC using MAVRIC sequence. Quantitatively, the artifact was reduced with MAVRIC sequence from 6.3 to 59.7%, depending on the position of implant and model; the middle fossa placement and the second generation implant being those generating shorter artifact shadow.

**Conclusion:** Artifact optimized sequences as MAVRIC reduce the artifact caused by the transcutaneous bone conduction implant. The middle fossa approach allows a better visualization of IAC canal in the ipsilateral ear with both implant versions, but the effect is more prominent with the new generation of transcutaneous bone conduction implant.
application of automatic noise management aimed at improving listening in noise could benefit school-aged children. Specifically, the application of classifier-based noise management technology could benefit pediatric cochlear implant (CI) users; however, currently there is limited evidence available regarding the use of this technology in children with CIs. The main objective of this study is to examine the effect of a classifier-based noise management algorithm on speech perception in noise in children who use CIs and to compare the speech perception outcomes of pediatric CI recipients with their age-matched, typically-hearing peers.

Methods: Fifteen children (age 8-14 years) with bilateral CIs and fifteen age-matched, typically-hearing children will be recruited for this study. Speech perception outcomes will be measured using the AZBio Sentences in Noise test via a clinically-feasible testing method to compare performance in the omnidirectional listening mode and classifier-based automatic noise management mode for pediatric CI users. Ratings of listening ease and clarity will also be recorded to obtain subjective measures of benefit. Speech perception outcomes and subjective measures will be compared to a group of typically-hearing children to evaluate whether speech-in-noise performance is significantly different with and without the application of advanced noise management, and whether the application of advanced noise management improves listening ease.

Results: Preliminary data suggests that the application of classifier-based noise management algorithm will improve speech perception in noise. Additionally, although children with CIs demonstrate poorer speech-in-noise performance when compared to their typically-hearing peers, the provision of advanced noise management improves speech perception overall and performance approaches levels achieved by the typically-hearing children. Lastly, both listening ease and clarity are improved for speech-in-noise tasks when using the classifier-based noise management algorithm.

Conclusion: Evaluating the effectiveness of a classifier-based noise management algorithm in the pediatric population will provide evidence as to whether advanced noise management features should be activated in this population. Given the difficult listening environments children face, especially in the typical classroom setting while listening for learning, provision of advanced noise management technology may benefit children using CIs to improve understanding in adverse listening situations and improve listening ease.
Introduction: Research and clinical experience have shown that children who meet adult cochlear implant (CI) candidacy criteria (e.g., normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss) benefit from CI use. When these non-traditional pediatric CI recipients maintain residual hearing, they are fit with electric-acoustic stimulation (EAS). If residual hearing is lost, they are fit with traditional full electric stimulation (FES) programs. Studies with adult CI users have suggested that bimodal listeners may experience a degradation in speech recognition in the ear contralateral to the CI over time. The present report investigates individual ear changes in word recognition for children with pre-operative residual hearing who received a CI.

Methods: This report includes 13 pediatric CI recipients enrolled in a clinical trial investigating outcomes in children with pre-operative low-frequency hearing thresholds of 75 dB HL or better. Six participants were fit with EAS and wore a hearing aid (HA) on the contralateral ear (EAS + HA). Seven participants did not maintain enough acoustic hearing for EAS and were fit with FES maps. Three FES users listened with a contralateral CI (FES + FES) and 4 with a contralateral HA (FES + HA). All participants received their first CI in the poorer performing ear. Individual ear CNC word scores were measured pre-operatively and after 12-months of device use.

Results: Participants experienced significantly improved CNC word scores in the CI study ear after 12-months of device use as compared to pre-operative performance. Interestingly, 54% of the study sample (n = 7) had a significant increase in CNC word scores in the contralateral ear. One subject became a non-user of both devices, while the remaining 38% (n = 5) had no significant change in the contralateral ear. All FES + FES participants experienced significant growth in both ears. Of the EAS + HA and FES + HA participants, 40% experienced an improvement in word recognition that brought them from bilateral CI consideration pre-operatively to established bimodal listener 12-months later. Participants were more likely to experience a significant increase in contralateral ear word recognition if they had a > 20 percentage point pre-operative score asymmetry. Changes did not appear to be dependent on hearing preservation in the CI study ear. Increases in word recognition were likely not developmental considering pre-operative word recognition, the age of the participants, and their pre-operative spoken language skills.

Conclusion: Children with normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss demonstrated significant benefit after cochlear implantation regardless of hearing preservation. Unilateral cochlear implantation should
initially be considered for children with bilateral residual hearing, and the contralateral ear should be monitored for candidacy consideration.

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Control Number: 2022-A-87-ACI
Complete Status: Complete
Presentation Number: 126
Publishing Title: A Proposed Model for Cost-Effective Pediatric Cochlear Implantation in a Middle-Income Country

Author Block: Karissa LeClair, MD, Maria Pomponio, B.A, Héctor López de Nava Cobos, MD, Gonzalo Corvera-Behar, MD, José Juan Narváez Huerta, MD, Ramon Horcasitas Pous, MD, Roberto Mejía Pérez, MD, Mónica Liliana Moreno Yáñez, MD, Felicitos Santos Garza, MD, Elizabeth Plascencia Villegas, MD, Pedro R. Becerril-Pérez, MD, Perla B. Becerril-Ramírez, MD, Susan Emmett, MD, James E. Saunders, MD; 1Dartmouth Geisel Sch. of Med., Hanover, NH, 2Hosp. Regional de Alta Especialidad del Bajío, León, Mexico, 3Instituto Mexicano de Otología y Neurotología S.C.,, Ciudad de México, Mexico, 4Hosp. Regional de Alta Especialidad, Veracruz, Mexico, 5Hosp. Infantil del Estado de Chihuahua, Chihuahua, Mexico, 6Instituto Nacional de Enfermedades Respiratorias, Ciudad de Mexico, Mexico, 7Médecine Privada Nayarit, Tepic, Mexico, 8Servicios de Salud de Nayarit, Tepic, Mexico, 9Instituto Otológico Monterrey, Monterrey, Mexico, 10Médecine Privada Guadalajara, Guadalajara, Mexico, 11Duke Global Hlth. Inst., Durham, NC, 12Dartmouth-Hitchcock Med. Ctr., Lebanon, NH.

Introduction: Cochlear implantation has been shown to be cost-effective in both high-income and many low- and middle-income countries (LMIC). However, there are no studies that investigate how cost-effectiveness and access to care are affected by intra-country regional variation. Mexico is considered a middle-income nation, but one with profound socioeconomic variability between states. Given this background, we aimed to collaborate with a diverse network of hearing healthcare teams across Mexico in order to understand public and private healthcare access for patients in economically and geographically different regions. Using a state-specific approach to data analysis, our goal was to identify state and practice-specific factors that affect variability in cost-effectiveness and access to cochlear implantation across Mexico.

Methods: Data were collected by 8 CI centers and 3 non-CI-affiliated otolaryngologists serving children from 27 of 32 states in Mexico. Primary metrics were cost (implant, hospital, travel) and access data (provider numbers, barriers) for CI by state. A validated
analysis model was used to calculate a cost-effectiveness index (CER/GDP) for CI based on lifetime costs, disability-adjusted life years, and per-capita gross domestic product (GDP) for each state.

**Results:** Most providers (92%) ranked implant cost as the most significant patient barrier to CI access in their state [Mean Rank: 1.46 of 8], followed by rehabilitation costs [2.54] and geography [3.85]. Cochlear implantation was cost-effective (cost-effectiveness index < 3) across all eight implant centers, with cost-effectiveness index (CER/GDP) ranging from 0.50-1.53 by state. The cost-effectiveness index (CER/GDP) for each center was negatively correlated with the number of implants performed annually ($R^2 = .588, p = .026$) - i.e., centers performing more implants per year achieved a lower cost-effectiveness index. **Fig. 1b** illustrates the association between annual surgical volume and gross domestic product by state, as higher implant volume was correlated with higher GDP per capita for the state in which the implant center was located ($R^2 = .536, p = .039$). There was no correlation found between annual surgical volume and cost-effectiveness ratio (CER), as shown in **Fig. 1a** ($R^2 = .084, p = .487$).

**Conclusion:** CI is cost-effective across Mexico, however, this does not guarantee access to care. For many children, cost and access to care are still prohibitive on an individual basis. Our analysis demonstrated that the most cost-effective centers were those with high volume centers located in areas with higher GDP. This suggests a model for CI in middle-income countries with implantation performed at a small number of high-volume centers augmented by expansion of local speech therapy and audiology resources to provide post-implant rehabilitation close to home.

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**Control Number:** 2022-A-88-ACI

**Complete Status:** Complete

**Presentation Number:** 113

**Publishing Title:** We Programmed Cochlear Implants in the Snow, Up Hill Both Ways: The legacy of early cochlear implants and what we’ve learned.

**Author Block:**

Jolie C. Fainberg, AuD\(^1\), Lisa Tonokawa-Marcacci, M.S.\(^2\);

\(^1\)Atlanta Institute for ENT/Atlanta Children's ENT, Alpharetta, GA, \(^2\)Jean Weingarten Children's Ctr., Redwood City, CA.

**Abstract Body:**

Since the first patients received a cochlear implant more than 40 years ago, there have been many changes in the world of CIs. Behind the ear and single unit devices have replaced body worn speech processors, performance standards and expectations
have increased and candidates who used to be considered “borderline” are now candidates. Programming software has become more automated and easier. While this is helpful in reducing clinical service time, there is a danger in the quick and easy method of programming. Understanding the basics of programming is essential in effectively working with CI patients, particularly when there is a programming or performance issue. The purpose of this presentation is to review how our legacy experience has shaped what we know and how we use CIs today. We will present some tips from the trenches from a historic and present-day perspective.

**Methods:** With over seventy years of combined cochlear implant experience, the authors started their CI career with single channel implants. In the past, we had to understand and be able to manipulate the parameters of the programming software manually. As the internal and external devices, programming strategies, and software changed, performance results and our expectations changed. We utilized our patient experience and evidence-based practices to make changes to our protocols and procedures.

**Results:** Understanding where we came from is essential to get us to the future. We have to be flexible to change with the times. Our ability to use our clinical knowledge has resulted in better CIs and better results. The newer generations of CI audiologists need to have the basics of the CI and mapping functions even as we get more automated.

**Conclusion:** Cochlear Implants continue to improve and will continue to improve indefinitely. We could not have imagined CIs today when we started in the 1980s. With a respectful nod to the past, we venture into the future.

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**Control Number:** 2022-A-89-ACI

**Complete Status:** Complete

**Presentation Number:** 146

**Publishing Title:** Beliefs and attitudes about Deaf education among families of children with cochlear implants

**Author Block:**

Ananya Uliyar, n/a\(^1\), Sherise Epstein, MD/MPH\(^2\), David Horn, MD\(^3\);

\(^1\)Otolaryngology - Prosthetic Auditory Development Lab, Univ. of Washington Med. Ctr., Seattle, WA, \(^2\)Otolaryngology, Univ. of Washington Med. Ctr., Seattle, WA, \(^3\)Otolaryngology - Prosthetic Auditory Development Lab, Univ. of Washington Med. Ctr., Seattle Children’s, Seattle, WA.

**Abstract Body:**

**Introduction:** Parental beliefs and attitudes about Deafness inform their decisions about communication methods, medical devices, and educational strategies for their children
who are Deaf or hard of hearing (CD/HH). This could present a barrier to clinicians, early interventionists, and educators in communicating evidence-based language intervention options for families of CD/HH children who use a cochlear implant (CI). This study aims to determine if beliefs and attitudes toward Deaf education of parents of CD/HH children who use CIs differ from parents of CD/HH children without CIs. Another aim is to determine if parental beliefs and attitudes differ based on language intervention among children with CIs. We hypothesize that parents of CD/HH with CIs will have more positive beliefs and attitudes toward oral/aural education compared to parents of CD/HH without CIs. A second hypothesis is that parents who chose language interventions that include American Sign Language (ASL) will have more positive beliefs toward visual language.

**Methods:** Data were obtained from the Gallaudet Research Institute Early Education Longitudinal Study (EELS) which evaluated speech and language development of 3-5-year-old children with a pure-tone average hearing threshold of 60 dB+ in the better ear and no severe cognitive impairment. We extracted communication methods used by CD/HH with CIs and scores for the parental Beliefs and Attitudes about Deaf Education (BADE) scale and the Letter Say/Sign and Write (LSSW) scale. The BADE scale contains 26 statements within 4 subscales (ss): (1) Literacy through hearing technologies, (2) Difficulties for hearing parents to learn ASL (3) Listening and spoken language, and (4) Visual language and bilingualism. The LSSW tests a child's ability to say or fingerspell and then write the letters of the alphabet with speed and accuracy. We used T-tests to compare mean scale scores by group.

**Results:** We identified 64 and 151 children with and without CIs, respectively. BADE scores differed between groups only for ss3 (2.97≈“neutral” non-CI vs. 3.71≈“agree” CI), with the CI group reporting more positive beliefs about supplemental oral/aural language. Among the five communication subgroups for children with CIs, we found 15 participants were bimodal bilingual, 5 use sign language only, 20 use spoken language only, and 24 either using sign supported spoken language or speech with cues. BADE scores differed by communication subgroup for ss2 with non-ASL groups reporting more negative views of ASL. There were no significant differences in mean LSSW scale between CI and non-CI groups or between communication subgroups. Further analysis of these data is ongoing.

**Conclusion:** These data show that positive views of hearing technology and negative views of ASL are more prevalent in parents who chose a CI and non-ASL language modality respectively. Despite these findings, the parental beliefs and attitudes reported here are highly variable and heterogenous. Limitations include the small sample size, inability to establish causality, and a likely overrepresentation of the Deaf perspective in this sample that is more familiar with Deaf culture relative to the general population.
Preoperative Imaging of Temporoparietal Scalp Thickness Predicts Off-The-Ear Sound Processor Retention in Cochlear Implants with Diametric Magnets

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Introduction: Recent MRI-conditioned diametric magnets offer less attraction force than axial magnets, and off-the-ear sound processors require higher attraction force for adequate retention. As such, some patients who have diametric magnets are unable to retain their preferred off-the-ear sound processor. Clinically, retention events have been observed much more frequently since the introduction of these two technologies. The purpose of this study is to determine if temporoparietal scalp thickness assessed via preoperative imaging predicts retention events in patients who have cochlear implants with diametric magnets and various sound processor types.

Methods: Data was retrospectively collected from 143 patients with Cochlear Nucleus CI600 series internal devices. Temporoparietal scalp thickness was measured by preoperative imaging. Demographic variables such as age and body mass index were collected. Retention events were divided in three categories: (1) Patient could not retain the device at all requiring processor exchange; (2) Patient could not retain the device at initial activation but later could (after being fit with loaner device and/or using alternative means of retention; e.g., headband); and (3) Patient could retain the device, albeit tenuously. These retention events were associated with skin flap thickness.

Results: Of 42 patients with the most recent generation off-the-ear sound processor (OTE2), 13 (31.0%) had retention events. Of patients with a temporoparietal scalp thickness <8 mm, all patients could ultimately retain the device, though 1 of 26 was noted to have tenuous retention. Of patients with 8-10 mm skin flaps, 3 of 6 (50%) could not retain the device, and with >10 mm skin flaps, 7 of 10 (70%) could not retain the device. In the >10 mm group, 2 additional patients could not either retain the device at initial activation or were noted to have tenuous retention. Of 124 patients with behind-the-ear (BTE) sound processors, only 2 (1.6%) could not retain the device at initial activation, and 3 (2.4%) exhibited tenuous retention after three months of device use.

Conclusion: Temporoparietal scalp thickness measured by preoperative imaging is associated with processor retention for patients with the OTE2 sound processor and diametric magnets. All patients with <8 mm scalp thickness could retain the OTE2, while 50% of patients with 8-10 mm scalp thickness and 70% with >10 mm scalp thickness could not retain the device. Patients should be counseled regarding their sound
Introduction: Cochlear implantation has been shown to benefit patients with single sided deafness (SSD) and the FDA has approved one cochlear implant system for treatment of SSD and asymmetric hearing loss. Our study reviews improvement in speech perception to sentence testing in quiet and noise along with single word testing to the implanted ear. We also aimed to determine if the length of deafness and etiology of hearing loss impacted improvements in speech perception.

Methods: Adult patients with hearing within normal limits in the opposite ear, as defined by hearing thresholds from 0dB to 25dB, who had a cochlear implant in the opposite ear were reviewed. Thirty-two total patients were identified and included in our review. AzBIO testing in quiet, +10 signal to noise ratio, and +5 signal to noise ratio were tested bilaterally pre and post implantation. Additionally, CNC testing was completed for the ear to be implanted pre and post implantation, while the non-CI ear was plugged with an EAR 15 earplug and muffed with a circumaural headphone. Etiology of hearing loss and length of deafness was also evaluated.

Results: There was an improvement in pre and post AzBIO testing for the quiet and +10 signal to noise ratio conditions but this improvement was not statistically significant. There was a statistically significant improvement post implantation for the +5 signal to noise testing and for the CNC testing. Length of deafness ranged from less than one year to more than seven years. There was not a significant difference in outcomes related to length of deafness. Cause of deafness also did not relate to a difference in outcomes.

Conclusion: Cochlear implantation as a treatment for single sided deafness has been shown to improve speech perception in noise and in single words presented to the implanted ear, only. Etiology of hearing loss and length of deafness did not have an
impact on speech outcomes. Cochlear implantation is a viable treatment option for individuals with single sided deafness.

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Control Number: 2022-A-92-ACI

Complete Status: Complete

Presentation Number: CS9-2.5

Publishing Title: Further Evidence for Individual Ear Consideration in Cochlear Implant Candidacy Evaluation

Author Block: Ankita Patro, MD, MS, Nathan Lindquist, MD, Jourdan Holder, Aud, PhD, Kareem Tawfik, MD, David Haynes, MD, René Gifford, PhD, Elizabeth Perkins, MD; Department of Otolaryngology, Vanderbilt Univ., Nashville, TN.

Abstract Body: Introduction: Asymmetric hearing loss (AHL) is a more recent indication for cochlear implantation (CI). Here, we report speech and quality of life outcomes after CI for AHL and assess the influence of contralateral hearing on these outcomes.

Methods: This is a retrospective review of 168 adults undergoing CI for AHL from 2015-2020 at a tertiary referral center. AHL candidacy included pure-tone average (PTA) ≥ 70 dB HL and AzBio in quiet < 60% in the implanted ear and AzBio in quiet > 40% in the contralateral ear. The main outcome measures were CNC and AzBio scores as well as speech, spatial and qualities of hearing scale (SSQ-12).

Results: Mean preoperative PTA and AzBio in the implanted and contralateral ears were 85 and 67 dB HL and 22% and 69%, respectively. Average CNC in the implanted ear increased from 17% preoperatively to 45% (p<0.0001) at 6 months and 49% (p<0.0001) at 12 months. Mean AzBio in the implanted ear improved from 22% preoperatively to 60% (p<0.0001) at 6 months and 64% (p<0.0001) at 12 months. AHL patients demonstrated significant improvement in all SSQ-12 domains at 6 and 12 months. When comparing patients with preoperative contralateral AzBio above 60% versus 41-60%, no significant differences existed in postoperative CNC scores in the implanted ear (6-month: 47% vs. 41%, p=0.08; 12-month: 50% vs. 46%, p=0.25). There were also no significant differences in 6-month (p=0.36) or 12-month (p=0.87) CNC scores in the implanted ear between AHL patients and 212 unilateral CI patients with preoperative contralateral AzBio ≤ 40%.

Conclusion: CI recipients for AHL derive significant speech and quality of life improvements, supporting individual ear consideration for CI candidacy and patient benefit outside of current Medicare criteria.
**A Five-Year Update on the Profile of Adults Undergoing Cochlear Implant Evaluation and Surgery - Are We Doing Better?**

**Ankita Patro, MD, MS**, Nathan Lindquist, MD, Jourdan Holder, Aud, PhD, René Gifford, PhD, Elizabeth Perkins, MD; Department of Otolaryngology, Vanderbilt Univ., Nashville, TN.

**Introduction:** This study aims to characterize the influence of expanding indications on the profile of adults undergoing cochlear implantation (CI) at a high-volume CI center.

**Methods:** This is a retrospective review of 774 adults undergoing CI evaluation from 2015-2020 at a tertiary referral center. Main outcome measures were demographics and preoperative audiometry and speech recognition (CNC and AzBio) scores.

**Results:** Of 741 (95.7%) patients qualifying for implantation, 642 (86.6%) pursued surgery. Mean age at evaluation was 65.4 years; 53.2% were male; 88.2% were white. Average distance to our center was 107 miles. The majority (61.4%) had public insurance (e.g., Medicare, Medicaid), followed by private (38.2%) and military (0.4%). Mean CNC, AzBio, and pure-tone averages for the ear to be implanted were 13%, 17%, and 77 dB HL, respectively. 479 patients (64.6%) met Hybrid/EAS criteria, and 438 (56.6%) had aidable hearing in the better hearing ear for a bimodal hearing configuration. Age (OR 0.96; 95% CI 0.93-0.92) and white race (OR 7.01; 95% CI 3.25-15.12) predicted CI candidacy. Likelihood of surgery increased for white (OR 8.94; 95% CI 5.57-14.34) and married (OR 2.12; 95% CI 1.45-3.09) patients and decreased for those with public insurance (OR 0.34; 95% CI 0.22-0.51).

**Conclusion:** Despite expansions in criteria, speech understanding at CI evaluation remains extremely low. Compared to 2013-2015, a larger percentage met Hybrid/EAS criteria (25.4% vs. 64.6%), and a smaller percentage had bimodal hearing (72.1% vs. 56.6%). Younger age and white race predicted candidacy while white, married patients with private insurance were more likely to pursue surgery.
Introduction: While video education has been used in other specialties to decrease patient anxiety and increase knowledge, the role of videos for cochlear implant (CI) patients, who already struggle with social deprivation and communication during traditional office visits, has yet to be explored. This study aims to evaluate video education's effects on patient knowledge and attitudes related to CI.

Methods: Using a prospective, provider-blinded, randomized-controlled trial, 56 adult CI candidates were enrolled in the study between 2020 and 2021 at a tertiary referral center. Following initial consultation with the surgeon and audiologist, patients were randomized into either the video (n=28) or control (n=28) group. Both groups completed five surveys: (1) prior to arrival; (2) after initial consultation; (3) on the day of surgery; (4) at the 1-month postoperative visit; and (5) at the 3-month postoperative visit. Video group participants viewed a 15-minute video on the CI process prior to completing the second survey. Main outcome measures were patient knowledge and attitudes.

Results: There were no significant differences in age (p=0.83), gender (p=0.79), race (p=0.33), education level (p=0.58), income (p=0.17), time to surgery (p=0.88), or baseline knowledge (p=0.08) between the video and control groups. Video group participants had significantly higher knowledge scores after initial consultation (83% vs. 67%, p<0.001) and at 1 month post-op (80% vs. 70%, p=0.02). On the day of surgery, a higher percentage of the video group (87%) felt fully confident in pursuing implantation compared to the control group (58%) (p=0.02). Nearly half of the video group reported that the videos directly influenced their decision to proceed with CI surgery. Average rating for the videos was 9.2 out of 10.

Conclusion: Video supplementation to the traditional CI process improved patient understanding at multiple timepoints and significantly increased confidence in pursuing surgery.
Introduction: A review of the research evidence on the literacy achievement of deaf students with cochlear implants indicates a significant positive shift from the historically poor outcomes reported for this population. Findings indicate that the majority performs at a level commensurate with hearing age peers, obtaining scores within the low average to average range on standardized assessments. However, despite these encouraging findings and the growing numbers of children being implanted bilaterally often in the first year of life, the research evidence on literacy outcomes for this cohort remains relatively limited. This study of cochlear implant users is part of a broader investigation of literacy achievement of deaf students in grades 4 through 12 conducted in a large school board in central Canada. The focus is on the following research questions: 1) How does the literacy achievement of school-aged deaf learners with cochlear implants compare to: a) age-based norms? b) deaf learners who use other hearing technologies? c) deaf learners with unilateral losses? and 2) How do demographic variables (e.g., Categories of Auditory Performance ratings (CAP, Archbold et al., 1995), additional disabilities, home language) impact outcomes?

Methods: Participants include 13 students with cochlear implants (n=3 unilateral, n=10 bilateral sequential) educated in inclusive settings who represent a subset of a larger participant pool (N=74). Participants’ teachers completed a questionnaire to document students’ demographic information and provided ratings for the CAP index (Archbold et al., 1995). Measures included subtests that comprise the Basic Reading (BR) (i.e., Letter-word Identification, Word Attack) and Reading Comprehension (RC) (i.e., Reading Vocabulary, Passage Comprehension) clusters of the Woodcock-Johnson III Diagnostic Reading Battery [WJ III-DRB] (Woodcock et al., 2004) and the two subtests from the Spontaneous Writing (SW) composite (i.e., Contextual Conventions, Story Composition) of the Test of Written Language-Fourth Edition (TOWL-4, Hammill & Larsen, 2009). Study measures were individually administered to participants in testing sessions lasting approximately 60- to 90-minutes.

Results: Preliminary findings point to reading achievement in the average to low average range, with mean standard scores indicating slightly better performance on measures of BR as compared to RC. There was no significant difference in performance between the
students who wore hearing aids and those with cochlear implants. However, students with unilateral losses or BAHAs outperformed both groups on the BR subtest, but only those with hearing aids on the RC cluster. Indications are that CAP ratings and home language impacted performance on the RC, but not the BR cluster. The mean standard score on the SW composite suggests performance in the above average range for the CI users, although scores for participants with unilateral loss and those without additional disabilities were statistically significantly higher.

**Conclusion:** As growing numbers of deaf children are able to develop age-appropriate language via cochlear implants, studies of literacy development are essential to establish the extent to which children are achieving age-appropriate literacy outcomes. These data will be necessary to create an evidence base for informing pedagogical practice and educational policy.

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**Control Number:** 2022-A-99-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-2.3

**Publishing Title:** Clinical Feasibility of the Spatial Words in Noise Test to Measure Binaural Device Benefit for Patients with Single Sided Deafness

**Author Block:** Charlotte Morse-Fortier, AuD, Elizabeth Doney, AuD, Julie Arenberg, PhD; Audiology, Massachusetts Eye and Ear, Boston, MA.

**Introduction:** Patients with single sided deafness (SSD) have impaired binaural hearing, which leads to increased difficulty with hearing in noise and sound localization. The potential to improve binaural hearing is one of the main appeals of cochlear implants (CI) as a treatment for SSD. Many clinical trials supporting CI for SSD show substantial improvements in localization and binaural hearing (such as speech in noise). However, due to logistical barriers, it is relatively rare to test binaural hearing in most clinical settings. For SSD patients, selecting a hearing device is very challenging, especially when some options involve surgery (such as CI and bone anchored devices). A tool that facilitates individual counseling would be very helpful. We investigated the clinical feasibility of using the Words in Noise (WIN) test with different spatial configurations, with and without devices, to inform decision making regarding device selection for SSD patients.

**Methods:** 46 patients with SSD performed the WIN as part of their clinical visits (40 adults aged 24-76, 6 children aged 10-16). Patients were tested both aided and unaided.
in three configurations: speech and noise collocated, speech front and noise at 90° to the 
right, speech front and noise at 90° to the left. From these six conditions, binaural 
summation, binaural squelch, head shadow, and spatial release from masking can be 
calculated. Ten patients were tested with a bone anchored hearing device, 28 were 
tested with a contralateral re-routing device, 4 were tested with a CI, and 4 (who had 
some residual hearing in the SSD ear) were tested with a conventional hearing aid. Due 
to clinical time constraints or patient fatigue, not all patients completed all conditions. 

**Results:** The WIN takes about 2.5 minutes per list to administer and provides valuable 
information about individual performance and device benefit for binaural hearing. It is 
relatively easy to implement in standard clinical audiology booths, as it only requires two 
sound field speakers 90°apart. Our pilot data suggests that bone anchored hearing device 
use led to a moderate improvement for only one condition (head shadow). Despite a 
small sample size, our SSD CI users showed a significant binaural hearing improvement in 
spatial release from masking and a moderate improvement on head shadow. In this pilot, 
neither conventional hearing aids nor re-routing devices were found to lead to significant 
benefit on any of the tasks in the WIN. These results are globally consistent with the 
literature on the benefits and limitations of these devices for SSD users. 

**Conclusion:** The spatial WIN is a feasible clinical measure which allows for the estimation 
of individual performance on binaural hearing tasks. As most audiology clinics have the 
necessary testing equipment, it could be quickly and widely implemented. WIN results 
can be used acutely to compare devices and help guide a patient through a complicated 
decision regarding how best to address their communication goals. The WIN also 
provides concrete examples of when a given device is or is not helpful. Thus far, the 
group data is promising, and our team hopes to develop criteria for individual patients 
about what constitutes a meaningful benefit or change on the WIN. Its use as a 
longitudinal outcome measure of binaural hearing improvement in SSD CI users is also 
promising and bears further exploration.

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**Control Number:** 2022-A-101-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS7-2.3  
**Publishing Title:** Electrocochleography and Cognition are Important Predictors of Speech Perception Outcomes in Noise for Cochlear Implant Recipients
Amit Walia, MD, Matthew Shew, MD, Cameron Wick, MD, Nedim Durakovic, MD, Shannon Lefler, AuD, Amanda Ortmann, MD, Jacques Herzog, MD, Craig Buchman, MD; Otolaryngology - Head and Neck Surgery, Washington Univ. in St. Louis, St. Louis, MO.

**Introduction:** The wide variability in cochlear implant (CI) performance makes it challenging to counsel patients on realistic expectations prior to implantation. Recognizing factors that affect CI performance at a preoperative candidacy level may have significant implications on post-CI aural rehabilitation, device design and fitting, and surgical technique. Recently, electrocochleography (ECochG) has been repurposed from a Meniere’s disease diagnostic application to investigating its role in improving CI outcomes. A single measure of residual cochlear function, ECochG total response (ECochG-TR), can be calculated by summing response amplitudes to the tonal stimuli of different frequencies across the speech spectrum. The ECochG-TR can explain just under half of the variance (47%) of postoperative CI speech-perception performance in quiet testing measures. For perspective, this is better than all of the traditional demographic, audiometric, and surgical factors combined. Two major limitations of previous studies utilizing ECochG-TR are: (1) the work has never been replicated/validated outside of the original study institution, and (2) there has been a focus on predicting performance in quiet rather than performance in background noise, a more realistic measure of natural listening.

**Methods:** Thirty-five patients underwent cochlear implantation and were seen at their 3-month postoperative visit for audiologic testing and ECochG recordings. Prior work has shown that ECochG responses do not diminish even when residual hearing is lost. Acoustically-evoked ECochG potentials were measured from the electrode array itself. A frequency sweep (250 Hz - 2 kHz) was performed followed by a fast Fourier transformation to determine the amplitude of the 1st, 2nd, and 3rd harmonics, which comprise the ECochG-TR. Speech perception testing was performed at candidacy determination and at 3 months using CNC, AzBio in Quiet, and AzBio +10 dB SNR. Cognition was assessed by the Montreal Cognitive Assessment (MoCA) score.

**Results:** There was a strong linear correlation between ECochG-TR and 3-month performance of AzBio in quiet ($r = 0.71, p < 0.0001$) and CNC ($r = 0.77, p < 0.0001$). A multivariable linear regression model including electrode type, hybrid stimulation, duration of severe-to-profound hearing loss, and ECochG-TR did not perform significantly better than ECochG-TR alone in explaining the variability in AzBio in Quiet and CNC scores. There were moderate linear correlations between AzBio +10 dB SNR with ECochG-TR ($r = 0.59, p < 0.001$) and MoCA ($r = 0.58, p < 0.001$). Multivariate modeling using ECochG-TR and MoCA scores explained 60.0% of the variability in AzBio +10 dB SNR scores.

**Conclusion:** As previously reported and validated within this study, ECochG-TR independently explains a large portion of the variance in speech-perception outcomes in quiet among adult CI recipients. Performance in noise is more complex. ECochG-TR alone independently explains only 34% of the variability of performance in noise. However, combining ECochG-TR with a measure of cognition (i.e., MoCA) explains 60% of this variability. Thus, ECochG-TR, a measure of the cochlear-neural substrate, is necessary but
not sufficient for explaining performance in noise. Rather, a cognitive measure is also needed to improve prediction of performance in noise.

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**Control Number:** 2022-A-102-ACI

**Complete Status:** Complete

**Presentation Number:** 168

**Publishing Title:** Effect of Increased Daily Cochlear Implant Use on Auditory Perception in Adults

**Author Block:** Jourdan T. Holder, AuD, PhD, René Gifford, PhD; Hearing and Speech Sciences, Vanderbilt Univ., Nashville, TN.

**Abstract Body:**

**Introduction:** Despite the recommendation for cochlear implant (CI) processor use during all waking hours, variability in average daily wear time remains high. Previous work has shown that objective wear time is significantly correlated with speech recognition outcomes. We aimed to investigate the causal link between daily wear time and speech recognition outcomes. We hypothesized that increased CI use would result in improved speech recognition.

**Methods:** Twenty adult CI recipients completed two study visits. The baseline visit included auditory perception testing (speech recognition and spectral processing measures), questionnaire administration, and documentation of data logging from the CI software. Participants watched an educational video, and they were informed of the compensation schedule. Participants were then asked to increase their daily CI use over a 4-week period during everyday life. Baseline measures were reassessed following the 4-week period.

**Results:** Seventeen out of 20 participants increased their daily CI use. On average, participants’ speech recognition improved by 3.0, 2.4, and 7.0 percentage points per hour of increased average daily CI use for consonant-nucleus-consonant words, AzBio sentences, and AzBio sentences in noise, respectively. Questionnaire scores were similar between visits. Spectral processing showed significant improvement and accounted for a small amount of variance in the change in speech recognition values.

**Conclusion:** Improved consistency of processor use over a 4-week period yielded significant improvements in speech recognition scores. Though a significant factor, spectral processing is likely not the only mechanism driving improvement in speech recognition; further research is warranted.
Abstract Body:

Introduction: Cochlear implants (CI) are substantially underutilized in part, due to a lack of clarity regarding audiological referral criteria for CI candidacy evaluation (CICE). Screening tools have recently been proposed to assist in determining appropriate referrals. However, these screening tools vary, and their generalizability is unclear. This study attempts to validate multiple proposed screening tools using data from a novel, cloud-based CI data capture platform.

Methods: A retrospective cohort study of adults who underwent CICE was performed. Data included 248 subjects with available pure tone audiometry and word recognition testing who underwent routine CICE testing. Five recently published screening tools for CICE referral, based on unaided pure tone average (PTA) and word recognition scores (WRS), were assessed for their ability to identify patients who met candidacy criteria, defined by private insurance (best-aided AzBio +10 SNR ≤ 60%) and Medicare criteria (PTA 0.5, 1, and 2 kHz ≥ 40 dB HL, best-aided AzBio +10 SNR ≤ 40%).

Results: The study cohort had a mean better ear PTA of 63 dB HL (± 21 dB HL), WRS 38% (± 26%), best-aided AzBio in quiet of 50% (± 30%), AzBio +10 SNR of 42% (± 28%), and CNC score of 39% (± 21%) at presentation. One hundred seventy-four (70%) and 88 (51%) patients met CI criteria for private insurance and Medicare, respectively. Screening criteria of the five published CICE referral tools varied across PTA and WRS. The sensitivities and specificities of these referral tools for private insurance criteria varied from 39% to 76% and 23% to 84%, respectively. Their positive predictive values (PPV) and negative predictive values (NPV) ranged from 57% to 85% and 15% to 51%, respectively. When screened by Medicare insurance criteria, sensitivities and specificities varied from 41% to 81% and 25% to 89%, respectively. PPV and NPV ranged from 36% to 80% and 29% to 73%, respectively. The screening tool proposed by Zwolan et al. demonstrated the best performance with the validation cohort for both private insurance (Youdan’s J 0.34, sensitivity 61%, specificity 73%) and Medicare criteria (Youdan’s J 0.41, sensitivity 65%, specificity 76%). Gubbels et al. had the best agreement with the validation cohort for...
private insurance criteria (Kappa 0.32) and Zwolan et al. had the best agreement for Medicare insurance criteria (Kappa 0.41). All screening tools performed worse on the external validation cohort relative to their respective development cohorts.

**Conclusion:** Current tools for determining CICE referral have diverse screening criteria. These combinations of PTA and unaided word recognition testing are only modestly successful at identifying CI candidates.

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**Control Number:** 2022-A-107-ACI

**Complete Status:** Complete

**Presentation Number:** CS5-1.5

**Publishing Title:** Stapedius reflex measurements in free sound field as a corrector for over- and under-stimulation in cochlear implant listeners

**Author Block:**

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**Introduction:** One of the most challenging aspects of rehabilitation after cochlear implantation is estimating the optimal electrical dynamic range of the cochlear implant (CI) system. A common procedure in clinical routine is the determination of the electrical dynamic range using psychoacoustic methods. This might result in under- or overstimulation. Both can be avoided by applying stapedius reflex measurements using acoustic stimuli in free sound field or direct electrical stimuli of single electrodes. Müller-Deile & Hey (2016) proposed to measure the acoustic stapedius reflex threshold using acoustic stimulation in free sound field. In their approach electrical dynamic range should be adjusted such that the acoustic reflex thresholds were between 70 and 90dB HL, similar to reflex thresholds in normal-hearing subjects. It is open to question whether fitting based on psychoacoustic measurements alone will result in reflex thresholds in the target range. Thus, first objective of this study was to determine the acoustical stapedius reflex thresholds of patients who had been fitted based on psychoacoustic measurements. The second aim of the study was to investigate whether speech understanding can be improved when the map, which was fitted based on psychoacoustic measurements, is replaced by a reflex-based map.

**Methods:** 50 CI user (N=57 ears) participated in this study. All patients had at least ten
months experience with their CI, were supplied with MED-EL CI systems, had at least one functioning middle ear for stapedius reflex detection, and had been fitted based on psychoacoustic measurements. Acoustical stapedius reflex measurement via the cochlear implant systems was performed with the activated used map, that had been used in daily life of the patients. For a subgroup, the used map was modified based on reflex measurement. In this process, the maximum of the electrical dynamic range of the used map was replaced by the electrically evoked stapedius reflex threshold. All other parameter of the map remained unchanged. Speech audiometric measurements were performed with the used map and with the reflex based map (instantaneous and after habituation).

**Results:** Twenty percent of the participants revealed acoustical reflex thresholds, below 70db HL and were classified as overstimulated. In ten percent of the participants no reflex was detectable with the used map, but reflexes were detectable after increasing the electrical dynamic range. They were classified as understimulated. Seventy percent of the patients revealed reflex thresholds in the target range of 70-90 dB HL and were classified as adequate stimulated. Speech recognition was found to be statistically significant better with reflex based maps compared to the used maps. The improvement of speech recognition score amounts to ten percentage points.

**Conclusion:** For cochlear implant fitting, stapedius reflex measurement should be performed to avoid over- or understimulation. Patients can benefit from stapedius reflex measurement by means of speech understanding.

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**Control Number:** 2022-A-108-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-3.2

**Publishing Title:** CI Audiology Billing Practices: The Bottom Line

**Author Block:**

Melissa Hall, AuD¹, Sandra M. Prentiss, PhD², Jennifer Coto, PhD³, Teresa A. Zwolan, PhD⁴, Meredith A. Holcomb, AuD²;

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**Abstract Body:**

Introduction: Cochlear implantation is well-established as the standard of care treatment for significant hearing loss in pediatric and adult populations. In the quest to provide a
multi-disciplinary approach to optimizing hearing outcomes for cochlear implant (CI) recipients, what is less well known is how to adequately bill and code for the services provided (Mohr et al. 2000; McKinnon 2013). The authors wanted to better understand trends related to CI billing and coding to help shed light on barriers to reimbursement for CI related services. The purpose of this study was (1) to assess the knowledge level of CI audiologists on topics relating to billing for CI services; (2) to examine the procedure codes used by CI audiologists when billing for CI services to determine if the NCCI edits were being followed; and (3) to investigate the amount of training CI audiologists received on the topic of billing and reimbursement. Efficient billing and coding for CI related service delivery is a relevant topic for all audiologists and program directors regardless of work setting.

**Methods:** The study involved a 48-question survey which was electronically distributed to and completed by audiologists who bill for CI services. Demographic data was collected, along with exposure to billing education. Information that was also collected included which codes and modifiers audiologists used to bill for commonly performed CI procedures.

**Results:** Data were obtained from 96 audiologists. While the majority (86.3%, n = 82) of respondents agreed or strongly agreed they understand billing and coding practices, half of the respondents (51.1%, n = 48) reported unfamiliarity with national billing guidelines. Wide variability was observed for various billing scenarios. Billing questions were presented, and answers were coded as correct or incorrect based on the NCCI edits. Only 16.8% (n = 16) of respondents reported receiving formal training for practice management, while 94.7% (n = 89) rated themselves as somewhat to highly efficient when performing billing practices.

**Conclusion:** Wide variation in billing practices was observed. Identifying barriers to efficient billing of CI audiology related services is critical to optimizing practice management. Incorporating practice management and current billing education into daily practice and into audiology training programs is essential to clinic efficiency, practice management, and CI program sustainability. Disparities in service delivery are also possible because of variance in billing and protocol structure surrounding reimbursement. Improving the accuracy and efficiency of billing practices is beneficial to avoid payment denials, which could negatively impact patients and to receive adequate reimbursement for the services provided.
Abstract Body:

Introduction: Cochlear implant and ossiointegrated surgery provides a way for pediatric patients with severe-to-profound single sided deafness (SSD) to access binaural hearing. The purpose of this investigation was to review our multi-disciplinary program. Our program consists of Audiology, Otolaryngology, Psychology, Therapy Services, and Social Work. We collaborate with patients' school districts and other various service providers to help achieve improved auditory benefit and outcomes.

Methods: A retrospective case review from a tertiary pediatric (<18 years) hospital with SSD. Speech perception testing, data usage, listening effort, self-report questionnaires, and language acquisition represent the main outcome measures.

Results: The mean age at cochlear implantation was 8 years (range 1.5 years to 14.5 years) and *** for ossiointegration. Speech perception results vary dependent on age. Improvements in speech perception observed from baseline to post activation of device in implanted ear.

Conclusion: Cochlear and ossiointegrated surgery is a viable treatment option for pediatric SSD. Open-set speech and improvement in background noise can be achieved. Thorough counseling prior to surgery and throughout follow up post-surgery appointments on expectations is vital to achieving successful outcomes.
Introduction: Growth of the Internet as an information resource has provided expanded opportunities for families to easily gather information. The Pew Research Center reported that 72% of mothers sought medical information on the Web during the timeframe March-May 2021. Internet use is highest among those 18-49. While utilization is slightly lower among certain groups (lower socio-economic and education), it is still above 75% across race, income and education. Among wired parents, 61% had made use of governmental websites. State Early Hearing Detection and Intervention (EHDI) websites are an important opportunity for families seeking information on options for their children who have been identified as deaf or hard of hearing.

Methods: A review was conducted of the 50 state and DC websites to assess whether essential need-to-know data was provided clearly, comprehensively, and without bias on: hearing loss basics, technology and communication options, and resources for family support. The content reviewed is specifically identified in the 2017 EHDI legislation, which states that “Information provided to families should be accurate, comprehensive, up-to-date, and evidence-based, as appropriate, to allow families to make important decisions for their children in a timely manner, including decisions with respect to the full range of assistive hearing technologies and communications modalities, as appropriate.” The website review was conducted between August and September 2021. The key data items were reviewed and rated as being comprehensive, somewhat helpful, or inadequate.

Results: Of the 51 sites, 26% were rated as “comprehensive”, 35% as “somewhat helpful”, and 39% as “inadequate” (which included four state websites that were not operational). Websites rated as comprehensive had thoroughly explored all of the key information items and often included videos or links to other resources. Somewhat helpful sites typically were lacking in some of the information parents seek. Sites that were rated as inadequate included little or none of the information that is a statutory requirement of the EHDI law. The outcomes of the review of the 51 websites will be published as an advocacy tool for parents and others.

Conclusion: Parents need timely information to make informed decisions regarding the early needs of their children with hearing loss. The Internet is increasingly a key source of health information for parents. While some states have utilized their EHDI website to effectively provide information to parents, the majority of such sites fall short. Paper resources are an alternative means of offering information but the Web provides an opportunity to support families that can be easily updated, widely disseminated, and offered in various formats. Future advocacy by parents and professionals could address the deficiencies in their state websites as an effective and efficient vehicle for information dissemination.
**Introduction:** Although Usher syndrome is the leading genetic cause of deafblindness, in the past, it was often ignored by professionals due to its rarity, a misunderstanding of deafblindness, and the lack of treatments and support for those with Usher syndrome. Today, Usher syndrome can be diagnosed through genetic testing at birth, parents can easily access information on Usher syndrome and find a community of support. While early cochlear implantation is an established treatment for deafness, there was little available for the vision issues. Today, patients can look to multiple treatments to mitigate vision loss which will be available within the next years. In this presentation, we will review the treatments that are currently in clinical trials.

**Methods:** Years ago if a child was diagnosed with Usher syndrome, it was assumed that they would learn sign language, go to a school or program designed for those with hearing and vision loss, learn Braille and communicate through Tactile Sign, a form of physical sign language. That is no longer the only outcome available. Children with Usher syndrome can learn to hear and speak like their peers, attend mainstream schools, participate in typical activities, succeed in the upper level grades with little intervention, attend college and maintain productive lives.

Early cochlear implantation and habilitation methods such as auditory-verbal therapy allow the child with Usher syndrome is learn to listen and speak. For vision loss, there are several clinical trials are currently taking place that will directly affect patients with Usher syndrome. These include drug development, RNA therapies, and cell therapies. There is more preclinical work being done for vision loss due to Usher syndrome than ever before. Because of success with other retinal diseases, the likelihood of these same treatments being available to those with Usher syndrome within in the next ten years is high. In the future, gene therapy, optogenic treatment, and CRISPR technology will be available to patients with Usher syndrome.

**Results:** The successful use of cochlear implants has diminished the effect of hearing loss for individuals with Usher syndrome. Vision loss still presents difficulties for those individuals. There are promising clinical trials in process that could reduce the effect of vision loss as well.
**Conclusion:** Early diagnosis is critical for children with Usher syndrome. While there is currently no cure, the best treatment involves early identification so that habilitation, educational programs, and cochlear implantation or hearing aids can begin as soon as possible. Early, bilateral cochlear implantation is an effective treatment for children with severe to profound hearing loss. While current clinical trials for vision loss are still in the investigative stages, the results so far are promising. Resources available today allow families and children with Usher syndrome to learn about their challenges, connect with people, participate in research and clinical trials or promising treatments, and most importantly, hope for something to prevent the complete loss of vision caused by Usher syndrome.

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**Control Number:** 2022-A-112-ACI

**Complete Status:** Complete

**Presentation Number:** CS1-1.4

**Publishing Title:** Barriers to implantation in children with single-sided deafness

**Author Block:** Kimberly Fiorentino, Au.D.¹, Andrea Warner-Czyz, Ph.D.¹, Sarah Crow, B.S.¹, Shari Kwon, Au.D.¹, Jacob Hunter, M.D.²;
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**Introduction:** Limited data exist on outcomes for children with single-sided deafness (SSD) with a cochlear implant (CI). Previous research shows children with SSD are 10 times more likely to repeat a grade in school and have trouble with speech recognition in noise and sound localization. Historically, audiologic management for children with SSD involved assistive technology such as contralateral-routing-of-signal hearing aids or bone conduction devices. While these provide some benefit for children with SSD, they do not mediate permanent changes in the auditory cortex caused by auditory deprivation. In contrast, a CI can provide auditory stimulation to avoid negative effects of auditory deprivation. In 2019, the FDA approved CI for those with SSD age 5 years and older. Researchers have shown significant benefits (e.g., improved speech recognition in quiet and noise, better sound localization, increased quality of life) in children with SSD who wear CI versus other (or no) auditory technologies. However, children with SSD and their families face barriers that may detract from pursuing a CI. This preliminary study explores potential barriers to CI in children with SSD based on clinical data.
**Methods:** This study involves a clinical case review of 20 children with SSD (i.e., profound hearing loss in one ear with limited benefit from hearing aids and typical hearing/mild sensorineural hearing loss in the contralateral ear), approximately half of whom received a CI. Most (75%) participants had congenital hearing loss with pre-implant speech recognition <30% correct. One-half have atypical anatomy (e.g., ossification, nerve hypoplasia) confirmed via imaging. One-half of participants used public health insurance. Variables of interest related to the decision to implant a child with SSD included demographic characteristics (e.g., age, hearing loss, etiology), insurance type (private vs. public), communication skills (e.g., speech recognition pre- and post-CI), and datalogging (i.e., daily device use in hours/day).

**Results:** Families of children with SSD had higher rates of pursuing CI for children with younger chronologic age (i.e., 75% vs. 20% for <6 years vs. >6 years, respectively) and private vs. public insurance (56% vs. 33%). Post-implantation, datalogging revealed the child implanted at the oldest age wore the device the least (1.6 hours per day) and the child with the highest speech recognition scores post-CI wore the device the most (9.2 hours per day) compared to the overall mean daily device use of 5 hours per day. All children implanted in preschool/early elementary school (4-5 years of age) showed better attention and more vocalizations post-CI compared post- vs. pre-CI.

**Conclusion:** Beyond meeting audiometric criteria, age at implantation and patient insurance are associated with whether children with SSD get implanted. Professionals working with this population should understand not only when to refer, but also how to counsel families with potential barriers to pursuing CI for children with SSD.

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**Control Number:** 2022-A-114-ACI

**Complete Status:** Complete

**Presentation Number:** 073

**Publishing Title:** Word Recognition or Sentence Recognition? Differential Relations of Auditory and Cognitive Functions to Speech Recognition Tasks

**Author Block:** Aaron C. Moberly, MD, Kara J. Schneider, AuD, Terrin N. Tamati, PhD; Otolaryngology, The Ohio State Univ., Columbus, OH.

**Introduction:** Clinical testing for assessing adult cochlear implant (CI) candidacy and outcomes relies primarily on speech recognition tasks in the audiology booth. However, emphasis is shifting from using sentence recognition materials to isolated word recognition materials. Some studies have even suggested that word testing may be
“superior” to sentence testing in determining CI candidacy and measuring long-term outcomes (Perkins et al., 2021; Sladen et al., 2017). That argument is based on the finding that sentence testing typically results in ceiling effects earlier than word testing after implantation. However, the central premise of the current study is that concerns other than ceiling effects after implantation should be considered when determining the speech recognition measures to use in evaluating CI performance in the clinic and in the research lab. Two main hypotheses were tested in a group of experienced adult CI users: (1) speech recognition scores would not all be broadly correlated across testing of recognition of isolated words, meaningful sentences, nonsense sentences, sentences with high talker variability, and sentences in multi-talker babble; and (2) auditory and cognitive functions would contribute differentially to performance on the different speech recognition measures.

Methods: Data were collected cross-sectionally from 65 experienced adult CI users. Speech recognition performance was measured using isolated words (CID-W22 words), meaningful sentences (Harvard Standard), nonsense sentences (Harvard Anomalous), sentences with high talker variability (PRESTO), and sentences in multi-talker babble (AzBio). A battery of auditory and cognitive tests was also completed to assess spectro-temporal processing, vocabulary size, working memory capacity, inhibition-concentration, nonverbal reasoning, and speed of lexical access. Correlation and logistic mixed-effects modeling analyses were performed.

Results: Partially consistent with our first hypothesis, speech recognition scores were only moderately correlated across some measures ($r = 0.58$ between sentences in babble versus sentences in quiet), while others were more strongly correlated ($r = 0.89$ between nonsense sentences and high talker variability sentences). Partially consistent with our second hypothesis, spectro-temporal processing and nonverbal reasoning predicted speech recognition scores across all word and sentence tests. In contrast, inhibition-concentration predicted only isolated word and meaningful sentence recognition scores. Lexical access speed predicted performance on all speech measures except sentences in babble.

Conclusion: Not all speech tests are equivalent in adult CI users. That is, some tests rely more heavily on specific auditory and cognitive functions than others. Additionally, there appear to be a core set of auditory and cognitive functions that contribute to general speech recognition abilities. These findings have implications for the choice of speech recognition measures to apply in the clinic for evaluating CI candidacy and outcomes, beyond just concern for identifying measures that do not suffer from ceiling effects.
Abstract Body:

INTRODUCTION: 466 million people worldwide (34 million of which are children), suffer from disabling hearing loss (WHO statement 2018). While the majority of patients with moderate to severe hearing loss can be supplied with conventional hearing aids, some patients may benefit more from implantable hearing devices such as the active transcutaneous bone conduction implant presented here. METHODS: The Systematic Review was performed using the guidelines available from the Cochrane Collaboration to identify all publications on the only available active transcutaneous bone conduction device, namely Bonebridge BCI601 (MED-EL). Subgroup analysis and sensitivity analysis was performed to test the stability of the results in meta-analysis. Separate random effect models were fitted to outcome variables of mean functional gain (FG), mean benefit in word recognition score at 65dB (WRS) with separate models fitted for subgroups of hearing loss types: CHL, MHL, SSD or combinations thereof. The follow up dependent complications incidence rate in person years were calculated for adverse events. RESULTS: This systematic review comprises of 39 citations comprising of 487 subjects: 303 CHL, 67 MHL and 53 SSD (for the remaining numbers no details regarding hearing loss were stated). The mean age was 35.6±16.9, ranging from 5 years up to 80 years of age. The via meta-analysis weighted overall FG exhibited a mean of 30.89 dB SPL [95%CI 27.53, 34.24]. Various kinds of speech tests were used and the meta-analysis outcomes for reported mean word recognition scores at 65 dB SPL resulted in an improvement of 56.73% for the 57 CHL subjects [95%CI 45.52, 67.94]. Outcomes were similar in the C/MHL subjects, reported in 3 studies comprising of 31 subjects (mean WRS improvement 55.14%) [95%CI 21.67, 88.68]. Outcomes in children (≤18 years) were reported in eleven publications. For children the average functional gain was 34 dB for 77 implantations and the average aided sound field threshold reported was close to normal hearing with the Bonebridge (i.e., 24 dB HL for 67 implants). 25 publications out of the 39 identified citations reported on complications, out of which 90.6%, explicitly stated that no complications occurred. In total 286 ears were evaluated for safety outcomes over a mean follow up period of 11.7±4.5 months, resulting in persons-years, the actual time-at-risk in years per person, of 148.9. CONCLUSION: Substantial and stable benefit for all implanted patients was shown. A mean weighted word recognition score benefit of 52.1% was achieved with the Bonebridge. SSD subjects still performed well, but not as high as the other hearing loss types (38.3% WRS Improvement). Most benefit was
reported for the CHL group with 56.7%. Speech understanding in noise also improved significantly. The devices’ transcutaneous technology results in an incidence rate of one in 148.9 person-years. Other, passive bone conduction devices, such as the percutaneous BAHA- and Ponto- system (Cochlear, Oticon, respectively) or the transcutaneous Sophono- and Baha Attract (Medtronic, Cochlear respectively) options still have to battle high complications rates. Based on the audiological outcomes, the high patient satisfaction as well as the low complication rate the authors recommend the Bonebridge as first line treatment for patients suffering from hearing loss within the devices’ indication criteria.

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Control Number: 2022-A-117-ACI
Complete Status: Complete
Presentation Number: 071
Publishing Title: Clinical Feasibility of Objective Measurements with Active Middle Ear Implants

Astrid Magele, PD Dr., Philipp Schoerg, BSc., Georg M. Sprinzl, Univ.-Prof. Dr.; Department of Otorhinolaryngology, Head&Neck Surgery, Univ. clinic St. Poelten, St. Poelten, Austria.

**Introduction:** The Vibrant Soundbridge (VSB) is a widely used active Middle Ear Implant to treat mild to severe sensorineural as well as mixed hearing loss. Depending on the type of hearing loss, the floating mass transducer (FMT) is surgically coupled to the short process (SP) of the incus, the long process (LP) of the incus, the stapes head (SH coupler or CLIP coupler), the round window (RW) membrane, or the oval window (OW). Energy transfer from the FMT to the inner ear depends on the coupling efficiency. Therefore, a reliable method to monitor the coupling efficiency intraoperatively is highly desired. Research groups have developed several methods, but limitations remain. This study aims to evaluate the clinical feasibility of a new research setup for auditory brainstem response (ABR) measurement to evaluate the coupling efficiency.

**Methods:** During surgery intra-op VSB-evoked ABR thresholds using the new tool for directly stimulation were recorded. The ABR thresholds were compared to pre-op bone conduction (BC) thresholds and post-op Vibrogram thresholds to evaluate feasibility of the method as a tool to monitor coupling efficiency.

**Results:** 14 subjects (6 female, 8 male) older than 18 years, inside indication criteria for the VSB, with stable BC threshold and absence of active middle ear infections, were
enrolled. The mean age was 50 ± 20 years, ranging from 25 to 89 years. The subjects had conductive- (CHL; n = 1), mixed- (MHL; n = 10) or sensorineural hearing loss (SNHL; n = 3). VSB implantations using the VORP503 implant (9 left, 5 right) were performed with different vibroplasty techniques (8 RW, 3 incus LP, 2 Clip coupler on stapes head, 1 incus SP). The mean pre-op BC threshold average at 1, 2 and 4 kHz (PTA3) was 47 dB HL, the mean intra-op ABR threshold was 54 dB, and the mean post-op vibrogram PTA3 was 60 dB HL. ABR was measurable in all subjects using the new tool. Correlation between pre-op BC thresholds and intra-op ABR thresholds was statistically significant, however one outlier was present.

**Conclusion:** The ABR threshold measurement with the new AcoustiAP device is feasible and reproducible. The first results correlate well with pre-op BC and post-op vibrogram thresholds. Good comparability between pre-op BC and intra-op ABR thresholds enables evaluation of coupling efficiency. Intra-op hearing threshold detection through ABR and direct stimulation of the VSB implant was reliable using this new tool.
threshold, where slope is defined as the steepness of this linear extrapolation of the AGF. In animal models it is suggested, that the slope of the ECAP AGF represents the number of responding auditory neurons. Other studies have shown, that the ECAP threshold is affected by the distance between the stimulating electrode and the excitable part of the neurons. The apical part of the cochlear is narrower, thus the distance between stimulating electrode and auditory neurons shorter. Our first hypothesis was that contacts located in the more apical region of the cochlea would have greater slopes than contacts located in the middle or basal regions. The second hypothesis was that the slope would be stable over time. If so, slope recordings measured at any point in time, even as early as during surgery, could be included for longitudinal monitoring of neural excitability. The present dataset may also be used as a baseline for exploring slope over time in clinical practice.

**Methods:** During the routine CI procedure at one single ENT clinic 14 patients agreed to participate in the study. Two of them, who were bilaterally (sequentially) implanted, contributed both sides. Therefore, recordings of 16 ears were available at one or more different points in time.

Included were only patients who had received an implant from one single, for technical reasons selected manufacturer.

13 electrodes were inserted via round window, 3 using cochleostomy.

ECAPs were recorded from all electrodes and slopes determined (a) intraoperatively, after implantation and wound suture (OP), (b) at initial activation (IA), (c) 3 months (III) and (d) 6 months (VI) after initial activation.

**Results:** Due to patient availability, not all 16 ears could be measured at all 4 points in time. A dependence of the slope on the electrode position was visible and statistically significant: At the three electrode contacts at the apical end of the array, the slope is greater compared to the medial and basal region of the cochlea. Different surgical inserting methods had no significant effects on the slope models.

**Conclusion:** The three most apical electrode contacts show higher slopes of ECAP AGFs (first hypothesis fulfilled). ECAP slopes do not change between surgery and initial activation but increase after initial activation (second hypothesis not fulfilled although the effect is smaller compared to the electrode position effect). In the long run, we believe that the systematic longitudinal collection of electrophysiological responses like AGF slope over time might provide useful information about the status of the nerve fibers and, crucially, a change in status. To that end, the slope parameter could potentially have clinical diagnostic relevance in the future.

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**Control Number:** 2022-A-119-ACI
Introduction: Several variables have been shown to affect post-operative speech recognition performance in adults with cochlear implants (CIs), including frequency-to-place mismatch between the electrode array and the estimated spiral ganglion frequency map. However, previous studies report mixed findings regarding the association between these variables. In addition, post-operative quality of life outcomes are important to consider, and are often not related to post-operative speech recognition scores thereby representing a unique outcome measure. The present study evaluated the effect of frequency-to-place mismatch on early measures of post-operative speech recognition and quality of life.

Methods: Using retrospective review of a prospectively maintained database, data from 133 adults (≥18 years) with peri- and post-lingual hearing loss who received unilateral CIs were included in the study. Patients were implanted with a variety of electrode arrays from three cochlear implant manufacturers, and revision surgeries were excluded. We examined the relationship between frequency-to-place mismatch estimates based on semitones differences (Canfarotta et al., 2020) with speech recognition scores and cochlear implant quality of life (CIQOL-35 Profile) measures assessed at 3-, 6- or 12-months post-activation.

Results: Across all patients, the average frequency-to-place mismatch based on semitone difference was -8.79, (ranging from -40.87 - 4.30). Results show no significant relationship between frequency-to-place mismatch and post-operative word or sentence recognition at any interval post-activation. However, frequency-to-place mismatch was significantly correlated with CIQOL-35 Profile domain scores. Early post-activation time intervals demonstrated lower CIQOL-35 Profile scores with greater frequency-to-place mismatch. In addition, age at implantation was correlated with post-operative measures of word recognition at 3- and 6-months post-activation, and with measures of sentence recognition at all three post-operative intervals suggesting better post-operative speech recognition scores in younger patients.

Conclusion: In contrast to some previous studies, post-operative speech recognition scores during the first year of CI use were not related to the estimated frequency-to-place mismatch in adult CI users. The patient population used was drawn from a wider variety of implant manufacturers and electrode array designs, which could help to account for the discrepancy observed here in comparison to previous studies which examined a more homogenous dataset. However, data from the CIQOL-35 Profile suggest
that patient-perceived device experience is related to frequency-to-place mismatch, for early time points post-activation. Further work is needed to better understand this relationship.

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Control Number: 2022-A-120-ACI

Complete Status: Complete

Presentation Number: 105

Publishing Title: A novel method of identifying inner ear malformation types

Author Block: Anandhan Dhanasingh, PhD¹, Abdulrahman Hagr, MBBS FRCS², Peter Roland, MD³, Vincent Van Rompaey, MD, PhD⁴, Paul van de Heyning, MD, PhD⁴;

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Abstract Body:

Introduction: Identification of the inner ear malformation types from radiographs is a complex process. We hypothesize that each inner ear anatomical type has a uniqueness in its appearance in radiographs.

Methods: The outer contour of the inner ear was captured from the mid-modiolar section, perpendicular to the oblique-coronal plane, from which the A-value was determined from CT scans with different inner ear anatomical types.

Results: The mean A-value of normal anatomy (NA) and enlarged vestibular aqueduct syndrome (EVAS) anatomical types was greater than for Incomplete Partition (IP) type I, II, III and cochlear hypoplasia. The outer contour of the cochlear portion within the mid-modiolar section of NA and EVAS resembles the side view of Aladdin’s lamp; IP type I resembles the side-view of the Sphinx pyramid and type II a Pomeranian dog’s face. The steep spiraling cochlear turns of IP type III resemble an Auger screw tip. Drawing a line parallel to the posterior margin of internal auditory canal in axial-view, bisecting the cavity into cochlear and vestibular portions, identifies common-cavity; whereas a cavity that falls under the straight-line leaving no cochlear portion identifies cochlear aplasia.

Conclusion: An atlas of the outer contour of seventy-eight inner ears was created for the identification of the inner malformation types precisely.

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Abstract Body:

Introduction: Older adults with late-onset hearing loss are at risk for cognitive decline. Our study addresses the question of whether cochlear implantation (CI) can counteract this potential influence. We investigated whether cognitive performance in older adults with severe and profound hearing loss improves 12 months after CI to a level comparable to controls with normal hearing, matched for age, sex, and education level.

Methods: This cohort study was performed at two tertiary referral centers. The study included 29 patients, of age between 60 and 80 years, with adult-onset, severe to profound bilateral sensorineural hearing loss and indication for CI (study group), as well as 29 volunteers with age-adjusted hearing abilities, according to the norm curves of ISO-7029:2000-01, (control group). Before CI and 12 months after CI, participants completed a neurocognitive test battery including tests of global cognition, verbal and figural episodic memory, and executive functions (attentional control, inhibition, and cognitive flexibility).

Results: Twelve months after CI, the performance of the study group improved significantly in global cognition (Clock Drawing Test), compared to the situation before CI. Differences in verbal episodic memory (CERAD-Word Lists Learning and Recall), figural episodic memory (CERAD- Constructional Praxis and Recall), and executive function (Stroop Test, Trail Making Test) were not significant. Moreover, the improvement of the study group was significantly larger only in global cognition compared to the control group. Non inferiority tests on the cognitive performances of the study group after CI revealed that comparable levels to normal hearing controls were reached only in global cognition, figural episodic memory (immediate recall), and attentional control. The improvement in global cognition was significantly associated with speech recognition 3 months after CI, but not with speech recognition 12 months after CI.

Conclusion: One year after CI, cognitive deficits in older individuals with adult-onset hearing loss, compared to normal-hearing peers, could only improve some cognitive
skills. Results, equivalent to those of normal-hearing peers, were observed in cognitive tasks, requiring planning, coordination, and attentional control. Performance in cognitive tasks, focusing on delayed recall, verbal retrieval, inhibition, and cognitive flexibility remained inferior in the group of CI recipients.

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Control Number: 2022-A-122-ACI

Complete Status: Complete

Presentation Number: CS10-3.4

Publishing Title: Adapting to the sound of music - development of music discrimination skills in recently implanted cochlear implant users

Alberte B. Seeberg, MSc¹, Anne Sofie F. Andersen, MD¹, Andreas Højlund, Ph.D.², Niels T. Haumann, Ph.D.¹, Kathleen Faulkner, Ph.D.³, Elvira Brattico, Ph.D., Professor¹, Peter Vuust, Ph.D., Professor¹, Bjørn Petersen, Ph.D.¹;

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Abstract Body:

Introduction: Considerable advances have been made in the cochlear implant (CI) technology with regard to speech perception in quiet conditions. However, CIs remain poor in conveying music, especially pitch, melody, and timbre. Here, we investigated early development of discrimination of music in recently implanted CI users (CIre).

Methods: The CIre group was tested twice, 1) shortly after activation of the implant (T1) and 2) approximately 3 months after T1 (T2). Electroencephalography (EEG) was deployed to record mismatch negativity (MMN) responses, using a recently validated musical multifeature paradigm. The deviants in this paradigm vary in feature (intensity, pitch, timbre, and rhythm) at four levels of magnitude (small, medium, large, and extra-large) adding to a total of 16 deviant variants. Additionally, participants completed a behavioral test, consisting of a 3-alternative forced choice music discrimination task, containing the same deviant variants as the MMN-paradigm. For reference, a group of experienced CI users (CIex) and a group of normal hearing (NH) controls were tested once.

Results: While no significant MMN responses were found at T1, CIre showed significant MMN responses for the timbre and pitch deviants at T2. This reflected a significant progress in the neural discrimination of these particular deviants. In their behavioral
discrimination, CIre scored above chance level at both times of testing for all features, but significantly below the NH reference for all features except rhythm. Both CI groups scored significantly below the NH group in discrimination of pitch. The CIre group’s behavioral discrimination showed no significant progress, suggesting that the early development is more clearly reflected neurophysiologically.

**Conclusion:** Cochlear implant users show early adaptation to spectral features of music neurally, but not behaviorally, after just three months of experience.

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**Control Number:** 2022-A-123-ACI

**Complete Status:** Complete

**Presentation Number:** 002

**Publishing Title:** Flap failure in Syndromic patient

**Author Block:** Khalid M. Badr, consultant

**Introduction:** Bartter syndrome (BS) represents a group of autosomal recessive salt-losing nephropathy, characterized by hypokalemic metabolic alkalosis with normal or low blood pressure. Hearing defect is a feature of BS Type IV and is typically absent in BS I, II, or III. Cochlear implantation was performed at the age of 16 months with excellent postoperative audiometric results and improvement in speech performance. Flap failure was happened as complication and managed in stepwise manner and excellent outcome achieved.

**Methods:** We report the case of a 1-year-girl with bilateral severe to profound sensory deafness who diagnosed with BS Type III in the neonatal period. Her deafness was noted at 5 months. She used hearing aids regularly for 1 year with very limited benefit; an aided visual reinforcement audiometry test resulted in a reading of only 55 dB. Flap failure happen as complication and managed in stepwise manner and excellent outcome achieved.

**Results:** Cochlear implantation was performed at the age of 16 months with excellent postoperative audiometric results and improvement in speech performance

**Conclusion:** Immediate action and close monitor for flap failure post cochlear implant patient give favorable outcome
**Abstract Body:**

**Introduction:** Temperament, individual differences in reactivity and self-regulation, is a core contributor to both personality development and social outcomes in children. The influence of auditory deprivation on the development of temperament has not been explored. The aims of the present study were to: Investigate if temperament differs between normal hearing and deaf/hard-of-hearing toddlers, and evaluate the impact of temperament on executive functioning skills, the self-regulation of cognition and emotion.

**Methods:** The present study reported on broad measures of temperament in deaf/hard-of-hearing toddlers (N = 15) as compared to age-matched, normal hearing controls (N = 14). Parents completed the short form of the Early Childhood Behavior Questionnaire (ECBQ) temperament scale, which has strong psychometrics, including internal consistency, test-retest reliability, and construct validity. The scale is comprised of subscales, including Activity Level/Energy, Attentional Focusing, Attentional Shifting, Cuddliness, Discomfort, Fear, Frustration, High Intensity Pleasure, Impulsivity, Inhibitory Control, Low Intensity Pleasure, Motor Activation, Perceptual Sensitivity, Positive Anticipation, Sadness, Shyness, Sociability, and Soothability. These specific subscales can then be collapsed to form the composite scores of Effortful Processing, Negative Affect, and Surgency.

**Results:** Results indicate that deaf/hard-of-hearing toddlers, as compared to their hearing peers, were rated by parents as experiencing greater problems in areas of attentional focusing, attentional shifting, frustration, inhibitory control, perceptual sensitivity, and positive anticipation. Interestingly, the Negative Affect and Surgency subscales did not differ amongst the groups. However, the Effortful Control subscale, which is a composite of attentional focusing, attentional shifting, cuddliness, inhibition control, and low-intensity pleasure, did differ amongst the deaf/hard-of-hearing toddlers and their normal hearing peers, suggesting that children with pediatric hearing loss display early disturbances in social, emotional, and behavioral adjustment in areas closely related to executive functioning skills. Furthermore, greater Effortful Control was associated with
lower levels of *Negative Affect* in the hearing sample, replicating previous work (Bridgett et al., 2013), but this association was not present in the deaf/hard-of-hearing sample.

**Conclusion:** These findings suggest that executive functioning skills may explain some of the individual differences observed in the development and expression of temperament. Further research should investigate if the ECBQ is clinically relevant for identifying deaf toddlers who may be at high risk for long-term executive dysfunction. Additionally, through the monitoring of temperament at the clinical level, more personalized intervention strategies and treatment methods can be employed to each child, allowing for optimal outcomes.

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**Control Number:** 2022-A-127-ACI

**Complete Status:** Complete

**Presentation Number:** CS10-1.3

**Publishing Title:** Cochlear Implantation Outcomes in Patients with Retrocochlear Pathology: A Systematic Review

**Author Block:** Jamie Schlacter, BS¹, Emily Kay-Rivest, MD, MSc², Joseph Nicholson, MLIS³, J. Thomas Roland, Jr., MD²;


**Introduction:** Retrocochlear pathologies including vestibular schwannomas, superficial siderosis, neurosarcoidosis, intracranial malignancy, as well as previous radiation exposure can lead to significant hearing impairment and a decrease in quality of life. The aim of the current study was to summarize outcomes following cochlear implantation (CI) in the context of retrocochlear pathologies. The primary outcome evaluated was speech discrimination scores between 6 months and 1 year after implantation. Secondary outcomes included CI daily usage, rates of tinnitus suppression, and outcome comparisons of irradiated tumors to non-radiated tumors.

**Methods:** A systematic search of databases PubMed/MEDLINE, Embase and Cochrane CENTRAL via Ovid, CINAHL Complete via Ebsco, and Web of Science was performed through September 1st, 2021. Search strategies were developed iteratively by a librarian experienced in systematic reviews. The searches included both keywords and subject headings to maximize retrieval and reflect the two main concepts: cochlear implants AND retrocochlear pathologies. Patients with previous surgery for their vestibular schwannoma were excluded.
Results: 2396 abstracts were screened against inclusion criteria and 51 studies were included from 15 countries, with individual data available for 156 adult patient cases with a minimum follow-up of 6 months. Pathologies included were vestibular schwannoma (58.3%), superficial siderosis (20.5%), neurosarcoidosis (7.1%), and malignancy/radiation (13.5%). The average patient age was 52.5 years (SD: 16.1). Among all patients, the average pre-operative CNC word score was 7.25% (SD: 13.2), and the average post-operative score was 44.4% (SD: 25.4). The CNC word scores (pre-op mean [SD]; post-op mean [SD]) for each individual pathology were: vestibular schwannoma (6% [12.2]; 43.1% [22.8]), superficial siderosis (13.3% [19.2]; 43.6% [21]), neurosarcoidosis (13% [7.1]; 89.5% [3]), and malignancy/radiation (1.6% [3.6]; 36% [29.5]). The average CNC post-operative word scores for irradiated and non-radiated vestibular schwannomas were 44.4% (SD: 20.8) and 41.8% (SD: 25.3) respectively. For cases without vestibular schwannomas but with prior brain or skull base radiation, the average post-operative CNC word score was 30% (SD: 30.2). 29 cases had promontory stimulation done prior to CI and 28 of those cases showed positive responses. These patients on average had a post-operative CNC word score of 53.1% (SD: 13.1). 39% of reported patients were daily CI users. 7 cases among 156 eventually resulted in CI explantation. Tinnitus suppression was rarely reported but appeared to be more variable in patients with vestibular schwannomas. Overall, 79% of cases reported a functional benefit after cochlear implantation.

Conclusion: A systematic review of current literature suggests that cochlear implantation in patients with concomitant retrocochlear pathology generally results in improved speech discrimination scores that are sustained over time. A large majority of implanted patients derived benefit, although more investigation is needed to determine what factors might predict lower rates of daily usage.

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Control Number: 2022-A-130-ACI

Complete Status: Complete

Presentation Number: CS7-2.5

Publishing Title: The Cochlear Implant Quality of Life-Expectation Instrument (CIQOL-Expectation): Enabling Evidence-Based Expectations Discussions

Theodore R. McRackan, MD, MSCR, Brittany N. Hand, PhD, Shreya Chidarala, BS, Craig A. Velozo, PhD, Judy R. Dubno, PhD;

1Med. Univ. of South Carolina, Charleston, SC, 2The Ohio State Univ., Columbus, OH.
Abstract Body:

**Introduction:** For patients who meet audiological criteria, previous research suggests that clinicians view realistic patient expectations as the most important factor in proceeding with cochlear implantation. However, clinicians have little data to gauge whether patients’ expectations are realistic so are forced to rely on their personal experiences to drive discussions on potential real-world outcomes after implantation. The current study aims to address this important and unmet clinical need through the development and psychometric analysis of a new patient-reported outcome measure, the CIQOL-Expectation.

**Methods:** A team consisting of two CI audiologists, a CI surgeon, a hearing scientist, and two psychometricians with experience in instrument development converted all items from the CIQOL-35 Profile instrument into statements reflecting expected outcomes. Then, 20 adults who were undergoing CI evaluations participated in cognitive interviews to ensure the clarity and comprehensiveness of the new instrument. Finally, responses to the CIQOL-Expectation instrument for 131 potential adult CI users were psychometrically analyzed using confirmatory factor analysis and item response theory (IRT).

**Results:** There were no major content or grammar changes identified during the cognitive interviews, but two participants recommended instruction clarification, which was completed. Overall, all CIQOL domains (communication, emotional, entertainment, environment, listening effort, and social) demonstrated adequate to strong psychometric properties. Several domains did not meet all a-priori established indicators of model fit or ability to separate CI users based on response patterns, but all met the majority of indicators. Potential CI users demonstrated the highest expectation scores (scale: 0[low]-100[high]) for the environment (70.2 +/- 20.8) and social (68.4 +/- 18.0) domains. In addition, the entertainment (15.3%) and environment (24.4%) domains had the highest percentage of patients with expectation scores of 100. Yet, normative CIQOL-35 Profile data from experienced CI users suggest few patients obtain this high degree of functional benefit after implantation (entertainment 7.9%; environment 4.0%).

**Conclusion:** The development of the CIQOL-Expectation instrument provides an opportunity to measure potential CI users’ expected outcomes using an established patient-centered framework. The included items and domains reflect real-world functional abilities valued by CI users and provides opportunities for an evidence-based shared decision-making approach to the CI evaluation process. Here, clinicians can compare individual patients’ pre-CI outcome expectations to established normative data and provide appropriate counseling.
Abstract Body:

Introduction: Some children who use hearing aids need modifications their intervention, such as cochlear implantation, to minimize persistent delays in spoken language. Pediatric providers consider many factors (e.g., audiologic, medical, family-related) when determining whether a child is a candidate for a cochlear implant (CI), but providers may face uncertainty when a child is a borderline candidate for a CI. Less consideration has been given to audibility (i.e., a child’s access to speech through their hearing aids) as an indicator of whether a child needs changes to their hearing technology. This study examines audibility (i.e., aided SII [Speech Intelligibility Index]) as a predictor of language delay in children who are hard of hearing (CHH) who use hearing aids.

Methods: Participants included 182 school-age CHH who wore hearing aids (better-ear pure-tone average: 21-77 dB HL) and 78 children with typical hearing who were matched for age and socioeconomic status. We collected hearing aid measurements (e.g., aided SII), assessed aided speech perception (PBK words in quiet, CASPA words in noise), and measured spoken language ability (receptive vocabulary: PPVT-4, syntax: CASL Syntax Construction, and pragmatics: CASL Pragmatic Judgement). Statistical analysis included advanced regression (generalized additive models) to examine relationships between communication outcomes and audibility. Regression lines were used to identify the level of aided audibility where children with hearing loss fell 1.5 standard deviations below the children with typical hearing.

Results: Aided audibility predicted global language ability (composite score of language measures) after controlling for age at intervention, socioeconomic status, and child age. The regression analysis identified aided SII = .61 (95% confidence interval [.53, .68]) as the level of audibility associated with risk of spoken language delay. Variation in speech recognition scores did not estimate values associated with delay.

Conclusion: Children with hearing aids who have an aided SII less than .53 are at significant risk for spoken language difficulties without modifications to intervention. Children in the .53 - .68 range are at an elevated risk and should be closely monitored. Pediatric audiologists should measure aided SII in children with hearing aids, in conjunction with other candidacy tools, when considering changes to their intervention, such referral for CI candidacy evaluation.
**Introduction:** Hearing loss (HL) is a low incidence disability with significant public health ramifications (U.S. Dept of Ed, 1992). Children with HL are at risk for delays in vocabulary development due to auditory deprivation early in development, significantly impacting their early reading skills (Lund, 2015). Children with HL who are impacted by poverty may be at further risk for developmental delays as they may lack the same exposure to detailed and rich vocabulary input, or to interventions as higher SES peers (Sacks et al., 2013). This can limit their achievement, even with appropriate auditory access. Interactive reading techniques (IRT) have been shown to promote vocabulary development of at-risk children and provide a framework to engage in conversations with a child that extend beyond the explicit printed text (Valdez-Menchaca & Whitehurst, 1992; Wasik & Bond, 2001). The Intensive Literacy Enrichment Activities for Diverse Backgrounds (I-LEAD) project was designed to meet the needs of children with HL from diverse and socioeconomically marginalized backgrounds and specifically focused on the use of IRT to improve receptive and expressive vocabulary and literacy skills.

**Methods:** Twenty-nine students with HL between the ages of 5-10, including those who use hearing aids and CIs participated in the three-week, intensive intervention over three summers. Informal measures designed specifically for the intervention were used to assess students’ ability to identify, label and define target vocabulary pre- and post-intervention. Between 10-20 tier-two vocabulary words were selected for vocabulary instruction yearly. Picture books with diverse characters and stories were selected for use with IRT, which targeted two to three vocabulary words each day, providing multiple opportunities for exposure to target vocabulary. Experiential project-based activities were used to reinforce vocabulary learning.

**Results:** Analyses demonstrated growth in receptive vocabulary, varying outcomes in expressive vocabulary, and an increase in the ability to define words for older children. In year 3, a Wilcoxon signed rank test was conducted to examine the change between pre- and post-intervention scores for the labeling and identification tasks. Paired-t tests were used to examine students’ ability to define vocabulary words. A statistically significant increase in the participants’ ability to identify (p=0.01) and label (p=0.00) target vocabulary were observed. There was a general, but not significant, increase in participants’ ability to define target vocabulary. Further analyses will examine outcomes...
over three years, including the trajectory of a subset of children with CIs.

**Conclusion:** Results suggest that IRT may improve vocabulary skills in children with HL from diverse and marginalized backgrounds. These techniques provide multiple exposures to vocabulary for at-risk-children with literacy delays.

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**Control Number:** 2022-A-133-ACI

**Complete Status:** Complete

**Presentation Number:** CS3-2.2

**Publishing Title:** Socialization and Support: Group aural habilitation for infants, toddlers, and parents

**Author Block:** Michelle Albera, MS, CCC-SLP, TSHH, Samantha Morgan, Doctor of Audiology; Audiology, WIHD/WMC, Valhalla, NY.

**Abstract Body:**

**Introduction:** Introduction: Frequent and consistent habilitative support is required for infant and toddler cochlear implant recipients in order to meet speech-language and hearing milestones. Provision of habilitation in a group format offers the added benefit of socialization for not only the patients, but parents as well, who may be looking for peer support during a new and challenging period in their child’s development. To provide habilitative and support resources to patients and their parents, a monthly group meeting was established.

**Methods:** Methods: Implant recipients, ages 6 months to four years, and their parents, are invited to participate in a group virtually via Zoom. The group is an hour in duration and facilitated by a speech-language pathologist and an audiologist. Each meeting follows a similar structure, including: an energy check, a shared activity, a discussion prompt, and a song. After six consecutive monthly meetings, participating parents were asked to complete a survey about the program and prompted to share what they would like to see more of during future meetings. Hands-on activities that are sent to the participant’s homes to utilize during the monthly group meetings. The grant funds are also applied to cover the cost of clinical time spent on non-billable procedures.

**Results:** Results: Provision of free group habilitation services introduces and/or reinforces auditory verbal strategies to support a child’s development of listening and spoken language skills. By providing a specific activity, the parents learn and practice the application of these listening and spoken language strategies during the group and then keep the item so that they can continue to play and implement the strategies discussed. For children attending weekly individual teletherapy, the structure of each group and the
strategies implemented mirror that of their weekly sessions and therefore further reinforce therapeutic strategies. The primary speech-language pathologist is able to build additional rapport in group sessions and is not limited by the frequency of therapy provision that is determined by insurance carriers. The inclusion of infant cochlear implant candidates from the time of surgical scheduling provides parents with a safe, low-stakes environment to observe other pediatric implant recipients, as well as the opportunity to engage with parental peers. The group increases the number of clinicians on the implant team with whom parents connect with. Perhaps most critically, this group provides a format in which parents can inform one another and share first-hand experiences, recommendations, and information. The group fosters an environment of parental empowerment.

**Conclusion:** Conclusions: Group habilitation has provided a way for families to connect with each other. They are provided with a forum to communicate freely with other parents who share similar challenges and goals. Families are provided with activities that they can keep after the meeting increasing the likelihood of continued carryover of the strategies implemented and discussed during the group session. Additionally, clinicians connect with various families with increased regularity without an increase in parental burden associated with travel and fees associated with in person audiology and therapy appointments.

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**Control Number:** 2022-A-134-ACI

**Complete Status:** Complete

**Presentation Number:** 145

**Publishing Title:** Outcomes of group Aural Rehabilitation for older adult cochlear implant recipients

**Author Block:** Mindy Schmelzer, AUD, CCC-A, Samantha Morgan, Doctor of Audiology, Michelle Albera, MS SLP; Audiology, WIHD/WMC, Valhalla, NY.

**Introduction:** While self-guided aural rehabilitation activities are prominent within the arena of rehabilitation, patient compliance with computerized programs is as low as 30%. Prior studies have indicated that those actively participating in a group rehabilitation option were more likely to have a higher self-report of quality of life and be considered good performers. This pilot study serves to collect clinically needed intelligence in regard to the impact of group aural rehabilitation on patient performance, patient perception of
hearing handicap, and quality of life. Further development of this delivery model provides the opportunity to improve upon the standard of care for implant recipients. Structured assessment of self-reported measures, in addition to evaluation of speech recognition abilities, is vital, as The Centers for Medicare and Medicaid Quality Strategy report include measures of quality of life measures as a primary outcome measure. (McRacken et al., 2017). The central question that this study serves to answer, is how does group aural rehabilitation affect outcomes of older adult cochlear implant recipients across various domains?

Methods: Older cochlear implant recipients were recruited on a volunteer basis to engage in an 8-week virtual aural rehabilitation course led by a speech language pathologist and audiologist. The course provided information on the best use of assistive listening devices and communication strategies in order to improve communication. The group also provided a forum for discussion of feelings related to hearing impairment as well as the stigma surrounding hearing loss and cochlear implants. The group informed participants of available community resources for the deaf and hard of hearing population. Participants were provided with several published resources. Between courses, participants were asked to employ strategies learned in the course within their daily lives and report back the following week. Prior to enrollment, subjective and objective measures of implant performance were administered, and these measures were re-administered after the conclusion of the rehabilitation program to meaningfully compare performance and patient-perceptions as a result of group engagement.

Results: Data on patient perceptions and speech recognition scores pre and post group rehabilitation will be shared and trends in data examined. Results will be utilized to describe and quantify the impact of an aural rehabilitation group on objective and subjective outcome measures. Needed clinical supports as well as clinical struggles associated with the provision and facilitation of group rehabilitation will also be shared.

Conclusion: By examining the direct impacts of patient engagement in group rehabilitation, we can ascertain potential benefits in a quantifiable way. Data collected can work to build the evidence base needed to mandate increased rehabilitative services for older adults in a format that can be integrated into billable clinical time. Information obtained may also illustrate additional ways to capture patient-perceived benefits of implantation.
Active Transcutaneous Bone Conduction Implants: experience of two generation of implants

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Department of Otorhinolaryngology, Head&Neck Surgery, Univ. clinic St. Poelten, St. Poelten, Austria.

Introduction: Since 2011 the Transcutaneous Bone conduction Implant first generation is routinely used for patients with mixed and conductive hearing loss and SSD patients. Since 2019 a new generation with a smaller FMT of the Implant is available. The first audiological results after one year of use and the patient satisfaction will be evaluated and compared to the data’s from the older Implant.

Methods: A retrospective chart review of 26 patients who underwent BCI 602 implantation for the treatment of SSD or M/CHL compared to 57 BCI 601 users was performed

Results: Twenty-three adult subjects (mean age 35.2±17.0) and three children aged five years or younger (mean age 3.3±1.2) were implanted with the BCI602. The BCI601 cohort comprised of 49 adults (mean age 47.0) and eight pediatric patients (mean age 11.0). The surgery time for the BCI602 in the adult population ranged from 22 to 50 minutes (mean 34. 9±8.5) and in the paediatric population (≤5) the mean surgery time was 27±11.5minutes (18-23 minutes). The mean surgery time for the BCI601 was 55.0±23.0). No surgical nor post-surgical complications occurred in the BCI602 cohort. The mean percentage of speech recognition in quiet for the BCI602 group at 12 months post-surgery significantly improved to 86.67±7.53 (p=<.0001) and was 83.46% for the BCI601. The mean speech reception threshold in quiet (SRT) improved significantly at the 12 months follow-up (BCI 602: from 54.76±10.04 to 38.00±9.89, p=.0222) (BCI601: from 65.56 to 41.11, p<0.001). The BCI602 subjects reported high satisfaction with the device accompanied with a mean wearing time of 9.5 hours per day (range 4-17 hours/day). For the BCI601 eleven patients reported at the 3-month interval a mean wearing time of 11.44 hours per day (range 9-15 hours/day).

Conclusion: The one-year results of the new BCI 602 showed significantly improved audiological performance (WRS, SNR), accompanied with high patient satisfaction and improved quality of life. These satisfying results are comparable to the reported 10 years of experience with the BCI601. The reduced size of the BC-FMT makes prior surgical planning redundant and reduced surgical time drastically. Based on these results; the new device BCI 602 can be highly recommended for the given indications and especially for difficult anatomical and surgical cases and a re-evaluation of the given indication for children 5 years or older is highly recommended.
Abstract

Body:

Introduction: OTOPLAN is a software for otological pre-as well as post-surgical CI planning. Since the cochlear structure dimensions can vary by as much as 30% to 40% between the shortest and longest cochleae, pre-operative planning is necessary to select the most suitable type of electrode that can prevent damage to the cochlear structure and degeneration of cochlear cells, and to preserve the postoperative residual hearing for candidates benefitting from electric-acoustic stimulation. Material & Methods: The study cohort investigated received Cochlear Implants from MED-EL using the Flex or Standard Electrode array series. Pre- and post-operative DTV images of 71 subjects were available. Measurement of interest used for intertester reliability calculations were: OTOPLAN, as well as applicability of the software auto-detect function of the respective frequency bands. Results: Out of the 19 evaluated cases two subjects were implanted with a Cochlear duct length different electrode array than measured via OTOPLAN. Full insertion of the proposed electrodes was possible in all cases except for two STANDARD Electrodes. The overall agreement/intertester reliability for 17 evaluated cases was 92.8%. This translates to an almost perfect agreement of outcomes. The analysis of the CDL at level of OC at 0° showed a substantial agreement between tester T1 and T2 of \(p=0.9794\) and a Pearson \(r=0.6905\) and moderate agreement between tester T1 and T3 a \(p=0.0199\) and a Pearson \(r=0.5747\). Post-operative DVT images showed that all implanted Electrodes were located within the Scala Tympani. Further evaluation regarding anatomy-based fitting and the frequency bands corresponding to the post-operative measured electrode positions showed for all 12 Electrodes a strong intertester relationship. A significant learning curve regarding amount of time necessary to perform the OTOPLAN planning was observed. Conclusion: The strong intertester reliability for all three outcomes tested in the first 19 OTOPLAN planned CI cases shows very promising application options for the clinical routine but further planning’s are necessary. Positively surprising was the short training and adaption time required until the planning time was reduced to an acceptable level within the clinical workload. The possibility of tonotopic pitch match with each MED-EL electrode array for anatomy-based fittings seems very
promising and further research is required to correlate fitting strategies with possibly improved audiological outcomes for the CI patients.

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Control Number: 2022-A-142-ACI
Complete Status: Complete
Presentation Number: 034
Publishing Title: Long term success with Round Window Coupling of Active Middle Ear Implants

Georg M. Sprinzl, Univ.-Prof. Dr.¹, Philipp Schoerg, MSc.², Sophie Speiser, MD², Astrid Magele, PD Dr.²;

Author Block: ¹Department of Otorhinolaryngology, Head&Neck Surgery, Univ. Clinic St. Poelten, St. Poelten, Austria, ²Department of Otorhinolaryngology, Head&Neck Surgery, Univ. clinic St. Poelten, St. Poelten, Austria.

Introduction: The objective of the study was to demonstrate the long-term outcomes of patients implanted with the active middle ear implant, the Vibrant Soundbridge through coupling of the floating mass transducer to the round window. The coupling, alignment and connection force of the FMT on the RW seems crucial for the effective transfer of mechanical stimulus to the cochlea. Evidence on safety and long-term stability of RW coupling is still scarce

Methods: This retrospective study evaluated the short- and long-term clinical, audiological performance and safety of the VSB coupled to the RW between 2013 - 2019 at the University Hospital St. Pölten, Austria. Outcomes were subdivided into short- and long-term examination groups, characterized as follow-up periods of less than twelve months vs subjects followed up for more than twelve months Cumulative survival outcomes were separated for subjects with and without Cholesteatoma.

Results: Of 45 subjects with 46 ears pre-operative and follow-up data of the VSB, with the FMT coupled to the RW without a coupler were fully available. Short-term follow-up data was accessible for 31 subjects, 31 ears and more than 12 months follow-up outcomes were available for 14 subjects, 15 ears. The mean age for the short-term group was 51.61±17.63 years (range: 9-82) and the group comprised of 18 men and 13 women. The mean follow-up of the short-term group was 1.84±2.06 months (range: 1-9). The long-term group exhibits 15 ears in 14 subjects with a mean age of 50.21±16.32 years (range: 22-80) and a mean follow-up of 31.86±15.78 months (range: 12-59). Out of these, 41 subjects underwent several, at least one, but on average 4 previous tympanoplasty
surgery (27 and 13, short- and long-term, respectively), 32 of them due to chronic cholesteatoma out of which 5 had a radical cavity. Complications requiring revision surgery were reported in 3 patients suffering from cholesteatoma (total 13.04%). The outcomes clearly show the correlation between underlying pathology, hence Cholesteatoma as well as radical cavity presence and revision rate on the subject’s survival rate. Over a course of 74 months the survival proportion of the Cholesteatoma group lies at 59.06% whereas the survival proportion of the group with no underlying pathology is at 100% (max. F/U time was 48 months). The residual hearing was not affected by VSB surgery. The word understanding in the Freiburger Monosyllabic speech test improved significantly at 65 dB and 80 dB, and these outcomes were stable for long-term follow up.

**Conclusion:** The VSB coupled to the RW is a safe implantation method for patients with conductive and mixed hearing loss. The hearing improvement was stable for the long-term follow-up up to 74 months. The revision rates were directly related to the underlying pathology of cholesteatoma (with radical cavity); thus, this special cohort requires additional counselling on potential complications.

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**Control Number:** 2022-A-143-ACI

**Complete Status:** Complete

**Presentation Number:** 161

**Publishing Title:** Cochlear Implant Electrode Array Migration through the Internal Acoustic Meatus and into the Cerebellopontine Angle: A Case Report

**Author Block:** Evie Wood, 1, Prajwal Shetty, MD2, Ishira Shetty, MD3, Simon Carr, MD, FRCS (ORL-HNS)2; 1Sheffield Children's Hosp., Sheffield, United Kingdom, 2ENT, Sheffield Children's Hosp., Sheffield, United Kingdom, 3Princess Royal Hosp., Sussex, United Kingdom.

**Abstract** Cochlear implant electrode array migration is a rare complication often needing revision surgery. Migration usually involves the round window, middle ear space, vestibule, or the internal acoustic meatus. We describe a unique case of a ten-year-old bilateral cochlear implant recipient with absent lamina cribrosa, who presented with neurological symptoms including change in handwriting and gait. A Computerized Tomography scan identified bilateral cochlear implant electrode array displacement into the cerebellopontine angle and impinging on the brainstem. This paper describes the presentation, management, and outcomes of this rare complication. Through this paper
we hope to provide readers with an appreciation for the variation in presentation of this rare complication.

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Introduction: Object: The aim of this study was to investigate whether participation in a novel 12-week intervention program based on the syllabic approach ('Simo-Syl') leads to improvements in the language abilities that support literacy acquisition (or early literacy skills) in children with cochlear implants (CI) and normal hearing (NH).

Methods: Methods: Three groups of children participated in the study: one group with CIs (n=10, mean age=62 months; SD=4.85) who participated in the intervention; all the children had profound congenital sensorineural hearing loss, the mean age at CI activation was 22.7 months (SD +/- 3.8; range 14-30); five children used bilateral CI, three children used monolateral CI, two children used bimodal stimulation. One group with NH (n=13, mean age=66.5 months; SD=3.50) who also participated in the intervention, and one control group of children with NH who did not take part in the intervention (n=17, mean age=61.70 months; SD=3.62). Children’s early literacy skills were tested in four tasks (syllable recognition, vowel recognition, syllable reading, word reading) using an ad-hoc computer-based assessment in two sessions, before and after the intervention for the CI and NH intervention groups and at corresponding time points for the control group.

Results: Results: Preliminary analyses showed that at T0 the syllable and vowel recognition abilities of the children with CIs did not differ between males and females, children with different modality stimulation, and did not correlate with maternal or paternal years of education completed (ps > .05). Their syllable and word reading skills were very weak (range = 0-1). A series of Analyses of Variance (ANOVAs) on each of the
four tasks showed significant Group x Session interactions for syllable reading (F(2,22)=3.57, p=.045) and word reading (F(2,22)=13.45, p<.001). Post-hoc tests with the Tukey correction showed significant improvements in syllable reading for all groups (CI: t(22)=-3.290, p=.003; NH: t(22)=-9.046, p<.001, Control: t(22)=-4.061, p<.001) and significant improvements in word reading between sessions only for the CI and NH intervention groups (CI: t(22)=-3.838, p<.001; NH: t(22)=-10.140, p<.001). At T1, the word reading skills of the NH intervention group were significantly better than those of the control group (t(34.4)=3.539, p=.003); those of the CI group were somewhat in between. **Conclusion:** Conclusions: These results show that participating in the Syllabic approach intervention benefits the syllable and word reading skills of children with CIs as well as those of children with NH, with potential positive consequences for their literacy acquisition process and school performance.

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**Control Number:** 2022-A-146-ACI  
**Complete Status:** Complete  
**Presentation Number:** 122  
**Publishing Title:** Verbal Language Outcomes a Decade after Pediatric Cochlear Implantation  
**Author Block:** Nae-Yuh Wang, PhD\textsuperscript{1}, Ann Geers, PhD\textsuperscript{2}, Christine Mitchell, ScM\textsuperscript{1}, Andrea Warner-Czyz, PhD\textsuperscript{2}, Laurie Eisenberg, PhD\textsuperscript{3};  
\textsuperscript{1}Johns Hopkins Univ., Baltimore, MD, \textsuperscript{2}Univ. of Texas at Dallas, Dallas, TX, \textsuperscript{3}Univ. of Southern California, Los Angeles, CA.  
**Introduction:** Long term follow-up of large, representative sample of children with severe to profound sensorineural hearing loss is necessary to document the attainment of normal spoken language levels over time in this population after receiving cochlear implantation at young age.  
**Methods:** The Childhood Development after Cochlear Implantation (CDaCI) Study is a multicenter study in the United States designed to identify factors influencing longitudinal development of spoken language in young children after receiving cochlear implants (CIs). Standardized verbal language tests were used to track spoken language skills through normed standard scores characterizing language development of age-mates in the general population. Time-to-event analysis and mixed-effects longitudinal regression models were used to prospectively estimate the cumulative incidence of attaining normal spoken language levels in 188 young CI candidates and identify factors
associated with normal spoken language achievement over time. Standard score of 85 from age-validated spoken language assessments was used as the threshold for normal language emergence.

**Results:** Age-appropriate sub-tests from the Comprehensive Assessment of Spoken Language (CASL) battery were used to assess spoken language development since the 4th annual follow-up. Syntax Construction was evaluated at 3-10 years of age, and Paragraph Comprehension was tested at 5-10 years of age, both were conducted annually prior to the 10th annual follow-up. Among the youngest implant recipients, about 75% of them attained normal level of Syntax Construction, and around 90% of these children achieved normal level of Paragraph Comprehension by the end of these assessments at 10 years of age. Antonyms tests were administered at 5-12 years of age. By age 12, close to 70% of the youngest implant recipients attained the normal level. Nonliteral Language levels were tested at age 7 and on, and Pragmatic Judgement was evaluated at age 3 and on. At the end of follow-up, close to 70% of the youngest implant recipients, with more than 12 years of implant experiences, attained the normal level on these two domains. The Core Composite score based on age-appropriate tests showed just over 50% of the youngest implant recipients, with more than 12 years of implant experiences, attained the normal level of spoken language.

**Conclusion:** Longitudinal assessment is essential in evaluating developmental outcomes after early cochlear implantation. Although spoken language development following implantation is highly variable, long term longitudinal follow-up data from the CDaCI Study showed an averaged upward trajectory of spoken language development over time, in core domains and overall, outpacing the language development trajectory of the normal hearing age-mates, to achieve normal spoken language, demonstrating the tremendous efforts by the implant recipients, their families, and all the supporting professionals after pediatric cochlear implantation.
**Introduction:** Hearing-related quality of life (HRQOL) measures are being increasingly used by clinicians who work with patients with cochlear implants (CIs). These subjective measures supplement data gained from speech recognition testing and provide a broader view of patients’ overall functioning in everyday communication environments. The Cochlear Implant Quality of Life scale (CIQOL), which examines both hearing-related and psychosocial domains, has been proposed as a comprehensive measure of real-world functioning. This study aimed to compare the CIQOL to various “real-world” auditory outcome measures, including sentence recognition and environmental sound recognition, as well as demographic factors like duration of deafness and duration of CI use.

**Methods:** We recruited 31 adult CI users from our audiology and neurotology clinic. All adults were postlingually deafened and had used their CI for at least one year. Participants completed a questionnaire with demographic details, such as age, duration of hearing loss, and duration of CI use. Participants also completed several auditory tasks, including AzBio sentences, CID words, CUNY sentences presented in auditory-only, visual-only, and audiovisual format, high-variability and standard single-talker sentence recognition, word recognition, and environmental sound recognition. Self-reported HRQOL was measured using the CIQOL-35.

**Results:** Preliminary data analyses suggest that the Global CIQOL score was correlated with several auditory measures, including standard sentence materials and more clinically used measures like AzBio sentences and monosyllabic words. Communication and Listening Effort domains of the CIQOL were correlated with most speech recognition measures, especially CUNY sentences presented in the audiovisual format, which is most reminiscent of real-world communication environments. Duration of CI use was correlated with several domains of the CIQOL, as well as the Global score.

**Conclusion:** Self-reported HRQOL, as measured by the CIQOL, was correlated with several clinical and non-clinical measures of speech recognition ability. The Communication and Listening Effort domains were most highly correlated with standard/clinical and real-world auditory measures. Overall, the CIQOL is a comprehensive measure of several facets of HRQOL for CI users’ and should be used by clinicians to determine patients’ satisfaction with their CIs. Other domains of HRQOL should be examined further in their relation to auditory measures.

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**Control Number:** 2022-A-148-ACI

**Complete Status:** Complete
Introduction: Cochlear implantation (CI) in children aged 5 years and older with single sided deafness (SSD) was approved in 2019 by the U.S. Food and Drug Administration. Many benefits have been reported in literature on objective audiometric measures. The purpose of this study is to evaluate subjective health related quality of life (HRQoL) benefits with CI in children with SSD compared to those benefits seen in children implanted for bilateral sensorineural hearing loss (SNHL).

Methods: Cross-sectional survey of parents of children who underwent CI for SSD and bilateral SNHL. The ‘Children with cochlear implants: parental perspectives’ survey was used which has 8 domains: Communication, General functioning, Self-reliance, Well-being and happiness, Social relationships, Education, Effects of implantation, and Support of the child. Average responses were calculated within domains and unadjusted comparisons of the groups with respect to survey domain scores were performed using t-tests. Analysis of covariance models were used to compare the groups while adjusting for age at implantation.

Results: Surveys were returned from 14 patients with SSD and 35 patients with bilateral SNHL. Parents of SSD children answered favorably in nearly all domains demonstrating HRQoL benefits with CI. Responses were near neutral in ‘general functioning’ and ‘supporting the child’ domains. When adjusted for age at implantation, parents of bilateral SNHL children responded more favorably in half the domains versus SSD children (General functioning, Well-being happiness, Support the child, and Communication). There was no difference in HRQoL benefits perceived by SSD children and bilateral SNHL children in the domains of self-reliance, social relations, education, and effects of implantation.

Conclusion: This study is one of the first to suggest there are HRQoL benefits of CI in SSD children. As expected, the impact of implantation is more profound in children with bilateral SNHL in comparison to children with at least one normal hearing ear in domains assessing ability to communicate, general functioning, support the child, and well-being domains.
Abstract Body:

Introduction: The A-value used in cochlear duct length (CDL) estimation does not take malformed cochleae into consideration. The objective was to determine the A-value reported in the literature, to assess the accuracy of the A-value measurement and to evaluate a novel cochlear measurement in distinguishing malformed cochlea.

Methods: High resolution Computer Tomography images in the oblique coronal plane/cochlear view of 74 human temporal bones were analyzed. The A-value and novel C-value measurement were evaluated as predictors of inner ear malformation type. The proximity of the facial nerve to the basal turn was evaluated subjectively.

Results: 26 publications report on the A-value; but they do not distinguish normal vs. malformed cochleae. The A-values of the normal cochleae compared to the cochleae with cochlear hypoplasia, incomplete partition (IP) type I, -type II, and -type III were significantly different. The A-value does not predict the C-value. The C-values of the normal cochleae compared to the cochleae with IP type I and IP type III were significantly different. The proximity of the facial nerve to the basal turn did not relate to the type of malformation.

Conclusion: The A-value is different in normal vs. malformed cochleae. The novel C-value could be used to predict malformed anatomy, although it does not distinguish all malformation types.
Introduction: When there is a significant asymmetry in hearing, individuals with single-sided deafness and asymmetric hearing loss lack binaural hearing benefits such as sound localization, spatial awareness, and hearing in noise in addition to suffering from increased listening effort and frequently, tinnitus. The technology options for this patient population are limited with traditional amplification, CROS/BiCROS or osseointegrated solutions in order to improve speech understanding and quality of life. Even after recent FDA approval of cochlear implantation for SSD and asymmetric hearing loss, some individuals still do not meet current FDA criteria.

Methods: Our facility has implanted approximately 30 non-traditional “single-sided” adult and pediatric cochlear implant recipients to date. Pre-operative assessment included unaided testing, aided testing if warranted, amplification discussions, audiology and otology counseling and imaging (CT scan and or MRI). Post-operative testing included unaided testing, cochlear implant detection testing, and speech perception testing in the soundfield. Specific mapping considerations were made with the goal of improved speech perception and decreased listening fatigue.

Results: Post-implant audiologic evaluations demonstrated cochlear implant detection thresholds within the expected range and each patient largely reported improved word recognition abilities post cochlear implantation. Patients each reported improved quality of life.

Conclusion: Special considerations should be made when treating patients with SSD and asymmetric hearing loss including counseling and setting realistic expectations. All technology options should be considered including off-label cochlear implant use. A clinic protocol for cochlear implant evaluation for these patients should be considered.
**Introduction:** After years of illness and multiple operations, patients with chronic otitis media often show profound hearing loss that cannot be compensated for with conventional or bone conduction hearing aids. In these cases, cochlear implantation is the most effective method of rehabilitation for sensorineural hearing loss. Surgical options in these patients remain part of an ongoing debate. The electrode extrusion through the skin and cartilage cover is a recurring problem in these cases, resulting in revision surgery. Therefore, a subtotal petrosectomy with obliteration of the external auditory canal is often performed as an alternative. However, this concept prevents clinical control of the underlying chronic disease in the middle ear and mastoid cavity. The present study analyzes the underlying mechanical effects of CI electrodes, which favor electrode extrusion to develop an optimized concept and electrode design.

**Methods:** To investigate the mechanical force effects of CI electrodes, an anatomical model of a temporal bone with a mastoid cavity was created, and systematic experiments for force measurements were carried out on electrode dummies. In the second step of the experiments, distinct models of electrode dummies were produced, which had a central deforming element of different lengths. Comparative force measurements were carried out. Electrical integrity tests were then carried out on the electrode cables.

**Results:** A tangential force resulting from a spring-like effect of the electrodes was identified as the most likely cause of the potential extrusion. Systematic analyzes of these specialized models resulted in almost complete elimination of the tangential spring forces. It was shown that the mechanical deformation of the electrodes did not have a negative influence on the impedance of the conductors, even after supercritical bending tests. The first two patients with mastoid cavities were successfully supplied with electrodes of this type using custom-made CI devices - without any postoperative complications.

**Conclusion:** In summary, it was observed that a novel design of electrodes with a malleable metal reinforcement significantly reduced the potential tangential spring forces. After successful clinical application, this new electrode design suggests a possible future improvement for patients with a mastoid cavity.
Abstract Body:

Introduction: There is mounting evidence that children’s language development is impacted by how much caregivers talk to them. However, evidence for this relationship is, so far, weak for children with cochlear implants. On the one hand, we might expect that because children with CIs are at risk for poor language outcomes that the amount of language input directed to them would be even more related to their language outcomes than it is for typically developing children. On the other hand, there are several factors that may more strongly moderate the relationship between language input and language outcomes in children with CIs than typically hearing children thus complicating the relationship. To better understand the complicated relationship between language input and language outcomes in children with CIs, it is important to conceptualize these many factors into a conceptual framework. This will allow us to gain or more complete picture of what will facilitate language development after cochlear implantation. Methods: We reviewed findings in our laboratory and others’ over the past 20 years investigating child, parent, and home environment factors that may impact the relationship between quantity of language input and language outcomes in children with CIs. A conceptual framework was then developed based on the findings. Results: We were able to develop a framework for conceptualizing the complex relationship between language input and language outcomes in children with CIs. The framework visually represents findings showing that language outcomes are influenced by the total language input that is accessible, attended to, and coordinated with the child and that accessibility, attention to speech, and parent-child coordination are more variable in children with CIs than children with typical hearing. Conclusion: Several findings published over the past 20 years are relevant to understanding the complex relationship between language input and language outcomes in children with CIs. The introduction of a conceptual framework that organizes how these factors interact with each other is an important step for organizing our current knowledge and identifying gaps for further investigation. Advancing knowledge in this area will help empower parents in their journey to provide their children with a language environment in which they can thrive.
Abstract

Introduction: Identification of the inner ear malformation (IEM) types from pre-operative images is a tedious process. We hypothesize that the single cochlear view helps in the differentiation of IEM types.

Methods: Twenty-two pre-operative computer tomography (CT) images identified with inner ear malformation types were loaded in OTOPLAN® (Otological preplanning software tool) to capture the cochlear view in the oblique coronal plane and the mid-modiolar section in the axial plane. Audiological outcomes are provided for those patients who eventually underwent cochlear implantation (CI).

Results: In the cochlear view, the outer wall of the cochlea was tracked, and it extended up to 360° of angular depth in Incomplete Partition (IP) type I, 450° in the IP type II, 360° in IP type III, and 540° in enlarged vestibular aqueduct (EVA) type. Beyond the tracked outer wall, the remaining portion of the cochlea appeared cystic. The mid-modiolar section differentiated the EVA from the normal anatomy inner ear by showing the presence of enlarged vestibular aqueduct. The average thresholds in free field tone audiometry (0.5 - 4 kHz) with CI were 37.5 dB (EVA), 42.7 dB (IP II), and 43.1 dB (more severe malformation group). The CAP (Categories of Auditory Performance) scores were 4.9 (EVA), 4.7 (IP II) and 4.5 for more severe malformation groups.

Conclusion: OTOPLAN simplifies the effort in getting the cochlear view and the mid-modiolar section. Just looking at the cochlear view, it is possible to differentiate the IP type I, II, III and EVA malformation types. The mid-modiolar section shows the presence of EVA. The hearing performance is positively related to less severe malformation types, although the majority of patients from each malformation group showed clear benefit from CI.
Introduction: Before making changes to the way Cochlear Implant (CI) clinicians interact with fitting software, extensive consultation with the target audience is required. In developing a new software, clinician research has led the design and development to promote a better fitting experience for both the patient and clinician.

Methods: 81 Audiologists participated in Focus Groups where participants conducted a series of tasks to define their ideal CI fitting software. The participants included researchers, experienced CI Audiologists, and new-to-CI Audiologists in 4 countries. In addition to the Focus Groups, ethnographic research was conducted with 56 Audiologists in 5 countries using in-clinic observation, interviews, and self-ethnography. The ethnographic research was used to identify the key challenges Audiologists face and how changes in fitting software could help alleviate these challenges.

Results: The Focus Groups uncovered common themes and pain points across the different groups. Most participants agreed that the goal is to optimize patient potential. Ethnographic research indicated that clinician’s top challenges include losing time to admin tasks and reaching desired outcomes in line with patient goals.

Conclusion: 1. Where possible, CI fitting software should have features that address clinician paint points 2. CI Fitting should promote an interactive, collaborative experience between the patient and client 3. Changes to CI fitting software should be a consultative process with a broad range of clinicians, ensuing only positive changes are made.
Introduction: The purpose of this study is to analyze speech production patterns of bilingual Spanish- and English-speaking bilingual children with hearing loss who use cochlear implants and their peers with normal hearing by specifically focusing on the effects of hearing status, language, syllable complexity, and word length on segmental accuracy.

Methods: Forty bilingual Spanish- and English-speaking children (20 cochlear implant users and 20 with normal hearing) between the ages of 5;3 and 7;9 (years; months) participated in the study. Cochlear implant users received their implants before they turned 3 years old and had at least 3 years of implant experience. Items from a single-word elicitation task were selected for the analyses to test the effects of hearing status (cochlear implant users versus their age-matched peers with normal hearing), language (Spanish versus English), word length in syllables (monosyllabic, disyllabic, and trisyllabic), and syllable complexity (no clusters versus including clusters) on segmental accuracy (percent segments correct). A repeated measures analysis of variance was conducted with hearing status as the between-subjects variable as well as three within-subjects factors: language, word length in syllables, and syllable complexity with segmental accuracy (percent segments correct - revised) as the dependent variable.

Results: There was a statistically significant main effect of hearing status \( F(1, 35) = 40.24 \) at \( p < 0.001 \), partial \( \eta^2 = 0.54 \), language \( F(1, 35) = 4.57 \) at \( p = 0.040 \), partial \( \eta^2 = 0.12 \), word length in syllables \( F(2, 70) = 13.42 \) at \( p < 0.001 \), partial \( \eta^2 = 0.28 \), and syllable complexity \( F(1, 35) = 52.63 \) at \( p < 0.001 \), partial \( \eta^2 = 0.60 \) on segmental accuracy. Statistically significant interactions included hearing status by syllable complexity \( F(1, 35) = 18.20 \) at \( p < 0.001 \), partial \( \eta^2 = 0.34 \), language by word length in syllables \( F(2, 70) = 18.03 \) at \( p < 0.001 \), partial \( \eta^2 = 0.34 \), language by word length in syllables by hearing status \( F(2, 70) = 4.63 \) at \( p = 0.013 \), partial \( \eta^2 = 0.12 \), language by word length in syllables by syllable complexity \( F(2, 70) = 10.67 \) at \( p < 0.001 \), partial \( \eta^2 = 0.23 \).

Conclusion: Hearing status, language, word length in syllables, and syllable complexity all have significant effects on segmental accuracy, as predicted. Interdependence between hearing status by syllable complexity suggests that more complex syllables are disproportionally more challenging for bilingual cochlear implant users than their peers with normal hearing. The interactions of hearing status by syllable complexity, language by word length, language by word length by hearing status, as well as language by word length by syllable complexity indicate the interdependence of these factors, painting a complex picture that is as informative for researchers in the field as it is for practicing speech-language pathologists, audiologists, and educators who work with bilingual children with hearing loss and their peers with normal hearing.
Introduction: Cochlear implant (CI) recipients with single sided deafness (SSD) and asymmetric hearing loss (AHL), experience significant improvements on tasks evaluating binaural hearing such as localization and spatial release from masking (SRM) as compared to preoperative abilities, though outcomes vary. There is limited information regarding patient and device variables that may contribute to variability in peak performance or the time course of improvement. The present study evaluated the association of age at implantation, duration of SSD/AHL, contralateral hearing thresholds, and angular insertion depth of the electrode array on the long-term performance of adult CI recipients with SSD and AHL.

Methods: The long-term localization and SRM of adult CI users with SSD or AHL was evaluated during annual clinical visits, out to 5 years post-activation. Participants were recruited from a cohort who received their device as part of an FDA-approved clinical trial. The localization task was performed with a 180º arc of 11 speakers. Participants were asked to identify the perceived sound source of a 200-ms broadband noise burst. Performance was calculated as the root-mean-squared (RMS) error. The SRM task was completed with AzBio sentences in a 10-talker masker. The target was presented from the center speaker at 0º azimuth and the masker was either co-located with the target, 90º towards the CI-ear, or 90º towards the contralateral ear. Performance was calculated as the difference in scores when the masker was offset to the CI-ear (SRMci) and contralateral ear (SRMcontra) relative to the co-located condition. Patient and device variables such as age at implantation, duration of deafness, contralateral hearing thresholds, and electrode angle of insertion were assessed.

Results: Participants with SSD (n=20) and AHL (n=19) completed the study procedures at the 1-year post-activation visit, with variable sample sizes at each follow-up visit. For localization, all participants experienced a significant improvement in RMS error relative to the preoperative interval, though the SSD cohort performed better than the AHL cohort at the 1-year and long-term visits. Age at implantation and contralateral hearing
thresholds were significantly associated with RMS error. For SRMci, there was a significant main effect of group (SSD/AHL), but not for interval. For SRMcontra, there were significant main effects of interval and cohort. There was a significant interaction of interval and cohort, with SSD participants reaching asymptotic performance within the initial months of CI use and AHL participants demonstrating continued growth out to 5 years. The improvement in SRM was significantly associated with age at implantation. Duration of SSD/AHL and angular insertion depth were not significantly correlated with performance for either task; however, this may have been driven by the homogeneity of the sample for these variables.

**Conclusion:** Participants with SSD and AHL had significant improvement in binaural abilities both initially and after long-term CI use. Age at implantation and contralateral hearing were factors associated with variability in localization. For SRM, the SSD cohort reached early asymptote while the AHL cohort continued to improve out to 5-years post-activation. This variability appears to be driven by differences in age at implantation.

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**Control Number:** 2022-A-171-ACI

**Complete Status:** Complete

**Presentation Number:** CS1-2.5

**Publishing Title:** Anatomy based fitting—a new fitting method for every cochlear implant user?

**Author Block:**

Anja Kurz, PhD., M.A., Rudolf Hagen, Prof. Dr. Dr. h.c., Tassilo Müller-Graff, Dr. med., Kristen Rak, PD Dr. med.; Comprehensive Hearing Center, Dept. of Otolaryngology, Univ. Hosp. Würzburg, Würzburg, Germany.

**Introduction:** Significant variability exists in angular insertion depth both across and within cochlear implant arrays. Mapping procedures use cochlear tonotopy by assigning low- to high-frequency information across apical to basal electrodes but do not individualize frequency allocation using the exact location of electrode contacts. Anatomy-based fitting is a new fitting method that allows personalization. The prerequisite is new fitting software, in which patient-specific data can be imported from a planning platform for otological surgery. It is then possible to calculate and display each individual electrode contact’s tonotopic frequency. The audiologist can then set a frequency-band distribution that is more closely aligned to the tonotopic frequency distribution. The aim of this study was to 1) compare the benefit of a new fitting
methodology with the established fitting methodology and 2) evaluate other influencing factors, e.g., insertion depth and electrode array.

**Methods:** Participants are adults who are experienced unilateral or bilateral adult cochlear implant users. In each individual, the angular insertion depth of the electrode array and the electrode contacts were calculated. The frequency filters in the audio processor were re-calculated and shifted to match the “better hearing” side e.g., in single-sided deafness the normal hearing ear; in bilateral users the better hearing side. Speech perception in noise (in different spatial settings), pitch and timbre perception in musical instruments and speech, and patient-reported outcomes were assessed at two intervals. At study start, subjects used their routine clinical map (with standard frequency bands). Subjects were then fit with an anatomy-based fit map. After three months of use with this map, subjects repeated the tests.

**Results:** Preliminary results are that bilateral users with different electrode array lengths had better overall sound quality and a higher acceptance rate with the anatomy-based fitted map than they did with their routine fitting. Using the anatomy-based fitted map may improve experienced bilateral user’s speech understanding in noise, but it also might decrease speech understanding in their weaker side. All unilateral patients that were implanted with a standard-length electrode array preferred the anatomy-based fitting, as shown by improved speech perception in noise and better sound quality.

**Conclusion:** Initial acceptance of anatomy-based fitting in experienced users is dependent on the electrode array length and insertion angle. Anatomy-based fitting should be considered as an alternative to the standard clinical fitting in dissatisfied cochlear implant users.

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**Control Number:** 2022-A-173-ACI

**Complete Status:** Complete

**Presentation Number:** CS8-2.1

**Publishing Title:** Individualized CI Electrode Placement based on pre-operative CT Image Analysis and intraoperative ECochG Monitoring

**Author Block:** Thomas Lenarz, Professor and Chairman
ENT Department, Med. Univ. of Hannover, Hannover, Germany.

**Abstract Body:**

Introduction: In recent years, the indication of CIs has been extended to hearing impaired with residual hearing at low frequencies before surgery. This population could benefit from an individualized electrode array placement including an electrode insertion
depth adapted to their residual hearing because this could minimize the insertion trauma and lead to improved preservation of the residual low-frequency hearing. The goal of this study is to investigate whether pre-operative CT image analysis combined with ECochG monitoring during insertion allows an individualized CI electrode array placement that leads to enhanced preservation of residual hearing.

**Methods:** CI candidates with 55 dB HL or better @ ≤ 500 Hz (EAS subjects) were enrolled in this study. Using an advanced research imaging software from Advanced Bionics (AB) a digital 3-D cochlea model, a scala tympani height profile, and a subject specific Greenwood frequency map was calculated based on pre-operative CT data. The pre-operative audiogram and the calculated cochlea Greenwood frequency map were used to estimate the targeted insertion depth of the AB HiFocus SlimJ electrode array. During surgery ECochG signals were recorded via the AB AIM System and were used to control the insertion.

**Results:** The use of an advanced imaging research software allowed for pre-operative CT images to be successfully analyzed and a subject specific Greenwood function could be calculated. In combination with the pre-operative audiogram, it allowed to plan the individual insertion depth before cochlear implantation. Achieved electrode insertion depth was in the range of pre-calculated values.

**Conclusion:** The combined use of pre-operative CT image analysis and intra-operative ECochG monitoring is a very helpful tool for an optimized and smooth surgical planning for an individualized electrode array placement with an electrode insertion depth adapted to the patient’s pre-operative audiogram.
include the highly contextual structure and the reliance on top-down processing strategies that can be altered by cognitive resources. Utilizing a word score could produce consistency among implanting centers in determining who is a candidate for a CI without cognitive influences. A multicenter study with data contributions from 12 academic and private practice cochlear implant centers representing 7275 patients was used from a cochlear implant registry to determine the distribution of AzBio Sentence scores if CNC scores ≤ 60% in the implanted ear were used as candidacy.

**Methods:** Preoperative CNC Word and AzBio Sentence scores from more than 1500 cochlear implant recipients were evaluated. Cochlear implant (CI) recipients who scored ≤60% preoperatively in the implanted ear on CNC scores were divided into groups that qualified for a CI based on an AzBio Sentence score ≤40% in quiet, +10 SNR, or +5 dB SNR in the implanted ear. These groups were evaluated for preoperative demographic and hearing characteristics. Linear mixed models were used to compare pre- to post-operative performance on CNC words for each of the AzBio qualifying groups.

**Results:** Of the patients who qualified for implantation using a CNC word criterion of ≤60% in the implanted ear also qualified for candidacy in one of the AzBio sentence conditions. Very few patients who qualified for implantation using the CNC word score did not qualify using AzBio sentences. Analysis of pre and postoperative CNC word scores showed a significant improvement for each group of the AzBio qualifying groups.

**Conclusion:** All patients who qualified for AzBio Sentences in quiet, +10 SNR, or +5 SNR were also a candidate based on a CNC word score ≤60% in the implanted ear. Patients who qualify for cochlear implantation using CNC words show significant improvements in speech perception. Using a CNC word score for implant candidacy would provide a better understanding of the patient’s speech perception abilities. Additionally, using a set presentation level without noise would provide equal candidacy guidelines between implanting centers.
**Introduction:** Congenital cytomegalovirus (cCMV) is the most common cause of acquired congenital sensorineural hearing loss worldwide, with higher rates reported in developing countries of up to 1 to 5% of live births. While most patients are asymptomatic at birth, cCMV is associated with significant morbidity and mortality, particularly involving the reticuloendothelial, hepatobiliary, and central nervous systems. As of yet, there is no universal newborn screening for cCMV nor established treatment regimen once detected. SNHL in cCMV is usually treated with hearing aids and/or cochlear implants. Outcomes with cochlear implants are difficult to assess given that concurrent neurological sequelae of cCMV can be a confounder. As such, it is imperative to clearly determine prognostic factors for success of cochlear implantation, and to establish basis for timing and type of CI intervention in cCMV-related SNHL patients. In this study, we aimed to describe findings and treatment in 16 patients with presumed cCMV SNHL who underwent unilateral or bilateral CI at the University of Miami Ear Institute.

**Methods:** 16 patients with presumed or confirmed cCMV who received CI at the University of Miami Ear Institute were identified for retrospective study. Chart review was performed for demographics, cCMV-related comorbidities, audiologic outcomes pre- and post-implantation, surgical technique and surgical complications. Literature review was conducted to evaluate current state of clinical work-up and treatment of cCMV-related SNHL patients.

**Results:** Our study described patient demographics of 16 presumed or confirmed cCMV-related SNHL patients who underwent CI. The clinical diagnosis of cCMV was reviewed. We also reviewed modifications to the standard audiological evaluation and CI surgical technique that may have a positive impact on functional outcomes and minimize complications.

**Conclusion:** cCMV-related SNHL patients represent a growing population that will be offered CI as treatment. It is critical to generate an awareness for the special considerations when offering CI to cCMV-related SNHL patients. More work should be done to elucidate factors that affect CI outcomes in these patients, potentially as basis for personalized intervention.

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**Control Number:** 2022-A-177-ACI

**Complete Status:** Complete

**Presentation Number:** 043
Evaluating the Revised Work Rehabilitation Questionnaire in Cochlear Implant users Cochlear Implant Outcome Assessment Based on the International Classification of Functioning, Disability and Health (ICF)

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Introduction: The 59-item Work Rehabilitation Questionnaire (WORQ) was developed based on the International Classification of Functioning, Disability and Health (ICF) core set for vocational rehabilitation to assess work related functioning. It was revised to include 17 questions, assigned to 14 ICF categories relevant to cochlear implant (CI) users. This cross-sectional multicenter study aimed to evaluate CI users’ responses on the WORQ questions to describe and generate ICF qualifiers for the revised WORQ in CI users, forming part of a broader framework of CI outcome measures linked to the ICF.

Methods: 177 adults over the age of 18 years with a minimum of one year’s device experience were included in the analysis. The WORQ was completed by the participants at a routine visit to the clinic, via email, or via post.

Abstract Body: Results: Most of the CI users perceived no problem on the WORQ questions (53.7% - 91%), finished secondary school (54.2%) or obtained a college or university degree (32.8%) and are either employed (41.2%) or retired (34.5%). CI users that are currently working mostly have a full-time position (34.5%). Subjects reported no problem (91%) with sensation of falling, while handling communication devices and techniques (10.9%) and tinnitus (9.6%) showed the highest number of subjects reporting a complete problem.

Conclusion: Overall, most of the CI users experienced no impairment, restriction or limitation on the WORQ questions and their assigned ICF categories. Their education level resembles the education level of the general population and they seem to integrate or reintegrate well in professional life postoperatively.
Background: In cases of sensorineural hearing loss, non-functional sensory cells can be bypassed by a cochlear implant (CI) to restore hearing which can dramatically improve the quality of lives of patients. The foreign body response (FBR) after implantation can result in fibrosis and reactive soft tissue that can negatively affect the outcome of CI. These reactions have been associated with increased electrode impedances, decreased battery life, further loss of acoustic hearing after initial hearing preservation, or in rare cases, device failure. This study investigates the effect of dexamethasone, a well-established, potent anti-inflammatory glucocorticoid, on the intracochlear FBR after cochlear implantation in a murine model of CI.

Methods: 10-12-week-old CX3CR1+/GFP Thy1+/YFP mice on C57Bl6 background with normal hearing, were implanted with a 3-channel cochlear implant (dexamethasone-eluting or control implant) in the left ear via a round window insertion. The right ear served as the unoperated control ear. Implant functionality was tested with serial impedance and neural response telemetry (NRT) measurements. Programming for electrical stimulation was based on NRT. Starting from postoperative day 7, electrodes were stimulated for 5 hrs/day, 5 days/week up to 28 days with stimulation threshold 30 CL below NRT threshold and comfort level determined with behavioral response. Cochleae were harvested at 10, 28 or 56 days post-operatively, fixed with 4% PFA, cryopreserved, sectioned at 30 μm parallel to the mid-modiolar plane, and labeled with antibodies against α-Smooth Muscle Actin (α-SMA) to label myofibroblasts to quantify the fibrotic response and MHCII to label antigen presenting cells. The outlines of scala tympani, Rosenthal canal, modiolus and lateral wall for each turn were traced manually to measure the volume of each and to quantify nuclei, and the density of CX3CR1+ macrophages, CX3CR1+MHCII+ antigen presenting cells, and spiral ganglion neurons (SGNs). The volume of α-SMA-positive fibrotic area was measured and the ratio of the volume of α-SMA+ area/volume of scala tympani calculated.

Results: At all time points, cochlear implantation caused infiltration of cells and CX3CR1+ macrophages into the cochlea. A subpopulation of infiltrating CX3CR1+ cells are MHCII+ antigen presenting cells. The inflammatory response is initially generalized and gradually
becomes predominantly localized to the scala tympani of the basal region of the cochlea by 56 days after implantation. Fibrosis is seen in the scala tympani throughout the time investigated. Compared to cochleae implanted with standard arrays, cochleae implanted with dexamethasone-eluting arrays showed significant reduction in macrophage density, CX3CR1+MHCII+ antigen presenting cells, and cellularity in the scala tympani, Rosenthal’s canal, lateral wall and modiolus and reduced fibrosis in the scala tympani.

Conclusion: Cochleae implanted with dexamethasone-eluting electrode arrays displayed a reduced intracochlear inflammatory response up to 9 weeks postoperatively, suggesting that anti-inflammatory reagents could help preserve the normal cochlear environment. This may further support long term preservation of cochlear health and help preserve low frequency acoustic hearing after implantation.

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**Control Number:** 2022-A-179-ACI

**Complete Status:** Complete

**Presentation Number:** CS3-2.3

**Publishing Title:** Educational Supports for School-Age Children - Contributions of Teachers of the Deaf

**Author Block:** Uma Soman, PhD, LSLS Cert AVEd., Dan Salvucci, M.E.D., Ed.M., Jenna Voss, PhD, CED, LSLS Cert AVEd;
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**Introduction:** It is not uncommon for children with cochlear implants to listen, speak, read, sing and learn along their hearing peers. At one time, full inclusion may have been perceived as available only to a small number of “superstar CI users”. However, in 2020 and beyond, children who have access to hearing technology and early intervention are often educated in inclusive learning environments alongside their typically hearing peers with few special educational supports and services, quite a contrast from the outcomes of deaf children only a few decades ago. The deaf or hard of hearing (DHH) children we provide services for today, and their outcomes are different than in the past, thus it follows that their intervention and support services they need during the school years also need to evolve.

**Methods:** In this presentation, we will share a summary of the current state of knowledge on language, literacy, and academic outcomes of school-age children who are DHH. Based on peer-reviewed research, clinical observations, and anecdotal evidence from families and practitioners we will describe areas of strength and areas of need for
school-age DHH children. Additionally, we will identify the challenges they face within the educational system and the various supports and services available to school-age children and families.

**Results:** One key source of support is the teacher of DHH students. Often children who have received robust early childhood education need continued intervention and progress monitoring to keep up with the demands of listening, language, literacy, and academic skills in elementary, middle, and high school. The transition from conversational language to formal language of academics, the expectations for using and understanding tier 2 and tier 3 vocabulary, complex language, and engage in “literate” language can be challenging for many children. A teacher of DHH students is uniquely qualified to assess children in these areas, interpret their performance within the context of their hearing loss, and provide intervention that facilitates acquiring the “language of academics”, along with developing age- and grade-appropriate reading and writing skills. Additionally, a teacher of DHH students can support development of social skills and self-advocacy skills with the classroom and the community. Finally, teachers of DHH students can work in collaboration with other members of the student’s team to ensure that the student continues to “catch up” or “keep up”.

**Conclusion:** In conclusion, a majority of DHH students in 2020 and beyond would benefit from being supported by a teacher of DHH students directly, or indirectly. A concerted effort to ensure that DHH students have the support of teachers of the DHH is necessary. Additionally, sustaining and expanding the number of teachers specializing in working with DHH children is important to DHH students’ successful outcomes. Intervention teams including medical professionals and rehabilitation professionals could explore ways to incorporate these highly skilled educators’ input into clinical decisions and post-implant progress monitoring.

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**Control Number:** 2022-A-181-ACI

**Complete Status:** Complete

**Presentation Number:** 098

**Publishing Title:** Tinnitus Reduction in Adult Cochlear Implant Recipients

**Author Block:** Allison Young, Au.D\(^1\), Andrea Bucker, Au.D\(^1\), Meredith Rooth, Au.D\(^2\), Margaret Richter, Au.D\(^2\), Noelle Roth, Au.D\(^1\), Sarah Dillon, Au.D\(^1\), Samantha Scharf, Au.D\(^1\), Adrienne
Introduction: Adult patients with moderate-to-profound sensorineural hearing loss often report the presence of tinnitus. For those who meet cochlear implantation candidacy criteria and receive a cochlear implant (CI), the tinnitus is reportedly reduced/suppressed when the CI is on. For some, the tinnitus is also reduced/suppressed with the CI is off. In rare cases, tinnitus severity reportedly increases after implantation. Little is known about the range of tinnitus severity for CI recipients post-operatively with the device on versus off and whether it is associated with preoperative severity. The present report aimed to characterize preoperative and post-activation tinnitus severity for adult CI recipients to improve the counseling for patients with tinnitus who are pursuing cochlear implantation.

Methods: The Tinnitus Handicap Inventory (THI) was administered to adult patients at the cochlear implantation candidacy evaluation (baseline) and at post-activation visits. Participants were asked to respond with their perceptions of their tinnitus severity with the device on (preoperative: hearing aid, post-activation: CI) versus off. Participants completed the THI at the pre-operative visit and at the 1-month, 3-month, and 6-month post-activation visits. Post-activation performance was compared to the preoperative perceptions and to the previous visit to determine the time course for changes in tinnitus severity when the CI was on versus off.

Results: Tinnitus severity at the preoperative visit in this sample ranged from slight to catastrophic, with the majority reporting moderate tinnitus severity. As expected, a significant reduction in tinnitus severity was observed after introduction of the CI—with the largest difference observed at the 1-month visit. The reduction/suppression of the tinnitus with the CI on was stable across the 1-month and 6-month visits. Tinnitus severity was poorer with the CI off, though reduced as compared to preoperative perceptions. There was no significant association with preoperative and post-activation tinnitus severity, though this may have been limited by floor effects.

Conclusion: Adult CI users experience a significant reduction/suppression of their tinnitus in the implanted ear with the CI on and off as compared to their preoperative perceptions. While the majority of patients experience this benefit, it is not experienced by all CI recipients. The present data is intended to support better counseling of CI candidates who also present with tinnitus on the realistic expectations for the post-activation period.
Introduction: Understanding the impact of the global pandemic on cochlear implantation rates across the United States is limited by the absence of a centralized national patient registry. Cochlear Americas and Advanced Bionics together supply approximately 85% of cochlear implants (CIs) in the United States. The objective of the current study was to characterize the impact of the COVID-19 pandemic on national cochlear implantation rates using prospectively registered patient data from Cochlear Americas and Advanced Bionics between 2015 and 2020 across all ages.

Methods: In this national cohort study, analysis of prospectively registered patient data from two major cochlear implant manufacturers in the United States was performed. Both children and adult implant recipient data was reviewed. The primary outcome of interest was annual implantation rates by age from 2015 through 2020.

Results: A total of 46,346 patients received Cochlear Americas or Advanced Bionics CIs between 2015 and 2020. The annual number of implant recipients increased significantly during the first five years of the study period for both children and adults, from a total of 6,179 in 2015 to 9,226 in 2019 (p<0.001). During 2020, national cochlear implantation rates witnessed a -13.1% drop across all ages compared to 2019, including a drop of -1.6% for those aged ≤3 years, -4.7% for those aged 4-17, -9.8% for those aged 18-64, -16.7% for those aged 65-79, and -22.6% for those aged ≥80. In a multivariable linear regression model, the percent drop in CIs differed significantly by age group (p=0.004) but not by miles traveled by the patient from home to the CI center (p=0.45).

Conclusion: Children ≤3 years old were prioritized nationally with minimal interruption witnessed during 2020. Increasing age was associated with experiencing significantly greater decreases in cochlear implantation rates, with those aged ≥80 years old experiencing more than a 3-year setback in total annual CIs.
Clinical Utility of Augmentative and Alternative Communication (AAC) in Pediatric Cochlear Implant Recipients with Complex Needs: A Systematic Review

Blair Richlin, M.S., CCC-SLP LSLS AVEd, TSSLD¹, Kevin Chow, B.A.², Maura Cosetti, MD¹; ¹Ear Institute, New York Eye & Ear Infirmary of Mt. Sinai, New York, NY, ²Otolaryngology—Head and Neck Surgery, McGovern Med. Sch. at the Univ. of Texas Hlth. Sci. Ctr. at Houston, Houston, TX.

Abstract

Introduction: Augmentative and alternative communication (AAC) encompasses all forms of communication exclusive of formalized linguistic expression. In children with cochlear implants (CI) with additional diagnoses outside of hearing loss, deficits in communication may pose an additional barrier to language development. While low-tech and unaided forms of AAC such as gesturing and signing have been frequently utilized post-implantation, recent innovations have permitted the use of high-tech AAC in the rehabilitation process. Our objective was to review the implementation of AAC (aided/unaided or low-tech/high-tech) as a modality to support language outcomes in cochlear-implanted children with complex needs.

Methods: A systematic review of existing literature examining the use of AAC in pediatric cochlear implant recipients was conducted in the PubMed/MEDLINE and Embase databases. Studies with pediatric CI users who had a documented additional disability and utilized any form of unaided/aided AAC from 1985-2021 were included. Studies limited to spoken or formal sign language (e.g., ASL) as communication modalities were excluded. Cohen’s kappa was utilized as a measure of interrater reliability.

Results: 418 studies were screened of which 29 were included. 14 studies were prospective, 9 were retrospective, 1 was a combination, and 5 were case reports. Of these 29 studies, 379 patients met the inclusion criteria (age <18, CI user, additional disability, utilized AAC). Cohen’s kappa was 0.87. Additional disabilities necessitating AAC included autism spectrum disorder, cerebral palsy, intellectual disability, Down syndrome, Usher syndrome, and blindness among others. Unaided forms of AAC included gesture/behavior, informal sign, and signed exact English, while aided AAC included a Picture Exchange Communication System (PECS), Voice Output Communication Aids (VOCA), and touchscreen programs such as TouchChat® HD. A large diversity of audiometric and language development outcome measures was utilized among studies, the most common of which were the Peabody Picture Vocabulary Test (PPVT) (n=4), the Meaningful Auditory Integration Scale (MAIS) (n=4), and the Preschool Language Scale, Fourth Edition (PLS-4) (n=4).

Conclusion: While unaided AAC has been utilized as a means of language development, there exists a gap in the literature regarding the use of aided and high-tech AAC in conjunction with cochlear implants in medically complex hearing-impaired children. Furthermore, the lack of consistent outcome measures highlights an opportunity for
future research. Additional exploration of advanced AAC in this diverse population is warranted.

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Control Number: 2022-A-186-ACI
Complete Status: Complete
Presentation Number: 044
Publishing Title: Establishing clinical protocols for single-sided deafness cochlear implants: Insights from a military medical center

Joshua G. W. Bernstein, Ph.D., Elicia M. Pillion, Au.D., Anthony M. Tolisano, M.D.;

Abstract Body:

Introduction: The intended benefits of cochlear implants (CIs) for single-sided deafness (SSD)—specifically for spatial hearing—differ markedly than for traditional CIs. Thus, new standards are required for candidacy evaluation, programming, and outcome assessment. Most SSD-CI literature derives from clinical trials. Because of the importance of spatial hearing in the military, SSD-CI has become a major clinical focus in our center, constituting half our CI caseload. We will overview data from our clinical experience toward establishing standard SSD-CI protocols in three areas: spatial-hearing assessment, electrode mapping, and telehealth.

Methods: Most clinics lack spatial-hearing assessment capability. We designed a sound-localization (SL) and speech-in-noise (SIN) test protocol using speaker arrays developed for clinical use via military-sponsored small-business innovation research initiatives. We compared spatial hearing to standard speech-in-quiet (SIQ) sound-field tests and quality-of-life (QOL) outcomes (N=16). Second, traditional CI maps may not optimize SSD-CI spatial hearing, which may depend on interaural frequency alignment. Thus, we compared interaural time-difference discrimination to computed-tomography (CT) scan estimates of electrode position (N=24) to ask if the binaural system adapts to interaural misalignment or if different frequency-mapping approaches are required. Third, CI follow-up travel can be onerous, especially in the military. SSD-CI patients are an ideal group to examine CI telehealth: with a normal-hearing ear, telecommunication is easier and SSD-CI users tend to be younger and more technically abled. We developed and validated (N=5) a telehealth system that is mailed to the patient, enabling remote programming with standard cables and outcome tests with calibrated headphones placed
over the sound processor.

**Results:** The time courses of QOL, SL, SIN and SIQ benefits differed, suggesting that these outcomes should be compared after plateauing. CI-alone SIQ and binaural SIN improvement were strongly related, meaning that monaural SIQ can stand in for binaural SIN tests when necessary. CT-scan and binaural-tuning estimates of electrode position were correlated, suggesting plasticity does not overcome interaural frequency mismatch for binaural processing. Pilot tests of CT-based frequency re-mapping show improved perceptual separation of competing speech. Finally, headphone and sound-field testing yielded equivalent results and pilot tests showed the feasibility of telehealth to replace some in-person follow-up visits.

**Conclusion:** Development of clinical algorithms for SSD-CI outcome assessment, programming and telehealth delivery are feasible and highlight considerations unique to this population. [The views expressed in this abstract are those of the authors and do not reflect the official policy of the Department of Army/Navy/Air Force, Department of Defense, or U.S. Government.]

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**Control Number:** 2022-A-187-ACI

**Complete Status:** Complete

**Presentation Number:** CS2-3.1

**Publishing Title:** Clinical Trial to Expand MED-EL Synchrony Pediatric Indications

**Author Block:** Nancy Young, MD, Denise Thomas, AuD, Elizabeth Tournis, AuD, Stephen R Hoff, MD; Ann & Robert H Lurie Children’s Hosp. of Chicago, Chicago, IL.

**Abstract Body:**

**Introduction:** Use of outdated FDA candidacy indications by public and private health insurers to determine coverage is often a barrier to early cochlear implantation. This situation is an important public health issue in light of growing evidence that early implantation improves language outcome. A clinical trial sponsored by MED-EL is underway to expand indications to include infants aged seven to eleven months. Data from the lead site for this multicenter clinical trial is the subject of this report.

**Methods:** Prospective study of safety and auditory outcomes of children implanted between 7 months and 5 years 11 months with the MED-EL Synchrony, followed post activation for 12 months. Primary outcome measures: 1. Little Ears Auditory Questionnaire (LEAQ) with score of 25 defined as clinical endpoint; 2. device and surgical related adverse events.
**Results:** Nine children with severe to profound sensorineural hearing loss were bilaterally implanted at a mean age of 8.3 months (range 7 - 16): seven (78%) before age 12 months; 4 (44%) before age 9 months. No serious unanticipated surgical or device related adverse events occurred. Eight children have completed the study. The LEAQ study endpoint was reached in 6 (75%); 1 (13%) by 3 months, 3 (38%) by 6 months, and two (25%) by 12 months. To date, all children achieving clinical endpoint were implanted before age 13 months. One child not yet meeting clinical endpoint will undergo final 12-month evaluation soon and the result will be included. The two children completing the study without meeting endpoint for auditory development were suspected of having autism spectrum disorder based upon lack of expected progress and behaviors. This diagnosis was confirmed in one, while the other awaits evaluation.

**Conclusion:** This study adds to literature demonstrating the advantage and safety of infant implantation. Expanding age at implantation to 7 months of age will reduce barriers to early implantation. Lack of expected progress by children implanted during infancy may be evidence of another developmental disorder requiring evaluation and additional intervention.

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**Control Number:** 2022-A-190-ACI

**Complete Status:** Complete

**Presentation Number:** 103

**Publishing Title:** *Limitation in sound localization with bone conduction-, cochlear- and middle ear implants*

**Author Block:** Martijn J. H. Agterberg, PhD

Biophysics, Donders Inst. for Brain Cognition and Behavior, Nijmegen, Netherlands.

**Introduction:** One of the longest debates in auditory science is on the true impact of unilateral hearing loss (UHL), and there is a high degree of variation in treatment of UHL. This variation does also exist for treatment of bilateral hearing loss (BHL). Fitting of hearing implants is complicated since for UHL the signals from the implanted ear should integrate with the normal hearing ear and for BHL the signals from the implanted ears should fuse in order to provide access to binaural cues. Potentially binaural hearing abilities can be achieved.

**Methods:** Participants underwent localization testing in unilateral and bilateral hearing conditions (unaided and aided). Broadband (BB; 0.5-20 kHz) 150-ms noise bursts were presented randomly at three different levels (45, 55 AND 65 DBA) in a partial sphere in
both the horizontal and vertical plane. Patients were treated with conventional behind-the-ear devices, bone-conduction devices, cochlear implants or middle ear implants.

**Results:** We demonstrate that early implantation with a bone-conduction device or middle ear implant does not result in better sound localization abilities compared to children implanted later in life. In general, treatment with hearing implants results in bilateral hearing instead of binaural hearing.

**Conclusion:** Obviously, the impact of the first hearing implant in case of bilateral hearing loss is significant. Still, a second hearing implant should always be considered even after a longer period of unilateral hearing. Although sound localization abilities with unilateral and bilateral hearing implants remain suboptimal the benefit can still be substantial. Sound-localization performance of patients with single-sided deafness is not improved when listening with a bone-conduction device while a cochlear implant results in an improvement.

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**Control Number:** 2022-A-191-ACI

**Complete Status:** Complete

**Presentation Number:** 005

**Publishing Title:** *Facilitators and Barriers to Cochlear Implant Uptake in Adult Candidates*

**Author Block:** Gabriel Brandner, BS, Cheng Ma, BS, David Aamodt, MS, Theodore R. McRackan, MD, MSCR, Kara C. Schwartz-Leyzac, AuD, PhD, Judy R. Dubno, PhD; College of Medicine, Med. Univ. of South Carolina, Charleston, SC.

**Introduction:** Despite robust literature demonstrating the benefit of cochlear implantation (CI) in adults, uptake is thought to be very low (6-10%). This study aims to identify barriers and facilitators that affect CI uptake and better understand patient factors associated with the decision to pursue cochlear implantation.

**Methods:** Participants were classified into a surgery group that underwent CI or a no surgery group that did not receive a CI despite meeting eligibility criteria. Speech recognition (CNC and AzBio) scores were used in audiological evaluation for CI candidacy. Participants completed surveys on contributing factors in their decision to undergo implantation, the Cochlear Implant Quality of Life (CIQOL-35) profile and CIQOL-expectations instruments. Analysis between groups was preformed using chi-square analysis or Fisher Exact test for nominal data and Student’s t test or Mann-Whitney U test for quantitative data. Effect sizes were reported using Cohen’s d.
**Results:** Overall, there were minimal differences in mean pre-operative CIQOL-expectations domain scores between groups (d=0.00-0.45). The no surgery group reported higher baseline CIQOL-35 scores for emotional (d=0.82, 0.11-1.51), entertainment (d=0.80, 0.10-1.50), and social QOL domains (d=0.58, -0.12-1.27). AzBio sentences in quiet scores were higher in the better hearing ear of the no surgery group (d=0.80, -0.24-1.61) than the surgery group. The most common reported barriers to pursuing cochlear implantation in the no surgery group were fear of surgical complications and perception that hearing was not poor enough for CI surgery. Difficulty with transportation was the most common reported barrier for surgery group. All respondents within the surgery group indicated the desire for better communication abilities and reduced listening effort burden due to hearing loss as facilitators of CI uptake.

**Conclusion:** Although pre-operative expectations were similar, higher pre-operative sentence recognition ability and higher CIQOL-emotional and entertainment scores in the no surgery group were potential factors that affect CI uptake. This study provides a better understanding of patient barriers that need to be better addressed and facilitators that can be emphasized to increase CI uptake.

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**Control Number:** 2022-A-192-ACI

**Complete Status:** Complete

**Presentation Number:** CS10-2.5

**Publishing Title:** Cochlear Implantation Can Improve Auditory Skills, Language, and Social Engagement of Children with Autism Spectrum Disorder

**Author Block:**
Carolyn M. Jenks, MD1, Stephen R. Hoff, MD2, Jennifer Haney, MA3, Elizabeth Tournis, AuD4, Denise Thomas, AuD4, Nancy M. Young, MD2;


**Abstract Body:**

**Introduction:** Knowledge of the range of outcomes and benefits of cochlear implantation for children with autism spectrum disorder (ASD) is vital for parental counseling, planning of habilitation and educational support. This issue is of growing importance because the incidence of ASD is increasing in the general population. In addition, ASD is known to be associated with congenital cytomegalovirus infection and other conditions associated
with sensorineural hearing loss (SNHL). Understanding of the needs and outcomes of this population is also paramount given the trends toward infant implantation, prior to diagnosis of ASD, and to implant children known to have conditions co-occurring with SNHL likely to impact language development.

**Methods:** Children with ASD who underwent CI between 1991-2018 were retrospectively reviewed, and surveys were sent to parents. Main outcome measures included speech perception, expressive communication mode, educational placement, social engagement, consistency of CI use, and parent survey of child behavior change.

**Results:** 30 children with ASD underwent CI between 1991 and 2018. Mean age at CI was 3.5 years (range 0.8-11.8), mean age at diagnosis of ASD was 5.1 years (range 2.0-15.0) (22/30 diagnosed after CI), mean follow-up was 10.5 years (range 1.4-21.6). 33% of all and 45% of the 22 consistent device users developed measurable open-set speech perception by an average of 4.5 years of device use. Educational placement at last follow-up included 13% mainstreamed without interpreter, 50% Special Education programs, 10% therapeutic residential or day programs, 23% total communication programs, and one home schooled. Spoken language alone was used by 31% and spoken plus sign by 14%, with the remainder using sign alone, augmentative communication devices or no mode of communication. By parent report, 86% showed improvement in social engagement compared to pre-CI.

**Conclusion:** Findings in this series, the largest to date, support a growing body of literature that cochlear implantation may improve auditory skills, language and enhance social engagement in deaf children with ASD.

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**Control Number:** 2022-A-193-ACI

**Complete Status:** Complete

**Presentation Number:** CS5-1.1

**Publishing Title:** Advanced Mapping Techniques to Reduce Tinnitus Severity in Adult Cochlear Implant Recipients

**Author Block:**

Allison Young, Au.D¹, Andrea Bucker, Au.D¹, Meredith Rooth, Au.D², Margaret Richter, Au.D², Samantha Scharf, Au.D¹, Noelle Roth, Au.D¹, Sarah Dillon, Au.D¹, Alyssa Flippo, Au.D¹, Adrienne Pearson, Au.D¹, Margaret Dillon, Au.D²;

¹Audiology, UNC Health, Chapel hill, NC, ²Audiology, UNC, Chapel hill, NC.

**Abstract Body:** Introduction: Most adult cochlear implant (CI) users describe a reduction in their tinnitus severity when listening with their CI as opposed to when the device is off. For some, the
perception of bothersome tinnitus remains when the CI is on. The present study aimed to
determine whether an alternative mapping procedure reduced and/or suppressed
tinnitus when the CI was on for patients who reported bothersome tinnitus. The
hypothesis was that increasing the electric threshold levels above detection for CI users
with persistent tinnitus will mask the tinnitus and decrease bothersome tinnitus over
time.

Methods: An alternative mapping procedure was attempted for adults who reported
bothersome tinnitus with their CI. The frequency of the tinnitus was determined using a
pitch matching procedure presented in the sound field or individual electrode
stimulation. The mapping procedure was based on the tinnitus habituation therapy (THT)
approach, which combines on the presentation of consistent low-level stimuli over time
to provide habituation to tinnitus perception. Electric thresholds for the affected
channels were measured behaviorally and then increased above detection. Low-level
noise was perceived by the participants for these channels. Participants listened with this
map in attempt to habituate to the tinnitus by activating the limbic system and
autonomic nervous system. Participants completed the Tinnitus Handicap Inventory (THI)
before and after application of the alternative mapping procedure. Speech recognition
measures were completed at each interval to ensure that mapping changes did not
negatively impact performance with the CI. Tinnitus habituation was considered to be
accomplished for cases who no longer perceived the tinnitus when the electric
thresholds were reduced below detection (current clinical mapping procedure).

Results: Participant reported a reduction in tinnitus severity acutely and after listening
experience with the alternative map. No participant experienced a decrement in speech
recognition with the alternative map. Most participants were able to return to their
clinical map after the habituation.

Conclusion: The present data support the effectiveness of an alternative mapping
procedure aimed to reduce tinnitus severity for adult CI users. Incorporating tinnitus
questionnaires into the clinical protocol may better identify CI users who may benefit
from this procedure.

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Control
Number: 2022-A-195-ACI

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Status: Complete

Presentation
Number: CS4-1.8

Publishing
Title: Incidence of Cochlear Implants Among the U.S. Medicare-Aged Population
Introduction: While prior studies have demonstrated that cochlear implant (CI) prevalence remains low (approximately 13%) in the adult patient population in the U.S., data describing the incidence of CI across age groups is limited. The current study evaluates the association between age and CI incidence among adults aged 65 and older residing in the U.S.

Methods: Deidentified CI data were derived from prospectively collected patient registries from two CI manufacturers (Cochlear Americas and Advanced Bionics), which supply an estimated 85% of CIs in the U.S. Data collected included patient age at time of surgery, surgical date, and unilateral vs bilateral CI status. Incidence of bilateral severe-to-profound sensorineural hearing loss by age group was extracted from Census and National Health and Nutrition Examination Survey (NHANES) data.

Results: The study cohort included 18,950 adults ≥65 years old who underwent CI between 2015 and 2019, including 15% who were ≥85 years old. Among the U.S. population estimated to have bilateral severe to profound sensorineural hearing loss, the incidence of CI decreased significantly with age (p<0.001), with the youngest age group (65-69 years old) exhibiting a 3.7-fold higher incidence compared to those ≥85 years old (440 vs 118 per 100,000 person years). Overall, annual incidence rates increased significantly between 2015 and 2019 (p<0.001). Bilateral simultaneous implantation only accounted for 1% of the surgeries performed, although its use decreased as age increased (p<0.001).

Conclusion: Although increasing age is associated with higher rates of hearing loss and thus audiologic CI candidacy, the incidence of CI is lowest among those ≥85 years of age.
Amit Walia, MD, Matthew Shew, MD, David Lee, MD, Cameron Wick, MD, Nedim Durakovic, MD, Craig Buchman, MD, Jacques Herzog, MD; Otolaryngology - Head and Neck Surgery, Washington Univ. in St. Louis, St. Louis, MO.

**Introduction:** Electrode choice likely depends on a patient’s preoperative hearing, cochlear anatomy, and whether residual hearing will be used for electroacoustic stimulation. Recent studies have shown that cochlear duct lengths vary across patients and the ideal insertion depth may be patient specific. Accounting for the patient’s cochlear duct length may be required for electrode selection to maximize both hearing preservation (HP) outcomes and cochlear coverage. By incorporating real-time electrocochleography (RT-ECochG) during electrode insertions, the surgeon can avoid trauma to the most apical hair cells and neural elements by optimizing insertion depth. Slim lateral wall electrodes (SLWE) were designed to maximize HP and optimize cochlear coverage if acoustic hearing was lost. The objectives of this study were to (1) compare long-term HP outcomes from a cohort of patients consecutively implanted with a newly designed SLWE with and without RT-ECochG, and (2) report on whether the use of RT-ECochG improved long-term speech-perception performance. No study to date has reported on audiologic outcomes using this new SLWE.

**Methods:** Thirty-eight post-lingual adults were implanted consecutively with the CI624 fitted with the new Slim 20 lateral wall electrode. Patients were offered the SLWE if they had a low frequency pure-tone average (LFPTA; 125, 250, and 500Hz) ≤ 60dB HL and normal cochlear anatomy. The residual hearing was monitored in 12 patients during insertion by RT-ECochG. The surgeons received instant feedback on any amplitude changes of the cochlear microphonic and made electrode adjustments by pausing insertion, withdrawing the electrode, or twisting the electrode in the anti-modiolar direction. The motivation for performing RT-ECochG monitoring was based on poor early HP outcomes for the first 30 subjects. Speech-perception testing was performed at candidacy and at 3 and 6 months postactivation using the CNC word test.

**Results:** Thirty patients underwent full insertion without RT-ECochG feedback, and HP was maintained at 6-months postactivation for 7 (23.3%) patients with median LFPTA shift of 61.7 dB HL (range, 11.7 - 105.0). RT-ECochG feedback was utilized on 12 patients, of which 6 patients had full insertions and 6 patients had anywhere from 1-3 electrodes left outside of the cochlea based on RT-ECochG feedback. At 6-months postoperatively, HP was achieved on 10 (83.3%) patients and median LFPTA shift was 20.7 dB HL (range, 5.0 - 53.3). Mean difference between LFPTA threshold shift at 6-months postactivation with and without RT-ECochG was 31.3 dB HL (95% CI, 14.6 - 47.9). There was a slight improvement in delta CNC from preoperative to 3-months postactivation when using RT-ECochG, with mean difference 20.7% (95% CI, 3.3 to 38.1); however, this difference was insignificant at 6-months with mean difference 9.9% (95% CI, -12.7 - 32.5).

**Conclusion:** This study reports the first clinical experience with the new SLWE and long-term hearing outcomes with and without RT-ECochG feedback. Use of RT-ECochG monitoring during SLWE placement may result in fewer full electrode insertions, but significantly better HP rates and improved early speech-perception performance when compared to unmonitored insertions. Long-term speech-perception performance is equivalent with and without RT-ECochG. While these results are preliminary, they
strongly suggest that that monitoring and feedback is required to maximize HP results and cochlear coverage with the new SLWE.

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**Control Number:** 2022-A-200-ACI

**Complete Status:** Complete

**Presentation Number:** CS6-2.4

**Publishing Title:** Adhesive Bone Conduction Device Long Term Result & Subjective Benefit in Children with Atresia

**Author Block:** Mario E. Zernotti, MD PhD, Maria F. Di Gregorio, MD PhD, Maximo Zernotti, MD; ENT, Sanatorio Allende, Cordoba, Argentina.

**Abstract Body:**

**Introduction:** Congenital aural atresia (CAA) results in profound conductive hearing loss (CHL). There are several options for the treatment of CHL caused by CAA. Surgical options are available, as well as non-surgical ones such as headbands, soft-bands or spectacle frames. The ADHEAR system (MED-EL, Austria) is a non-surgical transcutaneous passive bone conduction system. The audio processor is placed retro-auricularly on an adhesive adapter. The aim is evaluating the hearing outcomes, speech discrimination and subjective satisfaction in children aided with the ADHEAR over a period of one year.

**Methods:** 15 children (5-16 years) with maximal CHL diagnosed with CAA were included in this prospective, observational, repeated-measures study. Each subject used an ADHEAR device for one year and served as his/her own control. Baseline, free field audiometry and speech discrimination tests were performed. To quantify the subjective satisfaction, the MAIS, MUS and KIDSCREEN questionnaires were used. Also, APSQ questionnaire was used to measure the subjective satisfaction.

**Results:** The unaided sound field threshold improved from an average PTA4 of 63.6 ± 3.4 dB HL to an aided average PTA4 of 29.3 ± 3.0 dB HL after 1 month of device use. The unaided word recognition score (WRS) improved from an average of 27.9 ± 15.9 % to an aided average WRS of 91.3 ± 4.4 % (p = .0003) after 1 month using the ADHEAR system. The average aided WRS was 92.0 ± 4.1 % (p = .0002) after 6 months and 92.7 ± 5.3 % (p < .0001) after 12 months with the ADHEAR. The test at the signal to noise ratio of +5 dB SNR revealed an unaided average WRS of 22.3 ± 13.1 %. After 1 month of device use, the aided average WRS was 80.0 ± 6.5 % (p < .0001), 81.3 ± 6.4 % (p < .0001) after 6 months and 78.7 ± 5.5 % (p = .0014) after 12 months using the ADHEAR subjective evaluation using questionnaires showed improvements and better results over time.

**Conclusion:** CAA patients using the new adhesive bone conduction hearing aid ADHEAR
had good functional gain (34 dB) and high satisfaction rates, as measured with the MAIS, MUSS and KIDSCREEN questionnaires.

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**Control Number:** 2022-A-203-ACI

**Complete Status:** Complete

**Presentation Number:** CS7-1.5

**Publishing Title:** MRI in Patients with Cochlear Implants Without Magnet Removal: A Review of 247 Cases with Focus on Patient Safety and Protocol Efficiency

**Author Block:** Robert J. Macielak, MD1, Brian J. Johnson, MD2, Robert E. Watson, M.D., Ph.D.3, Britany J. Wiste, B.S.3, Heidi A. Edmonson, Ph.D.3, John I. Lane, M.D.3, Matthew L. Carlson, M.D.2;

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**Abstract Body:**

**Introduction:** Cochlear implantation is a common option for hearing rehabilitation, with over 700,000 patients implanted worldwide. Currently there is tremendous variability among institutional practices regarding MRI use in patients with cochlear implants. The objective of this presentation is to describe methods and safety data of our established institutional protocol for obtaining MRI in patients with a cochlear implant, without the magnet being surgically removed.

**Methods:** To address increasing demand for performing MRI in patients with cochlear implant magnets in place, a radiology-administered protocol was designed based on input from neuroradiology and neurotology. Radiology technologist training modules, consent instructions, patient educational material, clinical audits, and other safeguards were implemented and applied beginning in 2018. The primary outcomes measured were magnet displacement during MRI, and operational efficiency under the new protocol.

**Results:** Since implementation in June 2018, 247 patients have completed one or more MRI studies using the radiology administered protocol. Regular clinical audit shows no reduction in patient safety when compared to a historical institutional cohort who were “wrapped” by an otolaryngology provider [12 (5%) patients experienced magnet tilt or flip]. The protocol has reduced pre- and post-scan delays and eased clinical demands for otolaryngology providers. Developed resources and other operational pearls will be shared during the presentation.

**Conclusion:** We describe a standardized radiology-administered protocol to streamline care and enhance safety for cochlear implant recipients who undergo MRI. Resources
developed, including a process map, radiology training modules, consent instructions, patient educational materials, clinical audit, and other procedural safety measures are provided so that interested groups may consider adopting similar measures according to need.

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**Control Number:** 2022-A-204-ACI

**Complete Status:** Complete

**Presentation Number:** 018

**Publishing Title:** Intraoperative use of electrical stapedius reflex testing for cochlear nerve monitoring during simultaneous translabyrinthine resection of vestibular schwannoma & cochlear implantation.

**Author Block:**

Armine Kocharyan, MD\(^1\), Ghazal Daher, MD\(^1\), Ashley Nassiri, MD, MBA\(^1\), Karl R. Khandalavala, BS\(^2\), Aniket A. Saoji, PhD\(^1\), Jamie J. Van Gompel, MD\(^3\), Matthew L. Carlson, MD\(^1\);

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**Abstract Body:**

**Introduction:** To report the novel use of intraoperative electrically evoked stapedial reflex (eSR) for cochlear nerve monitoring during simultaneous translabyrinthine resection of vestibular schwannoma (VS) and cochlear implantation (CI).

**Methods:** Study Design: Case report with video demonstration. Setting: Tertiary academic referral center.

A 58-year-old female presented with a small right intracanalicular VS with associated asymmetrical right moderate to severe sensorineural hearing loss, poor word recognition, tinnitus, and disequilibrium. Based on patient symptomatology and goals, simultaneous CI with translabyrinthine resection of the VS was performed. Cochlear implantation before the tumor was resected facilitated intraoperative eSRs by delivering repeated single electrode stimulations through the CI electrode during tumor resection. A pulse duration of 50-us and a current amplitude of 200-CL or 648-us was used to elicit eSRs visible through the facial recess. Intraoperative eSR was monitored in conjunction with electrically evoked compound action potentials (eCAP) via neural response telemetry (NRT) and electrical auditory brainstem response (eABR).

**Results:** Despite the transient eCAP amplitude and eABR latency changes, the visually observed eSRs were preserved and remained robust throughout tumor dissection,
indicating an intact cochlear nerve. Eight weeks postoperatively, the patient exhibited open-set speech capacity (65% CNC word, 40% phoneme, and 76% AzBio).

**Conclusion:** The current study demonstrates the feasibility of using intraoperative eSR via a cochlear implant electrode to monitor cochlear nerve integrity during VS resection and predict postoperative open-set performance. Future studies will be needed to substantiate these promising, yet preliminary data.

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**Control Number:** 2022-A-205-ACI

**Complete Status:** Complete

**Presentation Number:** Publishing Title:

**Author Block:** Ranin Khayr, MA1, Riyad Khnifes, M.D / M.H.A1, Noam Yehudai, M.D / M.H.A1, Talma Shpak, PhD2, Karen Banai, Ph.D. Associate Professor1;

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**Introduction:** Speech perception outcomes in cochlear implant (CI) users are quite variable, particularly in daily listening environments. Although portions of this variability can be explained by demographic, audiological and cognitive factors, considerable unexplained variability remains. Different forms of implicit learning are though to play a role in speech perception in listeners with intact hearing and in listeners with hearing loss. The goal of this study is to explore the potential contributions of perceptual, statistical and incidental learning to the perception of challenging speech in post-lingual adult CI users.

**Methods:** 30 post-lingual adult CI users (age range 35-77, M= 55) participated so far. Participants completed a comprehensive test battery including challenging speech perception tests (sentences presented in speech shaped noise as well as four-babble talker noise - HeBio, and as natural fast speech). HeBio (the Hebrew version of the AzBio sentences). The test battery also included cognitive measures (vocabulary and memory), a perceptual learning task (time-compressed speech TCS) and two visual learning tasks (statistical and incidental). Accuracy in the speech tasks was modeled with a series of generalized mixed linear models that accounted for demographic, cognitive and speech-related factors before accounting for the contribution of the learning tasks.

**Results:** No association was found across the different learning tasks; however,
perceptual, statistical, and incidental learning had unique contributions to the perception of HeBio sentences in 4-talker babble noise. A better performance in each of the learning tasks (one SD increase in the performance) predicted about 14% increase of the odds of correctly recognizing HeBio sentences in noise. Among the learning tasks, only the perceptual learning, assessed by TCS sentences, had a significant contribution to the perception of natural fast speech sentences. **Conclusion:** CI users exhibited implicit learning, suggesting that implicit learning is either maintained or restored with the use of the implant. This learning accounts for some of the individual differences in speech recognition in noise. Similar findings were reported previously in normal-hearing young adults and in older adults with age-related hearing loss. Thus, across populations, rapid implicit learning might serve as a skill listeners can use to support speech recognition. In CI users, the ability to rapidly adjust to on-going acoustical challenges is one of the factors associated with good CI outcomes.

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**Control Number:** 2022-A-207-ACI

**Complete Status:** Complete

**Presentation Number:** 059

**Publishing Title:** Cognitive involvement evaluation of listening effort in subjects with cochlear implant

**Author Block:** Sara Ghiselli, MD¹, Erica Pizzol, Audiologist¹, Orazio Tedone, Audiologist¹, Andrea Laborai, MD¹, Vincenzo Vincenti, Associated Professor², Domenico Cuda, MD¹; ¹ENT, AUSL Piacenza, Piacenza, Italy, ²ENT, Parma Univ., Parma, Italy.

**Introduction:** Cochlear implant (CI) is a standard care for individuals with severe-to-profound hearing impairment experiencing limited benefit from conventional hearing aids. However, even in a homogeneous sample of implanted patients with similar sensitivity and speech test results, quality of life and performance in everyday situations can vary considerably among subjects. One of the more promising domains explaining part of these variations in patients with CI is the ‘listening effort’ (LE). The engagement of the Working Memory (WM) during listening in difficult situations, is one of the essential factors related to LE degree. Literature agrees that LE needs to be evaluated by using multidimensionality modalities. Sentence-final word identification and recall (SWIR) test and pupillometry are two available options. The first one is a behavioural test based on engagement of the WM capacities during a repetition and recall task; pupillometry reflects the allocation of cognitive resource that is seen in the contributions of the
autonomic nervous system during the processing of a stimulus. In this study we want to evaluate different LE domains in patients with CI.

**Methods:** 15 CI users and 15 normal hearing subjects were evaluated by pupillometry during SWIR test procedure. All CI patients had good hearing performance evaluated by speech perception test and pure-tone audiometry with CI. The tests were performed at least 6 months after activation. SWIR test is composed of two tasks: identification and free recall. The participants were asked to report the final word of each sentence immediately after listening to it (identification task) and after that they were asked to recall, in any order, all the words that they had previously reported (free recall task). Both tasks were performed in noisy conditions with individualized SNR (95% speech perception in stationary noise). The pupil dilatation was recorded during both SWIR tasks and the maximum pupil dilatation was evaluated.

**Results:** Score difference was found in SWIR test in normal hearing compared implanted subjects. Free recall task showed a higher percentage of correct word recalled in the final or medium list position in both groups. Comparison of the two groups showed overall difference in pupil dilatation. Large pupil dilatation was shown during free recall task compared to repetition task. A correlation was found between SWIR score and maximum pupil dilatation.

**Conclusion:** SWIR test and pupillometry are two helpful measures for LE evaluation in patients with CI. These are good instruments that objectively underline the different LE degree in implanted patients compared to normal hearing subjects.

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**Control Number:** 2022-A-208-ACI

**Complete Status:** Complete

**Presentation Number:** 039

**Publishing Title:** SHIMP versus HIMP in diagnosing patients with Bilateral Vestibulopathy

**Author Block:**

Tessa S. van Dooren, MD\(^1\), Bieke Dobbels, MD PHD\(^2\), Floor Lucieer, MD\(^1\), Dmitrii Starkov, MsC\(^1\), Nils Guinand, MD PHD\(^3\), Angelica Perez-Fornos, MD PHD\(^3\), Vincent Van Rompaey, professor\(^2\), Raymond van de Berg, MD PHD assistant professor\(^1\), Herman Kingma, professor\(^1\);

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Abstract

Body:


Introduction: A horizontal vestibulo-ocular reflex gain (VOR gain) of < 0.6, measured by the video head impulse test (VHIT or HIMP), is one of the diagnostic criteria for bilateral vestibulopathy (BV) according to the Bárány Society. However, VOR gain calculations can be influenced by compensatory saccades during the head impulse (i.e., covert saccades). To overcome this issue, eye movements are desaccaded by the HIMP paradigm. An alternative is the Suppression Head Impulse test (SHIMP), since it reduces covert saccades in BV patients which make VOR gain calculations probably more reliable. The goal of this study was to determine the clinical consequences of using SHIMP instead of HIMP when diagnosing BV.

Methods: This study comprised 98 BV patients (diagnosed according to the Bárány criteria in Antwerp University Hospital and Maastricht University Medical Centre). They were sequentially tested with HIMP and SHIMP paradigm. Artefacts were removed from all impulses. A custom-made algorithm was used for saccade detection. VOR gain (area under the curve) was calculated on the artefact free impulses. Both VOR gain and the frequency of covert saccades were compared between the two tests. Lastly, the agreement on BV diagnosis (VOR gain < 0.6 or not) between the two paradigms (HIMP and SHIMP) was assessed.

Results: BV patients in this study showed significantly fewer covert saccades during SHIMP, compared to HIMP (p<0.005). VOR gain differed statistically significant between SHIMP and HIMP for both rightwards and leftwards head impulses (p < 0.000). In most patients there was agreement between SHIMP and HIMP on the diagnoses of BV (VOR gain <0.6 or not).

Conclusion: To our knowledge, this is the largest study population on SHIMP testing in BV patients. Covert saccades and VOR gains were significantly reduced during SHIMP, compared to HIMP. However, the clinical relevance of these statistically significant differences is small. Based on this large study population, current HIMP and SHIMP paradigm are both able to diagnose BV. To conclude, the current HIMP paradigm seems to be sufficient to identify BV, despite the interference of covert saccades.

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Control Number: 2022-A-209-ACI

Complete Status: Complete

Presentation Number: CS8-3.3
Introduction: The Cochlear implant and the sound processor has to be monitored and programmed regularly as per the needs of the child / adults to get the desired results in effective listening and the development of speech and language. Many of them had just got their surgeries done when the lockdown was imposed due to the pandemic. This greatly affected the switching on of their sound processor and affecting their progress. Remote mapping is an innovative means to provide these services to the recipients at the convenience of the clinician and the clients. Remote Mapping was done prior to the pandemic to cater to individuals who couldn’t travel due to time constraints and vast geographical distance. But the pandemic made it mandatory to offer mapping services remotely in times of switch ons of the device, troubleshooting of the device and the regular mapping needed by the recipients. Hence remote mapping became the need of the hour to help the cochlear implant recipients without the fear of travelling to their respective clinics. This needed a lot of changes in the mindset, attitude of both the recipient and the clinician. As this was a very new concept which was not very time tested. The clinician had to explore new roads and develop them to cater the services. This article provides a brief overview of remote mapping; its potential applications, the various benefits and the leading challenges surrounding it. Though technologically, remote mapping was connecting with unknown remote clinics and with our recipients, but the main focus was keeping the recipients comfortable and secure in their own space very close to home and thus providing a lot of mental peace.

Methods: Cochlear implant recipient parents filled in a survey form about their experience and quality of service offered in Nairobi, Kenya and several cities across India.

Sample Size - 24 recipients

Results: The study reflected 1. The good mental health of parents and children who availed the remote mapping services. 2. There were many families who were not comfortable taking online mapping sessions but they were forced to avail these services due travel restrictions during the pandemic. 3. Since we were offering our services online, we could cater to families who were more than 400 kms away from us and the outcome of the services provided great satisfaction. 4. None of the recipients were without their processors in the lockdown period as they could connect with us online for all their sound processor troubleshooting. 5. The remote clinics were educated in the mapping process and have become permanent partners with us. 6. This process was cost effective for the families. For example, travel expense, stay expense and the cost for doing covid tests if they had to travel to different states / countries.

Conclusion: This method proved to be a safe process keeping in mind the pandemic, which was very stressful to lead lives in a normal way in itself. Establishing connects with unknown remote clinics was very challenging initially but later on gave immense satisfaction to the recipients, remote clinics and to us. This also provided revenue
generation for the remote clinics. The pandemic gave us the way forward with a lot of confidence that remote mapping can become the new norm.

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**Control Number:** 2022-A-213-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-3.6

**Publishing Title:** Outcomes after revision of Clarion 1.2 cochlear implants

**Author Block:** Nicholas S. Andresen, M.D., Stephen P. Bowditch, AuD, Lekha V. Yesantharao, BS, Deepa J. Galaiya, MD, Francis X. Creighton, MD; Otolaryngology - Head & Neck Surgery, Johns Hopkins Univ. Sch. of Med., Baltimore, MD.

**Introduction:** Cochlear implant reimplantation (CIR) for technology upgrade or device failure is becoming increasingly common as the population of cochlear implant recipients ages. Patients with Advanced Bionic (AB) Clarion 1.2 cochlear implants may undergo CIR for device age/failure or desired technology upgrade. The objective of this study was to evaluate audiologic outcomes for patients who were initially implanted with an AB Clarion 1.2 internal device and underwent CIR for technology upgrade or device failure.

**Methods:** Retrospective chart review was performed at a single academic medical center for patients with an AB Clarion 1.2 internal device who underwent CIR to a later generation AB internal device and had available audiologic data. Pre- and post-CIR speech performance scores (AzBio, CNCw, HINT) and pure-tone averages (PTA) were compared with a student’s t-test.

**Results:** Forty-eight individuals with a mean age of 37.2 years (range 4-91 years) with a Clarion 1.2 implant underwent CIR. Twenty-six patients (54%) underwent CIR for device failure and twenty-two (46%) for a desired technology upgrade. Thirty-six (75%) were upgraded to an AB HiRes90k Advantage and 12 (25%) to an AB HiRes Ultra 3D internal device. Pre- and post-CIR speech understanding was not different for AzBio (mean change=10.2, 95% CI=−13.1-33.6, p-value=0.38), CNCw (mean change=4.7, 95% CI=−11.8-21.2, p-value=0.57), or HINT (mean change=22.2, 95% CI=−3.0-47.3, p-value=0.08) scores. Pure-tone average improved following CIR (mean change=4.3 dB, 95% CI=1.5-7.1 dB, p-value<0.01).

**Conclusion:** Revision of AB Clarion 1.2 cochlear implants does not worsen audiologic outcomes and may improve hearing in some individuals. CIR should be offered to patients with Clarion 1.2 implants that desire technology upgrade.
Abstract Body:

Introduction: When programming a cochlear implant, audiologists may choose between subjective, objective, or combination (subjective and objective) means to optimize sound perception and quality. When utilizing a subjective approach to programming the cochlear implant processor, the clinician is reliant on the patient to confirm the presence and quality of a sound stimulus. An option for subjective programming is loudness scaling, in which the audiologist can utilize a loudness-scaling chart and the patient can scale the stimuli being presented. Options for objective programming include electronically evoked compound action potentials (ECAP) and electrically evoked stapedial reflex thresholds (ESRT), in which the audiologist uses specific physiologic responses to sound as a programming roadmap. The goal of this study is to analyze and compare the outcomes of a patient cohort who have experienced both strategies following implantation.

Methods: A retrospective review was performed a single cochlear implant center to identify patients who presented to our center or were implanted at our center between 2015 and 2021. Patients were selected for analysis if clinical documentation identified that they had been programmed both by subjective loudness scaling (SLS) and either ESRT or ECAP. Demographic details, programming strategies, objective performance measures and subjective performance measures were collected as distinct data points.

Results: 6 patients having the CI622 (1), CI522 (3) and the CI512 (2) implants met inclusion criteria for this study. Their average age was 64, and 33% were female. In this study, patients were initially programmed with SLS and then switched to ESRT programming strategy by clinician. Clinician obtained ESRT measurement, then subtracted 15 clinical units and set C levels across the electrode array on electrodes 22, 16, 11, 6, and 1 (as appropriate). Regarding the group switching to objective programming from SLS, the average improvement in performance in terms of AzBio, CNC
words and phonemes was 35%, 76% and 47% respectively at 1 month of follow-up.

**Conclusion:** Though there are multiple potential options for cochlear implant programming, objective strategies, such as those based on ECAP or ESRT, are necessary tools for the CI audiologist's armamentarium. Specifically, these strategies are important considerations in suboptimally-performing patients who have previously only known SLS programming.

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**Control Number:** 2022-A-215-ACI

**Complete Status:** Complete

**Presentation Number:** CS7-2.2

**Publishing Title:** The effect of the Anatomy Based Fitting in Cochlear Implant users

**Author Block:** Luis Lassaletta, MD, Miryam Calvino, MD, Isabel Sánchez-Cuadrado, MD, Jose Manuel Morales, MD, Javier Gavilán, MD; Otolaryngology, La Paz Univ. Hosp., Madrid, Spain.

**Introduction:** Scientific evidence supports the importance of complete stimulation of the cochlea and the tonotopic alignment of the electrodes within it. The objectives of this study are (1) to determine the frequency-to-place mismatch in cochlear implant users implanted with equal electrode array length, and (2) to verify its effect on the fitting, as well as on speech results and subjective hearing quality.

**Methods:**
Prospective observational study. 8 adults underwent postoperative Computed Tomography (CT) following surgery. The Synchrony ST Flex28, with an active stimulation range of 23.1 mm was used in every case. The length of the cochlear duct and the insertion depth for each patient was measured in millimeters and degrees, taking the first most apical active electrode as reference. The tonotopic distribution of each electrode was calculated using the specific Otoplan software (CAScination AG, Bern/Switzerland). The frequency-to-place mismatch was calculated in octaves through the difference between the tonotopic distribution and that performed by default in the standard fitting software. A speech audiogram in free field, in quiet and noise, was performed at 3 months after the first fitting. A subjective open questionnaire was used to evaluate the hearing quality of the patient.

**Results:**
In 6 of the 8 patients, the cochlear duct length was >35 mm, with an insertion angle >
600º, while the other two patients had a cochlear duct length between 30 and 35mm, with an insertion depth of 540º or less. The mean mismatch for the low frequencies (most apical channel) was 0.67 for the wider insertions, and 0.93 for the shallowest insertions. The mean mismatch for the medium frequencies (1 to 3 KHz) was 0.003 for the wider insertions, and 0.01 for the shallowest insertions. It was observed that the shallower the depth, the wider the application of bandwidth in the most apical electrodes; for the insertions <540º the bandwidth for the most apical channel was >180 Hz in ABF map vs 104 Hz in the standard map. Three patients were tested with the speech in quiet and noise 3 months after the first fitting, the results being: 79% in quiet and 79% in noise for 600 º of insertion, 83% in quiet and 54% in noise for 600º and 75% and 67% for 542º. Patients with deeper insertions reported great naturalness of the sound comparing the new fitting map with their first fitting. The two patients with the shallowest insertion depth reported the lowest frequency sounds with respect to their auditory memory, this effect improving after 3 months of use.

**Conclusion:**

Insertion depth is critical in finding the best tonotopic match. The most important parameter appears to be the insertion depth of the most apical active electrode. It appears that the response with ABF would be better with insertions of 540º or greater (one and a half turns). More data are necessary to corroborate the benefit of the Anatomy Based Fitting over standard fitting in speech and subjective tests.
fNIRS (functional near infrared spectroscopy) showed that during a lip-reading task, cross-modal plasticity was positively associated with CI outcome. Thus, cross-modal plasticity appears to detrimental or beneficial, perhaps depending on the stimulus used. In this study, we examined brain responses to visually presented silent movie clips and related neural plasticity to speech perception in noise outcomes in CI users.

**Methods:** Fifteen adult CI users with at least one-year of CI experience and age-matched normal hearing (NH) controls were recruited through the Sunnybrook Health Sciences Cochlear Implant Program. While recording a high-density electroencephalography (EEG), participants were instructed to watch a 2.5s silent movie clip of a male articulating a monosyllabic word. Following a prompt, participants indicated what word was perceived. Brain source activity consisting of both evoked responses and induced oscillatory activity was compared across CI and NH groups. Both types of measures were related to clinical measures of speech in noise perception.

**Results:** CI and NH groups did not differ in visual-word identification behavioural performance. However, visual evoked potentials to the silent movie yielded significantly greater brain activity in auditory cortex in CI users compared to NH suggesting cross-modal plasticity in CI users. Greater alpha oscillations were observed in CI users compared to NH controls suggesting different neural networks are elicited. Significant correlations between the auditory cortex activation and speech in noise perception were suggesting that the degree of cross-modal plasticity is associated with better clinical outcomes in CI users.

**Conclusion:** We found that cross-modal can be quantified in CI users using silent movies as stimuli. Importantly, the degree of cross-modal activity was positively associated with speech in noise perception. These data suggest that visual language-based stimuli reveal positive cross-modal associations with outcome and may help explain the apparent contradictory findings to previous studies that have used simple, non-language visual stimuli. Importantly, the data suggests that rehabilitation may benefit from both auditory and visual based therapy.
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\textbf{Introduction:} Hearing loss greatly affects quality of life in the elderly population. It is understood that hearing loss may have a cascading effect and interact negatively with physical, cognitive and psychosocial conditions. The primary focus of this study is therefore to evaluate the change in health-related quality of life following cochlear implant (CI) treatment in the elderly. For the secondary objective, it utilizes a full array of assessments to evaluate the impact of CI treatment on healthy aging, including its physical, cognitive and psychosocial domains.

\textbf{Methods:} The study is designed as a multinational, multicentre prospective study in a large cohort of elderly individuals with equivalent CI experience. 100 first-time unilateral CI recipients at 60 years or above are examined on the full array of evaluations from preimplant to postimplant conditions, i.e., at 12 and 18 months after surgery. The primary indicator of changes in overall quality of life is the Health Utilities Index Mark 3 (HUI-3), whereas the other evaluations consist of details collected through case history and interview questionnaires by clinicians, data logging, self-report questionnaires completed by the recipients and a series of commonly used audiometric measures and geriatric assessment tools.

\textbf{Results:} This presentation will describe how these evaluations cover the different domains of healthy aging and will characterize the preoperative condition of the study population. Preliminary data will be presented.

\textbf{Conclusion:} The outcomes of this study have the potential to provide crucial clinical evidence on the improvement of overall health status in the elderly through CI implantation and its associated cost savings from a payer and societal perspective.
Introduction: Cochlear implant (CI) recipients with hearing preservation experience significant improvements in speech recognition with electric-acoustic stimulation (EAS) as compared to preoperatively with a hearing aid or postoperatively with a CI-alone. Despite the observations for better performance, outcomes across EAS users vary. These individual differences may be due in part to the wide variability across CI recipients in the angular insertion depth of the electrode array, which is influenced by cochlear morphology, array design, and surgical approach. The default mapping procedure does not consider array placement relative to the cochlear place frequency or region of aidable acoustic hearing. This results in frequency-to-place mismatches for the majority of EAS users and electric-on-acoustic masking for recipients of arrays within the region of aidable acoustic hearing. Mismatch negatively affects the speech recognition of CI-alone users, though some can acclimate to mismatch over time. For EAS users, acclimating to electric mismatch may be problematic since acoustic stimulation is resolved at the natural cochlear place. Electric-on-acoustic masking negatively affects the performance of EAS users due to the electric stimulation masking the perception of low-frequency acoustic cues. EAS users may experience better performance with a place-based map that aligns the electric filter frequencies to the cochlear place frequency to eliminate mismatch and reduces stimulation levels for contacts within the region of acoustic hearing to limit electric-on-acoustic masking. The present study assesses the performance of EAS users listening with either default or place-based maps within the initial months of device use to determine the benefits of individualizing maps.

Methods: Twenty adult CI recipients with hearing preservation were randomized at activation to receive a default (n=14) or place-based (n=6) map. Participants listened exclusively to their assigned map and completed speech recognition tasks at activation, and at 1-, 3-, and 6-months post-activation. Speech recognition tasks included vowel recognition and CNC word recognition. The vowel stimuli were presented via direct audio input and the word stimuli were presented in the sound field at 60 dB SPL. Postoperative computed tomography imaging was used to calculate the angular insertion depth of individual contacts, estimate the cochlear place frequencies, and determine whether contacts resided within the region of aidable acoustic hearing.

Results: For the default group, mismatch ranged from -12 to 2 semitones (mean: -6; SD: 4) and 3 participants had electric-on-acoustic masking. Preliminary data suggest electric-
on-acoustic masking or large magnitudes of mismatch negatively influence early speech recognition with EAS. Participants with place-based maps or default maps with minimal mismatch and no electric-on-acoustic masking experienced better speech recognition that persisted to the 6-month interval.

**Conclusion:** EAS users may experience better performance within the early months of device use with a place-based map that considers the placement of the array relative to the cochlear place frequencies and region of aidable acoustic hearing. Investigation is ongoing to determine whether EAS users with default maps eventually acclimate to the electric mismatch and achieve similar speech recognition as observed for EAS users with place-based maps.

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**Control Number:** 2022-A-221-ACI

**Complete Status:** Complete

**Presentation Number:** 141

**Publishing Title:** Cochlear implantation auditory outcomes in children with ossified and no ossified cochlear

**Author Block:**

Alessandra Murri, Medicine and Specialization in Otorhinolaryngology, Nicola Quaranta, Medicine and Specialization in Otorhinolaryngology, Roberto Bartoli, Medicine and Specialization in Otorhinolaryngology, Mara Casulli, Audiologist, Francesca Giagnotti, Speech and language therapist; Department of Otorhinolaryngology, Azienda ospedaliera Universitaria consorziale policlinico di Bari, Bari, Italy.

**Introduction:** To investigate the auditory outcome of cochlear implantation in children with ossified cochlea and to compare the outcomes in ossified and non-ossified cochleas.

**Methods:** Ossified cochlea deaf (n=39) and control (n=133) children treated with cochlear implants were included in the study. The degree of ossification of the cochlea was evaluated from a high-resolution computed tomography (HRCT) scan whereas the degree of obliteration was determined intraoperatively by the surgeon. All subjects had a Nucleus 22 cochlear implant, speech processor programming and follow-up testing in our center. The mean time of follow-up was 36 months in both groups. The hearing tests, closed and open set identification and recognition tests at various time points were analyzed in both groups.

**Results:** Children with cochlear ossification showed significant improvement in their hearing and speech perception abilities after implant. Children with cochlear ossification
had at a lower result at closed and open set identification and recognition tests, but not significantly different, than group of controls with non-ossified cochleae at both the 6- and last follow-up postimplant intervals.

**Conclusion:** Prelingually deafened children with ossified cochleae receive significant benefit from cochlear implants with auditory results like no ossified children.

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**Control Number:** 2022-A-222-ACI

**Complete Status:** Complete

**Presentation Number:** 022

**Publishing Title:** Is there a place for a middle ear implant in patients older than 60 years?

**Author Block:** Luis Lassaletta, MD, Miryam Calvino, MD, Isabel Sánchez- Cuadrado, MD, Jose Manuel Morales, MD, Javier Gavilán, MD; Otolaryngology, La Paz Univ. Hosp., Madrid, Spain.

**Introduction:**

The treatment of conductive and mixed hearing loss has dramatically changed in the last few years with both the development of new bone conduction implants, and the disappearance from the market of some middle ear implants. In this scenario, senior patients with mixed hearing loss who are not good candidates for hearing aids usually still have to choose between either bone conduction implants and middle ear implants as the main implantable options. So the main objective of this study was to compare the audiological, surgical, quality of life, and quality of sound outcomes in adults younger and older than 60 years undergoing a middle ear implant.

**Abstract Body:**

**Methods:**

21 adult patients with conductive or mixed hearing undergoing surgery with placement of the Vibrant Soundbridge (Med-El) where divided in two groups, <60 and ≥60 years old. Preoperative tests included air conduction and bone conduction (BC) thresholds, and speech discrimination score (SDS) at 65 dB for disyllabic in quiet. Postoperatively, measures included BC thresholds, free field warble tone threshold, and SDS at 65 dB for disyllabic in quiet with VSB on. Subjective benefit was evaluated using the Nijmegen Cochlear Implant Questionnaire (NCIQ), Glasgow Benefit Inventory (GBI) and Hearing Implant Sound Quality Index (HISQUI19) tests.

**Results:**

All patients underwent surgery uneventfully. Chronic ear with previous middle ear
reconstruction was the most frequent indication for the Soundbridge placement. In the older group two patients has unusual indications, including hearing rehabilitation following an infratemporal approach for a paraganglioma, and a subtotal petrosectomy in order to seal CSF leak. Both achieved results comparable to the rest of the group. Mean follow-up was 108 months (43-143), and 68 months (5-164), in the <60 and ≥60y groups, respectively. There was no significant change in the BC following surgery. Mean functional gain was 32 and 28 dB in the <60 and ≥60y group, respectively. D5 at 65dB significantly improved from 18 to 96%, and from 29 to 86% in the <60 and ≥60y groups, respectively. All NCIQ domains improved following surgery both in younger and older implantees. All patients had a positive overall GBI score (mean 61 and 39 in <60 and ≥60y, respectively). Mean HISQUI19 score was 97 in both age groups, being defined on average as “good” the quality of sound.

Conclusion:
VSB is an effective method of hearing restoration for older adults suffering from conductive or mixed hearing loss. Unusual indications can also be considered in this age group.
Res. Ctr., Nottingham, United Kingdom, \textsuperscript{a}Univ. of Nottingham, Nottingham, United Kingdom.

**Introduction**: To study the evolution of type D personality traits in older adults after cochlear implantation compared to a control group of severely hearing-impaired older adults who did not receive a Cochlear Implant (CI). A secondary purpose was to assess whether the Covid19 period influenced this evolution. Type D personality combines a high degree of negative affectivity (NA) and social inhibition (SI).

**Methods**: In this prospective, longitudinal, controlled multicenter exploratory study, 76 older CI users and 21 severely hearing-impaired controls without CI were included. The CI group and the control group did not differ significantly regarding age, formal education, residual hearing, DS14 total score, NA and SI at baseline. Type D personality traits were assessed with the Type D Scale-14 (DS14) at baseline (T0) and 14 months later (T14).

**Results**: Type D personality traits differed significantly over time between the CI group and the control group ($p < 0.001$). In the CI group, the DS14 total score ($p < 0.001$), NA ($p < 0.001$) and SI ($p < 0.001$) improved significantly over time, while no significant difference was found in the control group. Significantly fewer subjects were categorized as Type D personalities in the CI group ($p = 0.023$) at T14, whereas no significant change was found in the control group ($p = 0.250$). Covid19 did not influence the evolution of type D personality traits significantly in the CI group.

**Conclusion**: Cochlear implantation has a positive effect on type D personality traits in older adults with a severe-to-profound hearing impairment.

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**Control Number**: 2022-A-226-ACI

**Complete Status**: Complete

**Presentation Number**: CS8-2.2

**Publishing Title**: Preclinical evaluation of a surgical tool for the measurement of insertion forces during conventional cochlear implant surgery

**Author Block**: Georg Böttcher-Rebmann, M. Sc., M. Geraldine Zuniga, MD, Viktor Schell, M. Sc., Rolf Salcher, Dr., Thomas Lenarz, Prof. Dr., Thomas S. Rau, Dr.-Ing.; Department of Otorhinolaryngology, Hannover Med. Sch., Hannover, Germany.

**Abstract Body**: Atraumatic electrode array insertion has been linked to hearing preservation, but insertion forces have never been measured in vivo. We developed a surgical tool that can measure insertion forces while maintaining the conventional surgical workflow. After validating basic functionality, we aimed to assess compatibility of
our tool with standard CI surgery by evaluating handling and visibility as well as reliability of the recorded data.

**Methods:** Three CI surgeons performed electrode array insertions into three human temporal bone specimens using our tool, which records both insertion force and axis orientation. Video documentation was synchronized with the recorded data. Surgeons evaluated usability of the tool and its workflow with respect to conventional surgery using a questionnaire.

**Results:** Twenty-two insertions were successfully conducted with our tool. Electrode arrays could either be fully (73%) or partially inserted (18% with one contact at the round window, 9% with one contact outside). The tool enabled versatile handling during the insertion and offloading of the electrode array. The workflow was rated to be equivalent to conventional surgery in terms of usability and patient safety in all trials. Using the tool did not impair visibility throughout the insertions. The insertion forces showed typical exponential profiles with an average maximum insertion force of 63.9 mN ± 39.5 mN. When the tool contacted bone, artefacts of up to 400 mN distorted the signal. The mean tool orientation change was 9.4° ± 7.5°.

**Conclusion:** The preclinical evaluation shows that the handling of our tool does not compromise standard cochlear implant surgery, as rated by CI surgeons. It can reliably measure insertion forces and axis orientations. Our work identifies best practices for future surgeon training with our tool to ensure reliable measurements. Intraoperative insertion force feedback provided by our tool could reduce the risk of inflicting intracochlear trauma during electrode array insertion.

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**Control Number:** 2022-A-227-ACI

**Complete Status:** Complete

**Presentation Number:** 003

**Publishing Title:** Cochlear Implantation in Patients with Otosclerosis: Our Experience

**Author Block:** Branislava Bercikova, MD., Lukas Varga, MD., MSc., PhD., Zuzana Volmutova, MD.; Milan Profant, Prof., MD., PhD., Zuzana Kabatova, MD., PhD.; 1Department of Otorhinolaryngology- Head and Neck Surgery, Comenius Univ., Bratislava, Slovakia, 2Department of Phoniatry, Comenius Univ., Bratislava, Slovakia.

**Abstract Body:** Introduction: Patients with otosclerosis who fulfill the criteria for cochlear implantation (CI) have a high risk of cochlear duct ossification and postoperative facial nerve
stimulation. The aim of our study was to analyze intraoperative findings, postoperative facial nerve stimulation and hearing outcomes in otosclerosis CI patients from our center.

**Methods:** Seven implanted patients affected by severe to profound sensorineural hearing loss due to otosclerosis were retrospectively evaluated out of 524 implanted in total since 1994. These patients were operated between 1999 and 2021, with average age 61.1-year-old, 6 subjects with bilateral profound deafness and one with asymmetric hearing loss. We analyzed preoperative and postoperative imaging, intraoperative finding, postoperative facial nerve stimulation, tone audiometry in a free field and speech perception performance after cochlear implantation.

**Results:** 5 patients were operated through cochleostomy, 2 via round window approach. One patient had a cochlear basal turn ossification. No patient had postoperative facial nerve stimulation. Free field tone audiometry (500-4000 Hz) after CI was 31.9 dB (SD = 9.2 dB) average. The average score in monosyllabic word test under SNR 60/50 dB condition was 35%. 2 patients have bimodal stimulation, and 5 patients have pure electric stimulation from CI.

**Conclusion:** Although patients with otosclerosis have a higher risk of cochlear ossification and postoperative facial nerve stimulation, our results demonstrate clear benefits over these risks.

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**Control Number:** 2022-A-228-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-1.6

**Publishing Title:** Complete Cochlear Implant Care (CCIC) Requiring a Single On-Site Visit: Preliminary Patient and Implementation Outcomes

**Author Block:** Ashley M. Nassiri, MD, MBA, Aniket A. Saoji, PhD, Melissa D. DeJong, AuD, Nicole M. Tombers, RN, David S. Haynes, MD, MMHC, Matthew L. Carlson, MD; Otolaryngology, Mayo Clinic, Rochester, MN.

**Abstract Body:**

**Introduction:** Challenges around access to relatively scarce high-volume CI centers and a growing population of eligible cochlear implant (CI) candidates stress the need for coordinated, convenient care that minimizes travel burden and expedites care. The Complete Cochlear Implant Care (CCIC) model integrates coordinated care, telehealth, and remote programming and minimizes travel to a single trip to the institution. Preliminary clinical outcomes and implementation successes and challenges of the CCIC clinical trial are provided in this update.
**Methods:** The CCIC model (previously described) leverages upfront electronic educational materials, telehealth, local healthcare resources, same-day in-person CI evaluation and surgery with next-day activation, and remote programming to provide patients with convenient, highly-coordinated care that minimizes travel burden. To date, the CCIC prospective two-arm clinical trial has enrolled 10 patients in the CCIC arm, and 20 in the traditional CI care “control” arm. Audiologic outcomes, patient and systemic financial implications, and implementation outcomes were evaluated. Patient satisfaction outcomes were measured via electronic survey. Patients are enrolled in the trial for 12 months after surgery.

**Results:** At six months postoperatively, there were no significant differences between the CCIC and traditional care cohorts in audiologic outcomes (CNC 61% vs 59%, respectively, p=0.8; AzBi in quiet 73% vs 74%, respectively, p=0.7 in the CI only condition). All CCIC patients rated 10/10 on likelihood that they would recommend CCIC with remote programming to a friend and make the same decision to enroll in CCIC. Initial implementation challenges such as managing the new clinical workflow and working closely with schedulers to ensure appropriate appointment scheduling were overcome within 3 months. Current hardware (laptops) requirements for remote programming may limit scalability in the long-term. The implementation of new technology within a large academic medical center required several approvals and collaboration with information technology (IT) teams, which produced initial delays in implementation. For non-Medicare patients, prior written authorization requirements were addressed through the development of an alternative CCIC pathway with two in-person visits (CI evaluation then surgery and activation).

**Conclusion:** Preliminary results from the CCIC trial, a highly-coordinated CI care model leveraging telehealth and remote programming, demonstrate high patient satisfaction while maintaining clinical outcomes. Implementation challenges across sites may be overcome with minor process alterations, however, widespread, high-volume use of remote programming is currently limited by hardware requirements.

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**Control Number:** 2022-A-229-ACI

**Complete Status:** Complete

**Presentation Number:** CS10-2.2

**Publishing Title:** Facial nerve stimulation in adult cochlear implant recipients with a far-advanced otosclerosis.
Isabelle Mosnier, MD1, Maria-Pia Tuset, MD1, Françoise Cyna-Gorse, MD2, Evelyne Ferrary, MD, PhD1, Olivier Sterkers, MD, PhD1;


Introduction: Cochlear implantation (CI) is a treatment option in far-advanced otosclerosis. Previous studies in small population report higher risk of facial nerve stimulations (FNS) in these patients that can affect hearing outcomes. The aim of our study was in cochleal implanted patients for a far-advanced otosclerosis to study the FNS occurrence by correlating on pre-operative CT-scan extension and location of otosclerotic lesions to FNS, and to evaluate its impact on short- and long-term hearing outcomes.

Methods: Among 2270 adult cochlear implanted patients (1991-2017), 100 patients presented FAO (4.4 %). Demographic data, speech performance, occurrence of FNS and extension of otosclerosis on pre-operative CT scan were retrospectively analysed in 91 ears (76 implants). The mean follow-up duration was 13 ± 18 years. Patients were implanted with straight (50%) and perimodiolar (50%) electrodes of the four brands of devices.

Results: The prevalence of FNS was 21%. FNS appeared in the first month after CI, between 1 and 6 months, 6 and 12 months and after 1 year in 21%, 26%, 21 % and 32% of cases respectively. The cumulative incidence at 15 years was 33%. Extension of otosclerotic lesions was more severe in ears with FNS compared to those without FNS with 13 ears (68.5%) having a stage III, 5 ears a stage II (26.5%) and one ear a stage I (5%) vs 18 (25%), 27 (37.5%) and 27(37.5%) in ears without FNS (p<0.001). Ossification of the round window was also different between the two groups (p<0.05). Surprisingly, the extension and location of otosclerotic lesions observed before implantation were not different between group of patients with late FNS (after 1 year) and group with early FNS. Thirteen ears (68%) were implanted with a straight electrode in the group with FNS vs 32 (44%) in the group without FNS, but this difference was not significant. FNS did not impact hearing outcomes at 1-year post-CI, despite an association with a lower percentage of activated electrodes (p<0.005). Long duration of profound hearing loss and previous stapedotomy were negatively associated with speech performance at 1-year post-CI. FNS were associated with a decrease of speech performance over time for monosyllabic words in quiet (p<0.001) and sentences in noise (p<0.05, linear mix model).

Conclusion: Cochlear implanted patients for advanced otosclerosis show greater risk of developing FNS, which affect speech performance over time, likely due to a higher percentage of deactivated electrodes. High Resolution CT-scan is an essential tool allowing prediction of FNS occurrence.
Introduction: Usually in patients with congenital aural atresia the conventional approaches to bone conduction prosthesis surgeries, establish a negative condition for posterior surgery for the reconstruction of the pinna. Problems with the blood supply and excessive healing over this zone negatively influence the plastic surgeries, therefore, many auricular reconstructive surgeries fail. Describe a novel alternative approach called Supra Temporal Line Approach (STeLA) and its technique and the benefits over the skin zone to reconstructive surgeries, avoiding direct healing over the auricular zone.

Methods: 10 patients affected from CAA implanted with Bonebridge were included; in all of them STeLA technique was used. All patients presented conductive hearing loss and microtia grade III according to Marx’s classification.

Results: seven males and three females, (average 15 years old) were studied. Follow-up average was 12 months. All patients presented aural atresia. Three patients showed bilateral compromise, three patients had associated Goldenhar and Treacher Collins’s syndrome. All patients have the idea to have a second surgery to reconstruct its pinna. There were no complications, neither immediately nor long term time. All of them presented a very good zone to do a reconstruction surgery of pinna, without healing lines crossing the skin of future pinna.

Conclusion: Supra Temporal Line Approach is simpler and faster surgery avoiding the zone of possible posterior reconstruction surgery of pinna. The technique is a suitable option to the other classical approaches with similar rate of audiological results, but better position to a future plastic surgery.
HiRes Ultra Series Recall: Failure Rates and Revision Speech Recognition Outcomes

Jourdan T. Holder, AuD, PhD, Elizabeth L. Perkins, MD, Nathan R. Lindquist, MD, Nathan D. Cass, MD, Ankita Patro, MD, Rene Gifford, PhD, David S. Haynes, MD; Otolaryngology, Vanderbilt Univ. Med. Ctr., Nashville, TN.

Introduction: Patients who underwent cochlear implantation with Advanced Bionics HiRes™ Ultra (v1) or Ultra 3D (v1) have dealt with device failures. Clinical data regarding this has been lacking. Herein, we report Ultra and Ultra 3D (V1) cochlear implant (CI) electrode failures and revision speech recognition outcomes for patients at a large CI program.

Methods: This is a retrospective case series at a tertiary referral center. We included patients who underwent cochlear implantation with HiRes™ Ultra (v1) or Ultra 3D (v1) and looked at failure rate, revision surgery, and pre- and post-revision speech recognition scores.

Results: As of September 21, 2021, 65 (21.1%) of the 308 implanted devices were known failures, with 61 (19.8%) definitively associated with the recent voluntary field corrective action (FCA). The overall failure rate for adults (18.6%) was lower than the pediatric (26.9%) failure rate ($p = 0.127$). Average time to device failure was 2.2 ± 1.1 years. 47 patients (77%) completed revision surgery. For adults, there was no significant difference ($p = 0.96$) between best pre-revision speech recognition scores (median CNC = 62%, SD = 23%) and most recent post-revision performance (median CNC = 54%, SD = 27%). 79% of patients recovered to within 15 percentage points of their pre-revision scores at last follow-up (median = 7.1 months).

Conclusion: A significant number of patients were identified with hard failures of the Ultra (v1) and Ultra 3D (v1) devices. This may be due to our institution’s diligent use of electrical field imaging (EFI) to confirm device failure, which is not ubiquitously available. Despite the high failure rate, the majority of patients achieve speech recognition scores similar to pre-failure performance after revision CI surgery.
Introduction: Adult cochlear implants (CI) have been shown to result in significant improvements in communication and quality of life in those with hearing loss, yet sociodemographic disparities exist and influence the utilization of adult CI globally. In Canada, factors such as financial limitations, education level, and age have been reported as barriers to adult cochlear implantation despite a publicly funded healthcare system. This study aims to measure the extent to which sociodemographic factors influence the adoption rate of adult CI, and to determine if these disparities in adults receiving CIs have narrowed, widened, or remained constant over 10 years.

Methods: All adults 18 years or older who underwent cochlear implantation between three time periods (2010 to 2011, 2015 to 2016, and 2020 to 2021) at a tertiary centre in Canada were selected using a provincial Cochlear Implant Program database. Demographic data including postal code address, gender, age of implantation, and occupation were collected for each participant. Using postal code address, household counts aggregated by Census Metropolitan Area (CMA) for each participant were obtained from Statistics Canada’s historical and projected Census Program results. Income, educational level, occupation, and age were collected for each CMA through the Census Program. Prevalence rates of cochlear implantation by income, education level, occupation, and age will be generated. A Poisson regression model will be used to evaluate the overall trend of calculated adoption rates of cochlear implantation. Data between the three time periods will be compared.

Results: Data collection and analysis is ongoing and expected to be completed December 2021. The preliminary data collected for the 12-month period between June 2020 and July 2021 includes 157 patients (86 female, 71 male). Preliminary data showed the median household income of adult CI patients during this time period to be $89,772. Of those who have received a CI, household income for those earning in the first quartile (lower class), second and third quartile (middle class), and fourth quartile (upper lower) based on the province’s population household income were 22.76%, 39.28%, and 28.82%, respectively. The majority of adult CI recipients have earned a post-secondary certificate, diploma, or degree (56.22%) compared to those who have not earned any certificate, diploma or degree (17.26%).

Conclusion: This presentation will identify long-term trends and barriers to the access and utilization of adult CI in a publicly funded healthcare system. As the demand for these medical devices amongst adults increases in Canada, this study will provide insight into the limited capacity of resources and help inform policy outcomes of cochlear
implant programs, including whether or not funding and resources are sufficient for current and future demand.

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**Control Number:** 2022-A-233-ACI

**Complete Status:** Complete

**Presentation Number:** 013

**Publishing Title:** Safety-Relevant Environmental Sound Recognition in Adult Cochlear Implant Users

**Author Block:** Michael S. Harris, M.D.¹, Nathan Luzum, BS², Valeriy Shafiro, PhD³;


**Abstract Body:**

**Introduction:** Improvement in safety-relevant environmental sound recognition (ESR) is a presumed benefit of cochlear implantation. The impact of cochlear implantation on ESR outcomes in adults remains unclear, however. The objectives of this study were (1) to evaluate the ESR abilities of cochlear implant users for safety-relevant sounds, (2) to investigate the relationship between self-reported familiarity with environmental sounds and identification accuracy, (3) to understand the relationship between ESR and speech recognition, and (4) to evaluate the feasibility of at-home, computer-based ESR evaluation.

**Methods:** In this cross-sectional study, a cohort of cochlear implant users and normal hearing peers completed a computer-based environmental sound recognition task in which they were asked to identify 42 different environmental sounds from a closed-set of alternatives, 28 of which were safety-relevant. In addition to sound recognition, participants also rated their familiarity with each sound and judged the importance of each sound to safety. Word and sentence recognition scores were obtained using CNC and AzBio, respectively. Demographic and audiologic factors were extracted from the electronic medical record to determine if they were associated with ESR outcomes.

**Results:** Preliminary data indicates several trends. ESR among our sample of cochlear implant users was mediocre and highly variable for both safety and non-safety sounds. Cochlear implant users rated safety-relevant sounds as more familiar and more important to safety, but they did not correctly identify these sounds at a higher rate. Moderate correlations were present between familiarity ratings and identification. Correlations between speech recognition and ESR were low-moderate but not significant.
It was also found that participants conducting the test at home demonstrated greater accuracy than those tested in the laboratory. No significant correlation exists between duration of cochlear implant use and ESR, but chronological age negatively correlated with ESR.

**Conclusion:** Environmental sound recognition among cochlear implant users was mediocre and highly variable for both safety and non-safety sounds with no difference between the two sound groups. Speech recognition may not always correlate with ESR, suggesting a need to independently evaluate ESR. ESR testing for cochlear implant users can be performed using remote, web-based technology.

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**Control Number:** 2022-A-234-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS10-1.2  
**Publishing Title:** Simultaneous Resection of Intracochlear Schwannoma and Cochlear Implantation  

**Author Block:** Tirth R. Patel, MD, MS¹, Lindsay Fleischer, BA², Mark Wiet, MD¹, Elias Michaelides, MD¹;  
¹Otorhinolaryngology-Head and Neck Surgery, Rush Univ. Med. Ctr., Chicago, IL, ²Cooper Med. Sch. of Rowan Univ., Camden, NJ.

**Abstract Body:** Intralabyrinthine schwannomas, including the intracochlear variety, are rare benign tumors. They can cause a number of symptoms and have the potential to grow to involve other critical structures of the inner ear and skull base. While surgical resection is feasible, there is typically permanent hearing dysfunction as a result of resection and subsequent fibrosis. Here, we present two cases of intracochlear schwannomas (ICS) that were successfully resected with simultaneous cochlear implant placement.

**Methods:** Patient 1 presented with an intravestibulocochlear schwannoma. This patient underwent a translabyrinthine approach. Endoscopic assistance was used to dissect the tumor from the vestibule and basal turn of the cochlea, through an enlarged round window approach. A cochlear implant was placed via a round window cochleostomy. Patient 2 presented with an intracochlear schwannoma involving the basal and middle turns of the cochlea. The patient underwent a trans-otic approach for resection. A large portion of the cochlear promontory required unroofing for complete exposure of the tumor. A cochlear implant was then placed via a round window cochleostomy.

**Results:** Upon cochlear implant activation, Patient 1’s soundfield thresholds using the
Implant were near the normal range of hearing, ranging from 25-50 dB HL from 250 to 6,000 Hz. Patient 2’s six-month post-operative cochlear implant soundfield testing ranged from 20 to 30 dB HL from 250 to 6,000 Hz and speech recognition testing revealed 59% on AZ Bio sentences compared to 0% pre-operatively.

**Conclusion:** Simultaneous cochlear implantation after resection of intracochlear schwannomas is safe and successful in restoring hearing. Resection of ICS can be safely performed with excellent results. Attention to adequate exposure and endoscopic assistance, when required, allows for gross total resection while minimizing trauma to cochlear structures. In such cases, immediate cochlear implantation allows for hearing rehabilitation before likely cochlear fibrosis can occur.

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**Control Number:** 2022-A-235-ACI

**Complete Status:** Complete

**Presentation Number:** CS1-2.1

**Publishing Title:** A Systematic Review of Sociodemographic Disparities in Pediatric Cochlear Implantation Outcomes

**Author Block:**

Anas M. Qatanani, BS¹, Mahmoud Omar, BS², Nerone Douglas, BS², Baraa Nawash, BS³, Tamara Ibrahim, BS⁴, Syed Zane Kaleem, BS⁴, Brian McKinnon, MD⁵; ¹Otorhinolaryngology, Drexel Univ. Coll. of Med., Philadelphia, PA, ²Otorhinolaryngology, Univ. of Pittsburgh Sch. of Med., Pittsburgh, PA, ³Otorhinolaryngology, Univ. of Pittsburgh Coll. of Med., Pittsburgh, PA, ⁴Otorhinolaryngology, Georgetown Univ. Sch. of Med., Washington, DC, PA, ⁵Otorhinolaryngology, Univ. of Texas Med. Branch at Galveston, Galveston, TX.

**Abstract Body:**

**Introduction:** Sociodemographic determinants, such as income, parental education, gender, and geographic location, impact access to cochlear implantation (CI) and postoperative resources. However, the impact on CI outcomes is unclear. This paper seeks to determine the impact of sociodemographic variables on learning outcomes among CI recipients around the world.

**Methods:** A qualitative systematic review of PubMed, Scopus, Web of Science, and Embase databases was conducted to determine the association of sociodemographic variables on pediatric learning outcomes, including speech perception and comprehension, expressive and receptive language, auditory development, and speech intelligibility. The NIH quality assessment tools were used to assess for risk of bias.

**Results:** Of 807 unique abstracts reviewed, 80 full-text articles were analyzed for
inclusion in our systematic review. Thirty-five studies were eligible for inclusion with an additional 3 articles identified via reference search of the eligible studies. There are 11 retrospective studies, 13 prospective cohort studies, 12 cross-sectional analyses, and 2 studies that are both cross-sectional and retrospective in design. The studies span the years 1999 to 2020, were conducted in 19 countries, and include a total of 3246 children. **Conclusion:** Significant determinants of CI outcomes were parental education, income, gender, geographic location, insurance status and type, the number of languages spoken in the household, and family size and composition, and ethnicity, with the first three variables being the most often studied. Addressing barriers to continuity of care may mitigate the impact of the sociodemographic factors on CI outcomes. Future studies should conduct multivariate analyses to delineate the individual impact of the sociodemographic variables significantly associated with CI outcomes.

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**Control Number:** 2022-A-236-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-1.3

**Publishing Title:** Use of Geographically Weighted Poisson Regression to Examine Spatial Varying Influences on Adult Cochlear Implantation within a Universal Healthcare System

**Author Block:** Melissa S. Lee, BMSc, MSc\(^1\), Zhen Mei, PhD\(^2\), Emmanuel Chan, HBSc\(^3\), David Shipp, MA, CAAA\(^4\), Trung N. Le, MD\(^4\), Joseph M. Chen, MD\(^4\), Vincent Y. Lin, MD\(^4\);

\(^1\)Faculty of Medicine, Univ. of British Columbia, Vancouver, Canada, \(^2\)Manifold Data Mining Inc., Toronto, Canada, \(^3\)Evaluative Clinical Sciences Platform, Sunnybrook Res. Inst., Toronto, Canada, \(^4\)Department of Otolaryngology–Head and Neck Surgery, Sunnybrook Health Sciences Centre, Univ. of Toronto, Toronto, Canada.

**Introduction:** In Ontario, three tertiary centres provide over 200 adult cochlear implant (CI) surgeries annually with costs covered by the province's universal healthcare system. As the prevalence of hearing loss and demand for adult CIs increase, the supply and expansion of CI programs have not increased at the same rate. Recent research has shown that geographical barriers and socioeconomic factors such as distance, population, age, and income create inequities in access to these devices for adults. Geographically Weighted Poisson Regression (GWPR) is a method to explore spatial varying impacts of these factors across the study area focusing attention on local variations. This study aims to (i) describe the geographic patterns of adult CIs within a universal healthcare system and identify clusters, and to (ii) analyze the spatial

**Abstract Body:**
association between adult CI and neighbourhood socioeconomic indicators using GWPR.

**Methods:** All adults 18 years or older who underwent cochlear implantation between June 2020 and July 2021 at one tertiary centre were selected using the provincial Cochlear Implant Program database. Demographic data including postal code address, gender, age of implantation, and occupation were collected for each participant. Using postal code address, household counts aggregated by Census Metropolitan Area (CMA) for each participant were obtained from Statistics Canada’s historical and projected Census Program results. Number of households, population, age, and income were collected for each CMA through the Census Program. Distances between CMAs and the tertiary centre’s CMA were collected. A comparative index for each CI recipient was calculated by dividing CMA household count by the Ontario population (reference group), with the average Ontario value index of 100. Indices greater than 100 indicate the value of the patient is higher than the average Ontario population for each factor, and vice versa. GWPR will be performed to assess the relationship between adult CI prevalence and socioeconomic factors (distance, population, age, and income).

**Results:** Data collection is complete and GWPR is to be performed by November 2021. The preliminary data collected for the 12-month period between June 2020 and July 2021 includes 157 patients (86 female, 71 male). Based on preliminary data, three CMAs with the highest comparative indices (values > 370) were located within 150 km of the tertiary centre, had 25% to 32% of the population older than the age of 65, and had average household incomes less than the average Ontario household income. Furthermore, the comparative indices of three CMAs with the largest populations and greatest average household incomes of all CMAs in Ontario were between 113 and 224. CMAs in rural regions (>700 km away from any tertiary centre) had no adult CI recipients. In addition, CMAs with comparative indices less than 100 were located greater than 150 km away from the tertiary centre and had smaller proportions of the population over the age of 65 (15.45% to 20.77%).

**Conclusion:** GWPR is useful in capturing the spatially non-stationary relationships between adult CI rates and predicting factors at a CMA level. By capturing the spatial heterogeneity between recipients of adult CIs, this presentation will identify geographic areas being under-serviced and allow for stakeholders to make informed decisions regarding improving equitable access to adult CIs within a universal healthcare system.

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**Control Number:** 2022-A-239-ACI

**Complete Status:** Complete
Introduction: An active bone conduction hearing device (BB 601) was approved in Germany in 2012. Next generation of the device (BB 602) was launched in summer 2019. We present our data regarding the surgical procedure and outcome of both systems.

Methods: Retrospective chart study, single-subject repeated-measures design in a single tertiary referral center. Three indication groups were identified: malformations, middle ear revision and single sided deafness. All patients implanted with a BB device were evaluated. Audiologic measurements were performed in German-speaking and cooperative patients. Different indication groups were compared regarding surgical problems and outcome. Air and bone conduction threshold and word recognition improvement scores in aided and unaided condition were measured. Tests varied according to individual abilities and age groups.

Results: 69 patients aged 5 to 71 years received 78 implants. 42 cases belong to the malformation group with a normal bone conduction hearing threshold in the most. 20 cases presented with a mixed hearing loss after multiple ear surgeries and 16 with a single sided deafness. In the last mentioned group, the device was used as a “Contralateral Routing of Signals”-(CROS)-hearing aid. A variety of individual anatomical and surgical situations was observed. Intraoperative complications were not seen. Implant fixation by self-taping or self-drilling screws was equally stable and easy to perform. Most of the patients were available for audiological testing. Significant speech discrimination improvement was found in all patients tested after at least 3 months. Audiological outcome was similar, independently of the implant version or fixation method.

Conclusion: BB is approved for use in children and adults. The active bone conductive hearing implant provides an excellent option for hearing rehabilitation in patients not able to use a conventional hearing aid. According to our experience since 2012 the surgical procedure is simple, safe and reliable.
Introduction: The aim of this study was to retrospectively investigate if there is any incidence of electrode tip fold-over with 31.5mm long and flexible lateral wall electrodes implanted in two high-volume Cochlear Implant (CI) centers in Germany. In addition, a detailed literature review was performed to capture all the peer-reviewed publications reporting on tip fold-over with CI electrodes from different CI brands for comparison.

Methods: Post-operative X-ray images of FLEX SOFT electrode from MED-EL in Stenver’s view were retrospectively investigated for the presence of electrode tip fold-over from 378 consecutive cases in two high-volume CI centers in Germany. All patients were implanted between 2010 and 2018 by three individual experienced CI surgeons using round window and extended round window approach for CI electrode insertion. A literature review was performed following a thorough PubMed (https://www.ncbi.nlm.nih.gov/pubmed/) search using the keywords “cochlear implant electrode tip fold-over” or “cochlear implant electrode tip roll-over” to capture articles that were published until December 2020 in English language only. Articles selection was based on electrode-related issues investigated only in-patient cases applying imaging modality. Those studies investigated tip fold-over in cadaveric temporal bones and cases with inner-ear malformation excluded.

Results: No single case of tip fold-over was clinically detected from the retrospective investigation of post-operative X-ray images from 378 consecutive cases. The electrode angular insertion depth as measured applying the cochlear coordinate system, varied from a minimum of 5608 to a maximum of 7208. The literature review on the tip fold-over issue resulted in 24 peer-reviewed published articles in total. Tip fold-over with pre-curved modiolar-hugging electrodes
was reported in 85 cases out of 1,606 implantations making an incidence rate of 5.3%. With the straight lateral wall electrodes, the tip fold-over was reported in four cases out of 398 implantations making an incidence rate of 1%, not including the number of implantations reported in the current study. Otherwise it would be 0.5%.

**Conclusion:** Electrode tip fold-over with 31.5mm long flexible lateral wall electrodes is highly exceptional and this can be generalized to any of the straight lateral wall electrodes from any CI brand. The literature review on tip fold-over revealed an incidence rate of 5.3% with pre-curved or modiolar-hugging electrodes and 1% with straight lateral wall electrodes from CI brands. Including this series of 0% tip fold-over, the incidence rate of electrode tip fold-over with LW electrode type would be 0.5%.

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**Control Number:** 2022-A-243-ACI

**Complete Status:** Complete

**Presentation Number:** 166

**Publishing Title:** Quality of Life of Chinese-Americans with Cochlear Implants

**Author Block:** Caleb J. Fan, M.D.¹, Maria A. Mavrommatis, M.D.¹, Kevin Wong, M.D.¹, Vivian F. Kaul, M.D.¹, Zachary G. Schwam, M.D.¹, Theodore R. McRackan, M.D. M.S.C.R.², George B. Wanna, M.D.¹, Maura K. Cosetti, M.D.¹; ¹Otolaryngology, Mount Sinai Hosp., New York, NY, ²Otolaryngology, Med. Univ. of South Carolina, Charleston, SC.

**Introduction:** The quality of life (QOL) of adult Chinese-speaking Chinese-Americans after cochlear implantation (Col) has not been investigated and may be a valuable tool in understanding barriers to hearing healthcare in this population. We hypothesize that socioeconomic factors may be associated with QOL outcomes in Chinese-speaking Chinese-American Col users, which may vary from that of English-speaking American Col users.

**Abstract Body:** We performed a prospective cohort study surveying 30 adult Chinese-speaking Chinese-Americans with prelingual (12) or postlingual (18) deafness who underwent Col
at a tertiary care center between 1995 and 2020. All patients were at least 1 year from CoI activation and completed a validated CoI-specific QOL instrument, the CIQOL-10 Global (scored out of 100), which was cross culturally adapted into Chinese using established guidelines. CIQOL-10 Global scores were compared to published normative values. 

**Results:** Compared to postlingually deafened patients, prelingually deafened patients were younger (Hedges’g = 2.7, 95% CI [1.7, 3.8]), more likely to speak English as a primary language with Chinese as a second language versus Chinese only (Cramer’s V = 0.70, 95% CI [0.5-0.9]) and more likely to have obtained a higher level of education (Cramer’s V = 0.52, 95% CI [0.4-0.8]). Prelingually deafened patients had a shorter duration of hearing loss prior to first CoI (Hedges’ g = 0.8, 95% CI [0.05, 1.6]) and had a longer duration of first CoI use (Hedges’ g = -1.5, 95% CI [-2.4, -0.7]) compared with postlingually deafened patients.

There were no detectable differences in mean CIQOL-10 Global scores between the prelingual (mean 51.9, SD 11.0) and postlingual (mean 44.0, SD 16.4) cohorts (mean difference 7.9, 95% CI [-2.3, 18.1]). Using bivariate analyses, no examined variables were associated with CIQOL-10 Global score in the prelingual cohort. In contrast, combined household income (r=0.5, 95% CI [0.07, 0.8]) was positively associated with a higher CIQOL-10 Global score in the postlingual cohort. For all enrolled patients, multivariable analysis demonstrated that only combined household income (β = 7.4, 95% CI [0.7, 14.0]) was positively associated with CIQOL-10 Global scores. The previously published mean CIQOL-10 Global score of English-speaking American CoI users is 51.5 (SD 10.4). While there was no significant difference between the mean CIQOL-10 Global score of the prelingual cohort and English-speaking American CoI users, there was a significant difference in the mean CIQOL-10 Global score of the postlingual cohort and English-speaking American CoI users (mean difference -7.5, 95% CI [-12.6, -2.4]).

**Conclusion:** This study is the first to evaluate QOL after CoI in Chinese-speaking Chinese-American adults. Combined household income may be positively associated with QOL. More resources are needed to assess outcomes and support rehabilitation in the Chinese-speaking Chinese-American CoI population, especially in those who are postlingually deafened.
**Abstract Body:**

**Introduction:** Preservation of residual hearing is an important goal of modern cochlear implant surgery. Many factors are thought to be significant in the preservation of residual hearing through the reduction in intraoperative trauma to the cochlea. The aim of this study was to determine the effect of various mechanical factors on intracochlear pressure variation during cochlear implantation.

**Methods:** In this in-vitro study, changes in intracochlear pressure were measured against: varying speeds, different depths; and level versus underwater insertions, of a dummy implant electrode array into an artificial cochlea model. Two variables were used to measure intracochlear pressure variation, measuring both transient and aggregate changes in pressure. Additionally, a novel surgical assistance device was used to maintain consistent performance. A total of 240 insertions were performed.

**Results:** The study found that a deeper insertion was associated with a greater transient intracochlear pressure variation (0.059 +/- 0.007 kPa versus 0.04 +/- 0.011 kPa). The study also found that performing an insertion underwater was associated with increased intracochlear pressure variation (0.069 +/- 0.022 kPa versus 0.03 +/- 0.003 kPa). The study did not demonstrate a relationship between the speed of insertion and the intracochlear pressure variation to a level of statistical significance.

**Conclusion:** Whilst deeper insertions and underwater insertions were associated with increased intracochlear variation, there was no association between speed of insertion and intracochlear pressure variation.
**Introduction:** Preservation of residual hearing is an important goal of modern cochlear implant surgery. Many factors are thought to be significant in the preservation of residual hearing through the reduction in intraoperative trauma to the cochlea. The effect of surgeon experience on residual hearing has never been studied.

**Methods:** Participants at a cochlear implantation hearing preservation workshop open to surgeons and audiologists were invited to participate in a challenge to insert a cochlear implant electrode into an In-Vitro model of a cochlea. Intracochlear pressure variation was measured as a surrogate marker for intracochlear trauma against insertion time, method of insertion, moisturization of the electrode, completion of the insertion and participant experience.

**Results:** The study demonstrated that the relative experience of a surgeon was a significant predictor of the sum of extra-physiological intracochlear pressure variation. No other variables were deemed significant for either sum extra-physiological pressure variation or for maximal pressure variation.

**Conclusion:** Surgeon experience was a significant factor in the reduction of intracochlear pressure variation during cochlear implantation simulations.

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**Control Number:** 2022-A-246-ACI

**Complete Status:** Complete

**Presentation Number:** 159

**Publishing Title:** TMPRSS3 gene variants with implications for auditory treatment and counseling

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**Abstract Body:**

**Introduction:** Autosomal recessive non-syndromic hearing loss (ARNSHL) is the most common form of hereditary hearing loss. It accounts for about 70-80% of congenital hereditary hearing loss. ARNSHL is an extremely heterogenous condition as more than 98 loci have been mapped and 77 causative genes have been identified to date. The *TMPRSS3* gene encodes a type III transmembrane serine protease that is structurally
defined by four functional domains: a transmembrane domain, low density lipoprotein receptor A domain, scavenger receptor cysteine rich domain, and a carboxyl terminal serine protease domain. The TMPRSS3 gene is expressed in inner hair cells, spiral ganglion neurons (SGNs), the stria vascularis, and cochlear aqueducts of fetal cochlea. The transmembrane serine protease 3 protein is thought to be involved in the development and maintenance of the inner ear, perilymph, endolymph and SGNs. While the function of the TMPRSS3 gene in the auditory system is not fully understood, its alteration has been linked with non-syndromic genetic hearing loss. The incidence of TMPRSS3-associated ARNSHL is variable amongst different ancestral backgrounds, ranging between 0.7 - 11% of ARNSHL cases. In contrast, pathogenic variants in the GJB2 gene are found in up to 50% of patients with ARNSHL. Despite the relatively low proportion of ARNSHL cases attributed to TMPRSS3, the gene remains a prime candidate for post lingual progressive ARNHSL in North European populations. We identify and report novel variants in the TMPRSS3 gene and their clinical manifestations related to hearing loss as well as intervention outcomes. This information will be helpful for genetic counseling and treatment planning for these patients.

**Methods:** Literature review of previously reported TMPRSS3 variants was conducted. Reported variants and associated clinical information was compiled. Additionally, cohort data from 18 patients, and their families, with a positive result for TMPRSS3-associated hearing loss were analyzed. Genetic testing included sequencing and copy number variation (CNV) analysis of TMPRSS3 and the Laboratory for Molecular Medicine’s OtoGenome-v1, -v2, or -v3 panels. Clinical data regarding patient hearing rehabilitation was interpreted along with their genetic testing results and in the context of previously reported cochlear implant outcomes in individuals with TMPRSS3 variants.

**Results:** There have been 87 previously reported TMPRSS3 variants associated with non-syndromic hearing loss in more than 20 ancestral groups worldwide. We report occurrences of known variants as well as one novel variant: deletion of Exons 1-5 & 13 identified from our cohort of 18 patients. The hearing impairment in many of these families was consistent with that of previously reported patients with TMPRSS3 variants (i.e., typical down-sloping audiogram). Recent studies have shown predominantly positive outcomes following cochlear implantation (CI) in patients with TMPRSS3 variants. This is in agreement with good outcomes following CI in two patients from our cohort.

**Conclusion:** Bi-allelic variants of TMPRSS3 are associated with down-sloping hearing loss regardless of ancestry. The outcome following cochlear implantation in patients with variants of TMPRSS3 is excellent. Therefore, cochlear implantation is strongly recommended for hearing rehabilitation in these patients.

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Introduction: This paper deals with retrospective study of complications that occurred in pediatric Cochlear implantations in our own center as well as in centers where I have mentored the ENT surgeons in Cochlear implantation.

Methods: Our implant program is 17 years old and we have 777 implants to our credit with 744 children and 33 adults. I have mentored 30 ENT surgeons from different parts of India & Vietnam. We had a total of 68 complications of which 41 occurred during surgery and 27 were post-operative complications. All these complications were managed by me in the respective centers and the mentees were taught not only how to manage them but also how to avoid them.

Results: The intraoperative complications were Emissary vein bleeding in two cases which was controlled with bone wax without compromising the hemodynamic status of the child. Three cases of Dural injury which occurred while drilling the bed for the implant by the mentee were closed with fascia grafting, tight bandage and oral acetazolamide postoperatively. Fourteen cases of CSF gusher were tightly plugged with Connective tissue and the patient was nursed in head high position and oral Acetazolamide. Three cases of External auditory canal breach were closed with cartilage reconstruction. Four mentee surgeons had difficulty in identifying the round window and hence had put the electrode array in wrong positions. They were taught how to identify the round window and misplaced electrode arrays were removed and these children were Re-implanted with new electrodes. Incomplete insertions which occurred in four cases underwent removal of the electrode and complete reinsertion. One case of tip fold over was revised during the first surgery itself. Two Minor facial nerve injuries recovered with conservative management. Receiver stimulator template which was left behind inadvertently by the mentee was removed by a separate incision. Post-operative complications like Hematoma and Receiver stimulator package migration were managed with drainage and repositioning the package and anchorage. Four cases of Scalp infection and device exposure were treated with antibiotics, debridement and periosteal flap rotation. Whenever this didn't work, explantation & Re-implantation was done. Two cases of Cholesteatoma in an implanted ear were managed by disease clearance with preservation of working implant initially and in case of recurrences explantation was done. These children underwent Re-implantation at a later date. Eleven cases of Failed
devices were explanted, and these children received new implant free of cost at the same sitting. Four cases of facial nerve stimulation were managed by switching off the offending electrodes and frequency transposition among the remaining active electrodes. In one case of displaced magnet, it was repositioned surgically. A case of Meningitis was managed conservatively.

**Conclusion:** Understanding the possible complications in Cochlear implant surgery will help everyone concerned in avoiding them. It also helps the surgeon in counselling the parents in difficult cases before surgery.

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**Control Number:** 2022-A-248-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-3.4

**Publishing Title:** Readability and Quality of Online Health Information about Cochlear Implants

**Author Block:**

Evan Nix, MD, MBA\(^1\), Abbigayle Willgruber, BS\(^2\), Chase Rawls, BS\(^2\), Brian Kinealy, MD\(^1\), Daniel Zeitler, MD\(^3\), Marissa Schuh, MPH\(^1\), Matthew Bush, MD, PhD\(^1\); \(^1\)Otolaryngology - Head and Neck Surgery, Univ. of Kentucky, Lexington, KY, \(^2\)Univ. of Kentucky, Lexington, KY, \(^3\)Virginia Mason Med. Ctr., Seattle, WA.

**Introduction:** Internet-based health and healthcare information directed at patients as consumers can have a significant impact on the type and timing of healthcare utilization. Patients are becomingly increasingly reliant on the internet as a means of obtaining educational materials related to their health; however, the clarity and accuracy of this information may vary widely. Internet website health information should be written at or below a 6\(^{th}\) grade reading level, based on American Medical Association recommendations. The purpose of this study was to evaluate the readability and quality of internet website health information about cochlear implants using validated assessment tools.

**Methods:** The term “cochlear implant” was queried in 4 internet search engines and the top 200 websites (either in English or Spanish) were aggregated. Hearing device sponsored websites were excluded. After removing duplicates, the remaining websites were evaluated for information quality using the validated DISCERN quality criteria (0-80 scale with 80 being the best quality) and by the presence or absence of Health on the Net Code of Conduct (HONcode) certification. Readability was assessed using the following validated tools: Flesch Reading Ease Level (FREL) for English websites and the Fernandez-
Huerta Formula (FHF) for Spanish websites. The readability assessments provide an objective score from 0-100 (worst readability is 0 and best readability is 100) that is closely correlated with a grade reading level.

**Results:** A total of 44 English and 42 Spanish cochlear implant health information websites were included in the study. English websites were written at a significantly more advanced reading level (mean = 51.07, SD = 11.9) compared to Spanish websites (mean = 59.94, SD = 6.66) \( p < 0.01 \). For both English and Spanish websites, these scores correlate to the reading level of the average 10th to 12th grade student. Only 12% of Spanish websites were HONcode certified, compared to 27% of English websites. The average DISCERN health information quality score was 41.67 for English websites and 43.46 for Spanish indicating significant concerns for quality. Based on DISCERN criteria, there was no significant difference in quality between English and Spanish websites.

**Conclusion:** Patient-directed English and Spanish websites regarding cochlear implantation were written at reading levels that significantly exceed the recommended 6th grade reading level. Furthermore, these websites have significant quality shortcomings. Patients would benefit from improvements in both the readability and the quality of online health information about cochlear implants through certification of quality and rigorous editing to improve readability of content.

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**Control Number:** 2022-A-249-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-3.5

**Publishing Title:** Electrode Position and Clinical Outcomes in Revision Cochlear Implantation

**Author Block:**

Arianna R. Winchester, MD, Emily Kay-Rivest, MD, MSc, Sean O. McMenomey, MD, David R. Friedmann, MD, MSc, J. T. Roland, Jr, MD, Babak Givi, MD, Daniel Jethanamest, MD, MSc; Otolaryngology - Head and Neck Surgery, NYU Langone Health, New York, NY.

**Introduction:** Revision cochlear implantation (CI) is an uncommon scenario that poses unique challenges in achieving optimal electrode positioning and clinical outcomes. We investigated the frequency of revision CI at our center with a focus on electrode array positioning and hearing outcomes.

**Methods:** All adult and pediatric CI from 2011-2020 were reviewed and revision cases were selected. Demographics, indications for revision, radiologic and surgical details,
complications and audiologic outcomes were analyzed. Intra-operative radiographs were independently reviewed by two investigators to determine angular depth of insertion (aDOI) in primary and revision CI.

**Results:** During the study period, 100 ears in 83 patients (44 adults, 39 children) underwent revision CI. Indications included hard failure (43, 43%), medical/surgical causes (infection, device migration, suboptimal insertion, trauma, cholesteatoma; 41, 41%), and soft failure (pain, extra sounds, minimal benefit; 16, 16%). Eleven patients (13.2%) required more than 1 revision; 1 required 3 revisions. The average time to revision was 5.0 years (SD: 6.4). A device from the original manufacturer was used in 89% of cases (n=89). In all sub-groups, patients declined significantly from their baseline word recognition score (WRS) on the failing side before undergoing revision and improved significantly afterwards. WRS with the revised device was not significantly different from baseline (p>0.99). Soft failures had significantly worse post-revision WRS than those revised for other indications (mean: 48.5, p<0.01). Patients who declined on post-revision score waited longer for their revision (mean: 9.4 years, SD: 8.0, p<0.01). Pediatric patients performed significantly better than adults at all timepoints and patients >65 years of age performed significantly worse at post-revision. Insertion depths were similar between primary CI (mean aDOI: 395.5°, SD: 39.8) and revision CI (388.9°, 54.0) (n=57, p=0.46). Only 12 (21%) of revisions with available imaging were >45° shallower than original insertions and had no difference in outcomes. Hard failures (mean original: 402.2°, SD: 43.5; mean revision: 392.8°, SD: 32.9) and medical/surgical failures (398.8°, 41.5; 377.3°, 58.0) had slightly shallower reinsertions; soft failures (362.3°, 50.0; 404.1°, 64.3) had significantly shallower original insertions (p=0.01) and deeper reinsertions than the rest. Those who received a different electrode at revision also had deeper reinsertion (392.6°, 51.4; 419.5°, 49.2; p=0.04).

**Conclusion:** Revision CI surgery is infrequent but generally leads to improved clinical outcomes. Most revisions are due to hard failures and medical/surgical causes, in which the success rate is high. Overall, revision electrode insertions achieve a comparable depth to primary insertions. Patients revised with a different electrode have deeper revision insertion with no associated change in outcomes.
Introduction: Earlier cochlear implantation (CI) in children with bilateral severe to profound sensorineural hearing loss is associated with improved language outcomes and should be performed as soon as possible, ideally within 12 months of age. However, access to early CI in pediatric populations can be complicated by multiple socioeconomic and psychosocial factors. The purpose of this study is three-fold: first, to describe the epidemiology of pediatric CI in California both from individual and geographic frameworks; second, to identify sociodemographic factors associated with early CI; and third, to investigate the role of maternal education and parenting in early CI.

Methods: The HCUP California SASD for 2018 was obtained. All patients who underwent CI (CPT 69930) aged ≤18 years were included in the final cohort. First, a binary outcome variable for early implantation was generated and defined as CI at ≤2 years of age. Binary logistic regression analysis was conducted to determine what socioeconomic factors were independently associated with earlier pediatric CI. Second, cases were aggregated into hospital referral regions (HRR) to characterize geographic variability in pediatric CI practice patterns. For each HRR, the incidence rate and the percentage of pediatric implants performed at ≤2 years old were measured. Finally, data regarding general population high school completion percentage, maternal high school completion percentage, and percentage of single mother households for each HRR were obtained from American Community Survey 2018 data. A multivariate generalized linear model was generated to determine whether these variables were associated with the percentage of early CI in each HRR.

Results: Among 229 pediatric cochlear implantation patients, 58 (25.3%) were implanted at ≤2 years of age. Asian children had the highest incidence rate of CIs relative to all other races, with 73.0 CIs per 1,000 children with sensorineural hearing loss, and there was no significant difference in incidence rates among White, Hispanic, and Black children. Relative to private insurance, Medicaid insurance was significantly associated with decreased odds of implantation prior to age 2 years or less (OR 0.23 [CI 0.08-0.67], p=0.007), and every 1% increase in maternal high school completion percentage in a HRR was associated with a 5% increase in percentage of CIs performed at age 2 years or less (b=5.06, [CI 1.72-8.40], p=0.003). There were no significant differences in race for early implantation.

Conclusions: Significant variability in pediatric cochlear implantation rates exist within California. Socioeconomic and parental factors persist as possible drivers of differences in access to early cochlear implantation and highlight the need to invest in initiatives to address barriers to appropriate and timely access to care.
Why Do Cochlear Implantation Candidates Decide Against Surgery? Exploring Factors That Influence Loss of Follow-Up

Vivian F. Kaul, MD, Stephany Ngombu, BS, Maxwell Bergman, MD, Aaron C. Moberly, MD, Yin Ren, MD, PhD;
Otolaryngology, OSU, Columbus, OH.

Introduction: Despite completing the process to become a cochlear implant (CI) candidate, some patients do not proceed with CI surgery. While this may be driven by individual preference over traditional amplification in some cases, other etiologies exist and remain to be elucidated. Furthermore, a fraction of CI candidates may be lost to follow-up. In this study, we aim to 1) identify the subset of patients amongst all CI referrals who ultimately did not undergo cochlear implantation, 2) characterize demographic and socioeconomic factors of this cohort, and 3) identify risk factors that may increase the risk of loss of clinic follow-up.

Methods: A retrospective chart review of all consecutive adult patients who were referred for CI evaluation at a tertiary academic cochlear implantation program between July 1989 and May 2020. The primary objective is to determine 1) the rate of qualification and likelihood of undergoing CI surgery; 2) demographic and socioeconomic characteristics associated with not proceeding with surgery including age, gender, ethnicity, marital and employment status, income level, and primary spoken language.

Results: A total of 931 patients were referred for cochlear implantation evaluation, and 74.7% (n = 696) met CI eligibility criteria. There were 88.9% (n = 619) patients who pursued surgery while 11.2% (n = 77) who did not. We then aimed to classify the reasons why patients did not pursue CI surgery. Of the 77 patients who did not receive a CI, 16.8% (n = 13) preferred to continue with conventional amplification, 20.7% (n = 16) had reservations about the surgical process, 14.3% (n = 11) deferred surgery due to their medical comorbidities, 9% (n = 7) cited surgery cost or insurance issues, and 38.9% (n = 30) patients were lost to clinic follow-up. Patients who were lost to follow-up tended to be younger (66 vs. 74 years, \( p = 0.05 \)), more likely to be African American vs. other race (\( x^2 = 8.1, p = 0.018 \)), and lived closer to the CI center (27 vs. 54 miles, \( p = 0.019 \)). On univariate and multivariate analysis accounting for patient age and gender, African American race was a significant positive predictor of loss to follow-up (hazard ratio [HR] = 8.0, \( p = 0.013 \) and HR = 7.9, \( p = 0.022 \), respectively).

Conclusion: Patients who did not undergo cochlear implantation surgery despite being a CI candidate after thorough evaluation differ from CI recipients in demographic and
socioeconomic characteristics. Early identification and intervention based on these disparities, especially focusing on the African American population, may improve access for CI-eligible patient populations.

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Control Number: 2022-A-252-ACI
Complete Status: Complete
Presentation Number: 038
Publishing Title: Cornerstone Vowel Production in a Child with Common Cavity Malformation with a Custom MedEl Electrode
Author Block: Ross Tonini, AuD, Ferenc Bunta, Ph.D.; Communication Disorders and Science, Univ. of Houston, Houston, TX.

Introduction: Speech production is a window into speech perception. We use spectrographic analysis of the cornerstone vowels /i/, /a/, and /u/ in a child with a common cavity with a custom cochlear implant to study the formant development—F0, F1, F2, and F3 over time.

Methods: Our subject was a 12-month-old female at the time of implant with a common cavity. She was implanted with a custom electrode based on the specific radiographic measurements of the common cavity. The implant was surgically placed using a unique dual cochleostomy approach of the cystic capsule. She was subsequently activated one month post-surgery and she received extensive and routine auditory verbal therapy. During routine programming sessions speech samples were digitally recorded of the cornerstone vowels /i/, /a/, and /u/. Each vowel sample was judged to be an accurate representation of the target vowel. Spectrographic analysis of each production was completed utilizing WaveSurfer software. The data were collected at sample ages of 29 months, 35 months, and 49 months.

Results: There is very little movement in the fundamental frequency, or the first formant for the /i/ vowel and it approximates normal hearing. The F2 shows more variability but does not approach the expected F2 frequency for the /i/ vowel in normal hearing five-year-old children (Lee, et al., 1999). The third formant, F3 is higher in frequency and more closely approximates the /i/ vowel F3 of normal hearing children. The /a/ vowel in the time series maintains a stable production across the time series for the fundamental frequency. The first formant rises in frequency over the time period almost approximating the expected frequency of normal hearing five-year-olds. The second formant—F2 also shows movement toward the normal hearing F2 production but
the third formant—F3 although high in frequency does not approximate the expected normal level. The /u/ vowel across the time series for the fundamental approximates the expected fundamental frequency for normal hearing as does the first formant. Again, F2 shows marked fluctuations over time and F3 appears to be moving toward the expected frequency of F3 in normal hearing five-year-old children.

**Conclusion:** In a child with a common cavity malformation, implanted with a custom electrode, speech production of the cornerstone vowels is close to expected levels when speech production is assessed spectrographically for the fundamental frequency and the first formant for all three cornerstone vowels. Variability is observed for the higher frequency F2 and F3 productions. The inability to accurately produce the F2 and F3 formants in a child without inherent apparent tonotopicity of the cochlear structure suggests that they are unable to perceive these higher frequency elements of the vowel. It may be possible to develop a strategy to increase perception of these higher frequencies especially in a patient with an abnormal cochlea. This assessment strategy of the cornerstone vowels may also provide strategies to improve speech development in patients with normal cochlea.

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**Control Number:** 2022-A-253-ACI

**Complete Status:** Complete

**Presentation Number:** 118

**Publishing Title:** EFFECTIVENESS OF COCHLEAR IMPLANTATION IN CHILDREN WITH COCHLEAR NERVE HYPOPLASIA OR APLASIA

**Author Block:** Le T. Q. Minh, MD., PhD
ENT Hosp., HoChiMinh City, Viet Nam.

**Abstract Body:**

**Introduction:** Description and assess the effectiveness of multi-channel cochlear implantation in children with cochlear nerve hypoplasia or aplasia results in ENT Hospital HoChiMinh City- South Vietnam.

**Methods:** Descriptive case study. There were 5 patients who had hypoplasia and aplasia included in this study who had cochlear implantation with multi-channel devices from May 2018 to November 2019.

**Results:** The average age of patients was 5.2 years (range 2-15). The male to female ratio was 1:4. All of cases were successful. All five patients underwent unilateral cochlear implant surgery including 3 right-sided and 2 left-sided ear. Surgeons spent about 115 minutes on average for CI in these cases. There were 4 patients with CN hypoplasia and 1
patient with CN aplasia identified on MRI. Postoperatively, CAP score was selected to measure the hearing and speech rehabilitation. After CI, the average CAP score was 5.2, which was better significantly than that preoperatively (p < 0.05).

**Conclusion:** CN hypoplasia or aplasia remain a challenge to cochlear implant surgeons. Our study noted that all patients obtained the good outcomes after CI. Understanding and experience about such anomalies will aid surgeons in making surgical strategy to obtain an optimal outcome.

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**Control Number:** 2022-A-254-ACI

**Complete Status:** Complete

**Presentation Number:** 116

**Publishing Title:** Impact of Improved Front-end Technology on Speech, Language and Voice Outcomes in Pediatric Cochlear Implant Recipients

**Author Block:** Fatema Jagmaag, Bachelors in Audiology and Speech Pathology\(^1\), Shabeena Backer, Master's in Audiology and Speech/ Lang Pathology\(^2\), Sasidharan Pulibalathingal, Master's in Audiology and Speech/ Lang Pathology\(^2\), Manoj Mp, MS- ENT\(^2\), Aninda Dutta Banik, PhD-Audiology\(^3\), Aravind Nair, Master's in Audiology and Speech/ Lang Pathology\(^2\), Smita Agrawal, PhD- Audiology\(^5\);

\(^1\)Audiology and Speech Therapy, Shaba Speech and Hearing Ctr., Mumbai, India, \(^2\)Dr Manoj's ENT Super Speciality Inst. and Res. Ctr., Calicut, India, \(^3\)Advanced Bionics, Mumbai, India, \(^4\)Advanced Bionics, Kochi, India, \(^5\)Advanced Bionics, Valencia, CA.

**Abstract Body:**

**Introduction:** Real-world impact of improved auditory input on speech-language-voice (SLV) skills and hearing performance in children with cochlear implants (CIs) has been of key interest to clinicians, parents and researchers. Auditory input can be significantly improved via enhanced front-end technology and wireless streaming (Bluetooth and devices like Roger). While there continues to be a debate on making the former available to younger recipients, the latter have seen greater adoption, especially in educational settings. The present study assessed the impact of these technologies in conjunction with a new Sound Processor (SP) on (1) SLV outcomes, (2) provision of tele-SLV therapy and (3) online education during the COVID-19 pandemic.

**Methods:** Fifteen experienced CI recipients (14 children [6.5 to 17 yrs] + 1 young adult [22 yrs]) from two clinics in India used a Marvel CI SP for up to 12 months. AutoSense OS 3.0, an automatic scene classifier program, was provided with Bluetooth streaming and Roger usage enabled. Outcome measures included speech perception scores, custom
questionnaires, SP datalogs and open-ended feedback from parents and recipients. Changes in SLV skills were assessed in 8 subjects at one study site. Impact of Bluetooth and Roger streaming on online schooling and speech-language therapy was evaluated. **Results:** Ratings for real-world speech understanding, sound quality, soft sound perception, and ease of listening improved with the study SP. Better speech perception during phone calls, online learning and tele-SLV therapy was noted without and with wireless streaming. Several parents reported increased confidence in their child’s ability to attend online school without their assistance in hearing the teachers. Clinically significant improvements were also noted in SLV starting at two months of Marvel CI use. Of the 8 who were evaluated in these domains, following was observed: improved *comprehension* (faster [5/8], improved incidental listening [5/8], reduced need for repetitions [4/8], increased participation in multi-speaker conversations [4/8], increased in no or low context situations [4/8], improved secondary language [3/8]), improved *expression* (increased vocabulary [6/8], increased length and complexity of sentences [3/8]), improved *speech production* (improved speech intelligibility [4/8] and rate of speech [5/8]), improved *voice* (reduced nasality [2/8], improved intonation [3/8] and naturalness [2/8]), and increased confidence in communication [3/8]). **Conclusion:** Improved automatic noise reduction technologies along with wireless capabilities of the Marvel CI processor can significantly benefit pediatric CI recipients in hearing performance as well as development of speech, language and voice skills. The impact of these technologies increases manifold in developing countries where high levels of ambient noise are present even at home.

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**Control Number:** 2022-A-256-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS7-1.3  
**Publishing Title:** Test-Retest and Inter-Rater Reliability of CT- Versus MRI-Based Estimates of Cochlear Duct Length  
**Author Block:** Steven C. Marcrum, PhD, AuD, Lena Weber, MD, Pingling Kwok, MD, Christopher Bohr, MD; Otolaryngology, Univ. Hospital Regensburg, Regensburg, Germany.  
**Abstract Body:** **Introduction:** Performance of post-lingually deafened adults with cochlear implants varies according to factors such as etiology of deafness, duration of deafness, age at implantation, and neurocognitive function, among others. Unfortunately, these factors
are largely outside of clinician control. The depth of electrode array insertion, however, which is influenced by both the physical characteristics of the selected electrode array as well as surgical technique, has also been suggested to meaningfully influence speech understanding and sound quality results. Optimizing electrode array insertion depth within an individual ear therefore represents an important opportunity for improving hearing outcomes. As cochlear duct length (CDL) varies significantly across ears, selection of the optimal electrode array requires the generation of ear-specific CDL estimates based on pre-operative imaging studies (CT, MRI, DVT). However, the reliability of such CDL estimates is currently unclear. The primary aim of this study was therefore to determine the test-retest reliability of CDL estimates obtained using CT and MRI. A secondary aim was to determine how reliability might vary according to differences in rater background and experience (audiologist, medical resident, experienced CI-surgeon).

**Methods:** A radiological software package was used to generate cochlear duct length estimates for 20 adults (40 ears) using CT and MRI datasets obtained prior to cochlear implant surgery. Estimates were obtained using both imaging modalities by an experienced clinical audiologist, a medical resident in our ENT department, as well as an experienced CI-surgeon. Estimates were obtained at 2 timepoints with a gap of 4 weeks. Significant effects of estimate timepoint (test-retest reliability) and rater (inter-rater reliability) were assessed using linear mixed effects models.

**Results:** Cochlear dimensions and cochlear duct length estimates observed in this study were consistent with previous work. Statistical analysis revealed absolute CDL estimates obtained using MRI were significantly larger than those for CT, though this difference is of questionable clinical importance (<1 mm). Additionally, no significant difference between raters was observed in terms of absolute CDL estimates. Finally, reliability was very good for both imaging modalities and all raters (Cronbach's alpha >0.8).

**Conclusion:** Results of this study suggest that comparable CDL estimates can be obtained reliably using both CT and MRI images. As the use of MRI technology does not require exposing the patient to radiation, its use for CDL estimation should be preferred, unless otherwise contraindicated. Further, as no difference in terms of CDL reliability was identified between raters, the use of non-medical professionals for this task could be considered.

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**Control Number:** 2022-A-257-ACI

**Complete Status:** Complete

**Presentation Number:** 127
A 5-year longitudinal economic analysis: Bonebridge 601 vs. percutaneous bone-anchored hearing devices

Andrew Soulby, MSci MSc, Nikul Amin, MBBS MSc FRCS(ORL-HNS), Daniele Borsetto, MD EBE-ORL, Irumee Pai, BSc MBBS MSc FRCS(ORL-HNS); 2nd Floor Lambeth Wing, St. Thomas' Hospital, St. Thomas' Hearing Implant Ctr., London, United Kingdom.

Introduction: Percutaneous bone-anchored hearing devices (pBAHDs) are the most commonly used bone conduction implants (BCI). Concerns surround the long-term complications, notably skin-related, in patients with percutaneous abutments. The active transcutaneous BCI Bonebridge™ system (MED-EL, Innsbruck, Austria) can help avoid some of these pitfalls but is often considered a second-line option due to various factors including perceived increased overall costs.

Methods: A retrospective case series analysis with a longitudinal economic analysis of Bonebridge BCI 601 versus pBAHD was performed over a 5-year follow-up period. Consolidated Health Economic Evaluation Reporting Standards (CHEERS) reporting guidance were followed. The study included adult patients (≥16 years) with conductive hearing loss (CHL), mixed hearing loss (MHL) or single-sided deafness (SSD), who received a Bonebridge or pBAHD implant between 1/7/2013 and 1/12/2018 with a minimum 12-month follow-up. In cases of MHL, only those who would have been audiologically suitable candidates for either device were included, with stable masked bone conduction (BC) thresholds of 45 dBHL or better between 500 and 4000 Hz on the implanted side. In cases of SSD, pure tone thresholds in the contralateral ear were 20 dBHL or better at all BC frequencies. The main outcome measure was the mean costs per implanted patient for both implants at 1, 3 and 5 years postoperative time points. In addition, clinical effectiveness was evaluated using both objective (speech discrimination using AB words [phonemes]) and subjective (Abbreviated Profile of Hearing Aid Benefit [APHAB]) measures, after a minimum of three months of device use. Unpaired two-tailed heteroscedastic t tests were performed to assess the statistical significance of differences between device groups at each time point, as well as between costings for various appointment types and processor replacement rate.

Results: The mean total cost (± standard deviation) per patient of Bonebridge was significantly higher than pBAHD at 1-year post-implantation (£8,512 ± 715 vs £5,590 ± 1,394, p < .001). However, by 5-years post-implantation this difference was no longer statistically significant (£12,453 ± 2,159 vs £12,575 ± 3,854, p > .05). The overall cost convergence was mainly accounted for by the increased long-term complications, revision surgery rates and higher cost of the pBAHD external processor compared to Bonebridge. Both devices were found to be approximately equal in terms of objective and perceived benefit for the audiological inclusion criteria used.

Conclusion: Our study suggests that the long-term costs of the Bonebridge system to healthcare providers are comparable to pBAHDs, whilst offering lower complication rates. In our experience, the audiological benefit and patient satisfaction are also comparable. In cases where patients undergoing BCI assessment meet the audiological
and surgical criteria for Bonebridge, the healthcare provider should not be prevented from being able to offer the device as an option, based on the initial cost alone.

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Control Number: 2022-A-258-ACI
Complete Status: Complete
Presentation Number: 023
Publishing Title: Combined use of intraoperative Electrocochleography and Fluoroscopy during Cochlear Implantation to optimize electrode position

Author Block: Thomas Lenarz, Professor and Chairman\(^1\), Rolf Salcher, Dr.\(^1\), Silas Ewald, M. E.\(^1\), Daniel Smyth, PhD\(^2\), Eugen Kludt, Dr.\(^1\);
\(^1\)ENT Department, Med. Univ. of Hannover, Hannover, Germany, \(^2\)Cochlear Ltd., Mechelen, Belgium.

**Abstract Body:**

**Introduction:** An increasing number of patients with significant residual hearing in the low frequency range now benefit from a cochlear implant. As the combination of electric and acoustic hearing signals can provide significant benefit in complex listening environments, the preservation of residual hearing is becoming crucial. Intraoperative measurements such as Electrocochleography (ECochG), evoked compound action potential (ECAP) and fluoroscopy are important tools to provide the surgeon with feedback about the condition of the cochlear health and the position of the electrode array during or after the insertion, in order to provide the patient with optimized and personalized implantation.

**Methods:** The surgical setup was optimized by combining fluoroscopy with a suite of intraoperative electrophysiological measurements, including ECochG, ECAP, and impedances to allow the surgeon to monitor the response of the inner ear with reference to fluoroscopic assessment of electrode position during insertion. This procedure was applied to five patients with hearing loss up to 100 dB at 500 Hz. Cochlear implants by one single manufacturer were used. During insertion ECochG response was monitored with a fixed frequency and stimulation amplitude. Both the monitored ECoChG signal and the fluoroscopy images were displayed to the surgeon simultaneously through a digital microscope. Insertion was paused at various insertion depths to perform electrophysiological measurements and then continued to the final position. Subsequently, the fluoroscopy images were fused with the preoperative CBCT images of the cochlear and related to the measurements.

**Results:** Results show that ECAP thresholds become lower by 6.3 ± 7.6 CL (average and
SD over all electrodes in the array) with positioning the electrode from a lateral position (average wrapping factor 0.71 ± 0.03 SD) close to the modiolus (average wrapping factor 0.65 ± 0.06 SD) The improvement of ECAP thresholds correlated with the distance decrease to the modiolus for individual electrode contacts and was most prominent for medial electrode contacts. The distance to the modiolus of the basal electrode contacts was increased and resulted in increasing ECAP thresholds. The maximum value of the ECochG signal during an electrode sweep at 500 Hz is not often found on the most apical electrode, but on more basal electrodes. This maximum is located at a certain insertion depth and is not changed by the insertion of the electrode array. Nonreversible, i.e., through surgical manipulations drops in ECochG response occur with deeper electrode insertion and are indicative for postoperative hearing loss.

**Conclusion:** By combining fluoroscopy and intraoperative measurements new insights can be gained between electrode position and electrophysiological status of the cochlea. Changes in CM amplitude can be used to adjust the surgical procedure to improve hearing preservation. This enables the surgeon to perform a personalized implantation.

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**Control Number:** 2022-A-259-ACI

**Complete Status:** Complete

**Presentation Number:** CS10-2.1

**Publishing Title:** Enlarged Vestibular Aqueduct: Disease Characterisation and Exploration of Potential Prognostic Factors for Cochlear Implantation.

**Author Block:** Haroon S. Saeed, MBBS, MRCS, DOHNS¹, Azita Rajai, Msc², Robert Nash, FRCS (ORL-HNS)³, Shakeel Saeed, FRCS (ORL)⁴, Stavros Stivaros, FRCR⁵, Graeme Black, FRCoOpth⁶, Iain Bruce, FRCS (ORL)⁷; ¹ENT, Manchester Univ. NHS Fndn. Trust, Manchester, United Kingdom, ²Ctr. of Biostatistics, Div. of Population Health, Univ. of Manchester, Manchester Academic Hlth. Sc. Ctr., Manchester, United Kingdom, ³ENT, Great Ormond Street Hosp. For Children, London, United Kingdom, ⁴ENT, University Coll. London Hosp., London, United Kingdom, ⁵Radiology, Manchester Univ. NHS Fndn. Trust, Manchester, United Kingdom, ⁶Centre for Genomic Medicine, Manchester Univ. NHS Fndn. Trust, Manchester, United Kingdom, ⁷ENT (Paediatrics), Manchester Univ. NHS Fndn. Trust, Manchester, United Kingdom.

**Abstract Body:** Introduction: Hearing loss (HL) associated with Enlarged Vestibular Aqueduct (EVA) is markedly heterogenous, with phenotypes ranging from the identification of profound
deafness in infancy to young children and adolescents with relatively stable HL without the need for cochlear implantation (CI). Current management is \textit{reactive}, seeking to identify early any deterioration in hearing or detrimental effects upon child development. Therefore, there is an unmet need to improve our understanding of the natural history of EVA by exploring potential clinical predictors (prognostic factors) for HL severity and progression. This will enable CI clinicians to optimise their approaches to CI candidacy selection and timing of surgery. The objectives of this study are to provide a detailed case characterisation of the largest European cohort of EVA patients to date and explore the relationship between candidate prognostic factors and timing of CI surgery.

\textbf{Methods:} The design of this study aimed to meet recognised standards for robust prognostic factor research. We undertook a retrospective review of 150 patients with confirmed radiological diagnosis of EVA, across three UK CI centres, between January 1995 to January review 2021. Data acquisition focused on demographics, genotype, longitudinal audiological data and radiological findings. Main outcome measures were age at which audiological candidacy for CI was met and age at 1st CI surgery. Statistically significant associations between candidate prognostic factors and the outcome measures were further explored with multivariate analysis.

\textbf{Results:} EVA was predominately a bilateral condition (144/150) with increased prevalence in females (M:F, 64:86). 51.7\% of patients failed new-born hearing screening, with 65.7\% having HL diagnosed by 1 year. Moderate to severe and severe to profound HL were reported most frequently at earliest audiological testing. In 123 patients, median age that audiological candidacy for CI was met for at least one ear was 2.75 years. Median age at first CI was 5 years (140/150) and 57.6\% of patients were ultimately bilaterally implanted. Incomplete partition type 2 was present in 63/140 patients. Pendred syndrome, ethnicity and presence of incomplete partition were not significantly associated with earlier CI surgery. There was an association for male patients to be assessed earlier for CI, and to have first CI surgery earlier than females. These associations were further explored with multivariate linear regression, demonstrating that male patients have first CI assessment and first CI surgery significantly earlier than females (coefficient of male gender in the linear regression for log(Age first seen for CI assessment)= -0.58, 95\% CI (-1.03,-0.13),p-value=0.012 , coefficient of male gender in the linear regression for log(age at first CI surgery)= -0.43, 95\% CI (-0.82,-0.05), p-value=0.028). 

\textbf{Conclusion:} Currently this is the largest European cohort to characterise EVA patients. It therefore provides useful clinical information regarding broad timeframes for CI surgery when counselling newly diagnosed patients with EVA. We provide evidence that EVA patients should be closely monitored for CI candidacy, especially within the first 3 years of life. Our exploratory prognostic factor study design builds confidence that male gender is an independent prognostic factor for earlier timing and assessment for CI surgery in EVA patients.
Introduction: During the last two decades more patients with cochlear nerve deficiency have undergone cochlear implantation. However, the reported audiologic outcome in children diagnosed with cochlear nerve deficiency is quite variable with some showing successful implantation outcome and others demonstrated poor outcome in this population. The aim of this study was to investigate cochlear implantation (CI) outcome in children with nerve deficiency.

Methods: A total of seven children with prelingual profound deficiency (hypoplasia or aplasia) were included. A control group of 10 CI children with no cochlear nerve anomalies was also included. In addition to implant stimulation levels, children’s performance on pure tone audiometry, speech reception measure, and auditory and speech skills ratings were compared across groups. Additionally, pre- and post-operative audiologic results were evaluated for the group with nerve deficiency.

Results: In general, children with nerve deficiency performed poorer than those without nerve deficiency on all tested measures. Stimulation levels were considerably higher and more variable than the control group. Results further showed that performance was dependent on the diameter of the internal auditory canal.

Conclusion: Overall, cochlear implantation outcome in children with auditory nerve deficiency is poorer and extremely more variable than those without nerve deficiency. However, three of the patients had a noticeable improvement in auditory performance post-implantation suggesting that CI is a viable option in this population but expected benefit can be dependent on the status of the cochlear nerve.
**Abstract Body:**

**Introduction:** Modern, FDA-approved cochlear implants (CI) are MRI compatible, under conditional circumstances. There are clinical scenarios in which an internal receiver-stimulator will be removed, and the electrode is cut and left inside the cochlea. Little is known about the effect of the electrode alone on MRI imaging, and some CI manufacturers are unable to claim continued MRI conditional status of their devices once the electrode has been cut. Additionally, initial scanogram scout images from the MRI may greatly exaggerate artifact, leading radiology technicians to cancel MRI imaging. The objective of this study is to evaluate the safety of a cut CI electrode remaining in the cochlea and evaluate imaging characteristics arising from the electrode only.

**Methods:** Case report on a CI patient who had been explanted with a cut electrode still in the cochlea who underwent MRI for brain imaging after removal of the internal receiver-stimulator.

**Results:** A 15-year-old female with a history of a clival chordoma status post resection and radiation with right profound sensorineural hearing loss. The patient underwent right CI, but unfortunately became a non-user, possibly due to central pathway involvement. The patient subsequently developed a high-grade glial tumor requiring frequent MRI imaging for management and follow-up. Given the patient’s newly diagnosed brain tumor and CI non-user status, the internal receiver-stimulator was removed with the electrode cut and left in the cochlea. Post-operative MRIs of the brain were performed four times with the electrode inside the cochlea. There were no complications associated with the residual electrode. The images did not demonstrate any significant artifact from the electrode that would limit evaluation of the surrounding skull base or brain parenchyma.

**Conclusion:** There is very limited data on the MRI safety of a retained CI electrode after explanation and whether the electrode can still be considered MRI-conditional. This case report demonstrates that MRI is safe when an electrode has been cut and left inside cochlea. In addition to being safe, the electrode does not seem to limit the evaluation of the surrounding skull base or brain parenchyma.
Abstract Body:

**Introduction:** Cochlear implants (CIs) are optimized for speech perception but poor in conveying music. Rhythm, however, is repeatedly reported as the most successfully conveyed property of music, with CI users often performing on par with normal hearing (NH) controls in rhythmic tasks. However, these are often based on rhythmic stimuli presented in single streams, being at variance with real-world music, in which multiple streams of rhythmic patterns occur simultaneously. Nevertheless, being able to perceive real-world musical rhythms is important for perception of groove, i.e., the pleasurable desire to move to music. NH listeners prefer moving to music of medium rhythmic complexity compared to high and low complexity. This relationship follows an inverted U-shape, implying that there is a “sweet spot” at which a maximum pleasurable sensation of wanting to move is experienced. However, groove perception in CI users remains largely unexplored. To achieve a more complete experience of rhythm and groove, it may be beneficial to complement the auditory stimulation of the CI with additional sensory input. Findings suggest that electro-haptic stimulation (EHS) enhances perception of various sound properties in CI users. If optimized for rhythm perception, EHS may enhance perception of complex rhythmic patterns and the ability to distinguish and integrate sounds of simultaneously occurring rhythmic instruments. This project studies rhythm and groove perception in CI users, and the potential effect of rhythm-specific EHS. It is hypothesized that EHS will allow CI users perception of groove to approach the U-shaped relationship found in NH listeners. Furthermore, it is hypothesized that CI users’ abilities to tap along to the rhythm will be improved by EHS. Finally, it is hypothesized that the EHS-enhanced rhythm perception will be reflected in stronger neural responses as measured with electroencephalography (EEG).

**Methods:** CI users’ perception of rhythm and groove will be mapped out both with and without EHS. Participants will be tested both behaviorally and using EEG. Stimuli will consist of drum-breaks varying in rhythmic complexity (low, medium, high) and number
of instruments (1, 2, 3). Stimuli will be presented in three conditions: audio only, EHS only, and audio and EHS together. We will measure how the different conditions influence 1) participants’ ratings of “wanting to move” and “experienced pleasure” (on a 7-point Likert scale), 2) participants’ abilities to tap along to the rhythm, and 3) the neural correlates of rhythm and groove perception as measured by EEG. NH controls will provide reference data.

Results: This is work in progress. Preliminary results are expected to be presented at the conference.

Conclusion: The experience of rhythm is a central part of contemporary music and the basis of how we dance to and socialize through music. Thus, enhancement of rhythm perception could have a substantial impact on CI users’ quality of life. Furthermore, enhancing rhythm perception with EHS may benefit sound localization and separation, including speech in noise and speech perception in general.

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Control Number: 2022-A-265-ACI
Complete Status: Complete
Presentation Number: CS6-1.4
Publishing Title: Optimal Speed Profiles and Alignment Angles in In-Vitro Robotic Cochlear Implant Electrode Array Insertions

Philipp Aebischer, Master of Science in Physics1, Georgios Mantokoudis, Dr. med.2, Stefan Weder, PD Dr. med.2, Lukas Anschuetz, PD Dr. med.2, Marco Caversaccio, Prof. Dr. med.2, Wilhelm Wimmer, PD Dr.1;
1ARTORG Center for Biomedical Engineering Research, Univ. of Bern, Bern, Switzerland, 2Department for Otolaryngology, Head and Neck Surgery, Inselspital Univ. Hosp. Bern, Bern, Switzerland.

Introduction: The insertion of the electrode array is a critical step in cochlear implantation that can lead to intracochlear trauma and consequently to poorer hearing performance. In this study, we comprehensively investigate the impact of the alignment angle and feed-forward speed on deep insertions in artificial scala tympani models with accurate macro-anatomy and controlled frictional properties.

Methods: Motorized insertions (n=1033) were performed in six different scala tympani models with varying speeds and alignment angles. The models reproduce the three-dimensional geometry of human cochleae from micro-computed tomography scans and are surface-treated with a hydrophilic coating to mimic in-vivo frictional conditions. We
recorded reaction forces, evaluated electrode array centerlines obtained from photomicrographs of the insertion process, and developed a mathematical model to estimate the normal force distribution along the electrode array.

**Results:** Insertions parallel to the cochlear base significantly reduce intracochlear forces exerted by the electrode array. Our data suggest that force differences are mainly induced in the basal region of the scala tympani, while the electrode array's insertion angle plays a lesser role for forces occurring in the apical cochlear turn. Parallel insertions are also associated with significantly smoother movement of the array tip, presumably reducing local stress peaks during insertions. In addition, we found that a slower feed rate decreases forces during the insertion process. Most importantly, we showed that non-constant feed-forward profiles with decreasing speed reduce the maximum occurring forces compared to a constant feed with the same total duration.

**Conclusion:** In cochlear implantation, smoothness and peak forces can be reduced with alignment angles parallel to the scala tympani centerline and with non-constant feed-forward speed profiles. Special caution is advised in the basal region of the cochlea and during the final stages of insertion, where most of the insertion energy is induced. Our results may help to provide clinical guidelines and improve surgical tools for manual and automated cochlear implantation. Most notably, non-constant speed profiles could find direct application in the robotic insertion of electrode arrays.
microvolt range and, depending on the remaining hair cells, may have a poor signal-to-noise ratio (SNR). The analysis of the signals is currently performed visually and requires an expertise in this field. The goal of this project is twofold: i) to improve the SNR and, therefore, to increase the number of subjects where ECochG measurements can be analyzed, and ii) to objectify the detection of ECochG signals, to make the analysis independent of the examiner.

**Methods:** Prospective cohort study of 20 CI users with preserved residual hearing. ECochG measurements were performed three times over a three-month period using the same measurement protocol; two measurements were recorded on the same day (morning and afternoon), one three months later. By performing multiple measurements, we verified the repeatability of our method (SNR improvement and objectifying ECochG traces). To increase the SNR we employed a method using Gaussian weighted averaging, bandpass filtering, and correlation analysis. To objectify the detection of ECochG signals, we compared four different methods: peak detection, correlation analysis, continuous wavelet analysis, and Hotelling T2 method. These methods were benchmarked against our visual analysis. **Preliminary Results:** We could increase the SNR of our measured responses by 4.9 dB. This allowed us to include 21.3 % more ECochG signals in the analysis. Our method for objectifying the ECochG signals showed that the signal could be detected with the same or even higher accuracy compared to visual analysis.

**Conclusions:** The advantages of an objective measurement tool are: i) Data recordings can be interpreted independently of the experience of the examiner. ii) In a specific patient, direct comparison at different measurement points is possible, as the data is always analyzed in the same way. iii) An objective measurement tool will allow comparison between different studies and implant centers.

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**Control Number:** 2022-A-271-ACI

**Complete Status:** Complete

**Presentation Number:** 050

**Publishing Title:** Influence of Automatic Scene Classification Systems in Hearing Devices on Speech Perception in Real-life Situations

**Author Block:** Andreas Buechner, Prof. Med. Univ. of Hannover, Hannover, Germany.

**Abstract Body:** **Introduction:** Automatic scene classification systems combining directional microphones and noise reduction algorithms have been implemented in the latest generation of CI
sound processor to relieve CI users from taking an often difficult decision, choosing the most optimal program when entering into a new listening situation. Focusing to a certain direction, enhancing speech e.g. coming from the sides or the back as well as automatically adapt to speech or music signals while streaming from an audio device can improve hearing abilities in everyday life of CI as well as HA users.

**Methods:** Speech perception was measured in a group of 20 study participants, bilateral and bimodal, using the adaptive matrix test in quiet as well as in noise comparing automatic programs and omni-directional microphones of the recently launched processor and the previous generation processor, each in combination with the respective HA generation. Streaming and automatic features were also tested in a take-home trial.

**Results:** While the omni-directional microphone settings led to comparable results on both sound processors, the automatic programs on the new processor improved speech perception by up to 5dB in noise or up to 40%, respectively. Direct streaming could improve subjective hearing impressions in everyday life situations as well as music enjoyment.

**Conclusion:** Scene classification systems in CI sound processors as well as in combination with hearing aids provide significantly better speech perception together with an uncomplicated handling in challenging listening situations. Nowadays, wireless streaming becomes more important and could be shown to be highly beneficial while listening to music or making phone calls.

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**Control Number:** 2022-A-272-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-3.3

**Publishing Title:** The Variability of Pediatric CI Device Failures Reinforces the Importance of Multidisciplinary Care

**Author Block:** Megan Marsh, Au.D.¹; Jennifer Wickesberg, Au.D., LSLS cert. AVT¹, Amy Cantu, M.A., LSLS cert. AVT¹, Alex Sweeney, M.D.², Ronald Vilela, M.D.², Michelle Nguyen, NA¹, Tylar McDaniel, B.S.¹;

¹Audiology, Texas Hearing Inst., Houston, TX, ²Otolaryngology, Texas Children's Hosp., Houston, TX.

**Abstract Body:** Introduction: In the history of cochlear implantation, there have been multiple, unfortunate occasions in which a specific device has been found to have an elevated
probability of failure. Given the consequences of improper device function, particularly during the critical years of speech and language development, prompt identification of a failing device is critical. While some instances of device failure can be characterized by a distinct pattern or profile, others may be more elusive and require a constellation of subjective and objective performance measures to support clinical decision making. Furthermore, in the pediatric population, it can be challenging to recognize when a more subtle failure is occurring if patients do not have the capacity to articulate their concerns.

Methods: A retrospective review was performed at a pediatric cochlear implant center to identify all patients implanted between 2016 and 2019 with a device known to have a higher-than-expected probability of failure, as indicated by the manufacturer. Demographic details, surgical reports, objective performance measures, and subjective performance measures were collected as distinct data points. Similar performance measures were also collected postoperatively for patients who underwent explantation and reimplantation with a new device. Four distinct audiologic data points coupled with current levels of performance, as reported by the speech therapist, were used to support the decision to explant a suspected device failure.

Results: Sixteen internal cochlear implant devices in 12 children were deemed a failure and met the inclusion criteria for this study. The average chronological age at time of explantation was 6 years; 3 months old, with an average device age of 2 years; 3 months old. Devices explanted were split evenly between right and left ears. Ninety-three percent of the failed internal devices exhibited poor performance on aided, frequency-specific detection threshold measurements. Seventy-five percent of the devices displayed abnormal impedance values, 69% revealed abnormal neural responses, and 60% displayed poor or limited aided word recognition scores. Only 56% of the devices explanted were considered a failure based on the initial integrity test. Participants experiencing a device failure demonstrated a wide variety of difficulties as it related to their speech, language and audition skills. At present, 62% of the devices in question have been explanted and reimplanted with a new device based on our pediatric protocol to manage suspected failures.

Conclusion: Detecting a cochlear implant device failure in the pediatric population can be a challenging endeavor. Our experience with a device that has a higher-than-expected probability of failing suggests that there is a wide spectrum of ways in which a potential failure can present, thus emphasizing the importance of multidisciplinary care when managing CI patients.

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Control Number: 2022-A-273-ACI
Complete Status: Complete
Introduction: To stimulate neurons, conventional CIs directly inject electrical current into surrounding tissue via implanted electrode arrays. While many CI users achieve strong speech perception scores, there remains significant variability. Since the CI is surrounded by a conductive fluid, perilymph, a spread of excitation occurs; furthermore, the cochlear biology is spatially dependent, and a wider area of excitation affects the functionality of the CI. Magnetic stimulation demonstrates potential for an alternate design of the CI to increase the number of independent stimulation channels as magnetic fields are unaffected by the material properties of biological components. Our group has previously demonstrated that magnetic stimulation exhibits improved spatial resolution of channels.

Methods: Optimization, finite-element modeling, and fabrication techniques were used to analyze and create the prototype. The activating function, a metric by Rattay for evaluating the stimulation effect of external fields on target neurons by evaluating the second spatial derivative of the extracellular potential which relates to the differential equation for determining membrane potential, was used to explain magnetic stimulation capabilities.

Results: The prototype stimulators are 4-turn solenoids with a 250-um turn radius, and a 37.5-um wire radius, secured with epoxy and coated in a conformal, insulating layer of Parylene-C. Obtained through the activating function, the microcoils require a 400-um wide area, centered at the bisection point of the solenoid, for each independent stimulation channel.

Conclusion: A maximized, 24-mm-long CI can hold 85 microcoils and can theoretically support 60 independent channels. This CI alternative magnetic stimulation design exhibits potential for reducing the necessary post-surgical rehabilitation and improving the CI user hearing experience.
Alternative Mapping Procedures for Pre-Curved Electrode Array in the Internal Auditory Canal

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Introduction: Malpositioned electrode arrays create challenging management decisions. Management options for patients with pre-curved arrays observed in the internal auditory canal (IAC) include revision surgery, discontinuing device use, or assessment with maps using alternative mapping procedures. The present report reviews the options for a case with an array in the IAC and the outcomes with an alternative map.

Methods: A 7-year-old male with bilateral cochlear implants (CIs) transferred to the study site. The patient had approximately 4 years of bilateral CI use. The patient demonstrated consistent responses and speech recognition with the right CI and inconsistent responses and no speech recognition with the left CI. Computed tomography revealed normal placement of the right pre-curved array and a malpositioned array on the left side. For the left pre-curved array, 4 contacts were observed in the basal cochlear turn and the remaining 18 contacts were wrapped in the IAC. Imaging further revealed incomplete partition 3. The family decided not to pursue revision surgery. An alternative mapping procedure was attempted for the contacts in the IAC. The patient completed a pitch ranking task to identify contacts that differed perceptually and were ranked tonotopically.

Results: The patient demonstrated an immediate improvement in speech recognition with the alternative map, successfully repeating several phonemes from the PB-K word list. After one month of listening experience, he was able to reliably respond to the aided sound field detection task, with thresholds between 20-30 dB HL. For PB-K words, the patient improved from no recognition to 32% with the left CI. In the bilateral condition, the patient improved from 56% to 72%. After four months of listening experience, performance improved to 52% with the left CI and 80% in the bilateral condition.

Conclusion: The patient was able to perceive discrete pitch differences between contacts inadvertently placed in the IAC, and demonstrated better speech recognition in the monaural and bilateral conditions with a map directly stimulating the auditory nerve. Individualizing the map settings using imaging and behavioral measures may improve the performance of challenging cases. An interdisciplinary team approach can provide greater insight into more complex cases.

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2022-A-275-ACI
Individualized Cochlear Implantation

Thomas Lenarz, Prof. Dr. med., Rolf Salcher, Dr. med., Nils Prenzler, Dr. med., Daniel Kley, M. Sc., Anke Lesinski-Schiedat, Prof. Dr. med., Andreas Büchner, Prof. Dr.; ENT Department, Med. Univ. of Hannover, Hannover, Germany.

Introduction: Individualized Cochlear Implantation - meaning an individual selection of electrode insertion depth and stimulation modality (electric-acoustic stimulation (EAS) or electric stimulation (ES)) - aims for the best possible hearing outcome for every patient. Usually, shorter flexible electrodes are used for EAS to achieve best hearing preservation results. However, if residual hearing is lost, longer electrodes provide higher cochlear coverage and lead to better speech perception in electric-only mode (Büchner et al, Plos One 2017). Partial insertion with the choice of a patient specific insertion depth and the option for its future adaption of electrical cochlear coverage, if hearing loss is progressive, could overcome this trade-off.

Methods: In total, n=55 patients were treated with an individual partial insertion using longer electrodes of 24 mm - 31 mm lengths. Furthermore, statistical analysis of the audiometry and geometry database of ours were performed to develop models for the prediction of postoperative residual hearing and the electrode location in a patient specific cochlea. These models were integrated into a software tool, which supports the surgeon with the selection of an individual electrode insertion depth. In n=28 patients the software tool was used for preoperative planning.

Results: The median hearing loss at first activation was 13 dB (n=15) for a partially inserted electrode of 24 mm length and 16 dB (n=21) for a partially inserted electrode of 28 mm length. The median hearing loss improved to 12 dB for a partially inserted 24 mm long electrode and to 13 dB for a 28 mm long at 6 months. N=33 patients used their low-frequency hearing for EAS and achieved in median 85% with the HSM sentence test in noise at 10 dB SNR at 6 months. In three cases, where the patients could not use the residual hearing for EAS, a successful afterloading of the electrode was performed, which offers the patient full cochlear coverage for ES-only.

Conclusion: The concept of individualized cochlear implantation allows for a patient specific choice of electrode insertion depth and modality. Taking cochlear geometry and the prediction of postoperative residual hearing into account, an optimal cochlear coverage, good hearing preservation results and individual outcomes using EAS can be achieved. If hearing is progressive over time, partial insertion allows for further, patient specific adaptation of the insertion depth. In the future individualized cochlear implantation will be combined with an optimized and minimal-invasive surgical approach and with pharmaceutical and biological therapies. Furthermore, this approach could
allow for an indication extension towards patients with more residual hearing e.g., those suffering from presbyacusis.

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**Control Number:** 2022-A-276-ACI

**Complete Status:** Complete

**Presentation Number:** CS1-2.4

**Publishing Title:** Does experience with speech input relate to speech recognition outcomes in adult CI users?

**Author Block:**
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Ohio State Univ., Columbus, OH.

**Introduction:** Adult cochlear implant (CI) users display vast individual differences in speech recognition outcomes. CI users’ everyday experiences with speech input may constitute an important, modifiable factor that contributes to individual differences in outcomes. However, a consistent relation between amount of speech input (using datalogging) and clinical speech recognition outcome measures has not been established. Beyond the amount of speech input, we propose that experiencing greater relative amounts of speech input in real-world challenging conditions (“speech input in adverse conditions”) promotes robust speech recognition abilities in adult CI users, by helping them tune into relevant acoustic cues for processing the degraded CI signal. Further, any relation between CI users’ experiences with speech input may also be better elucidated using speech recognition measures involving real-world challenges (e.g., multiple talkers) and multiple linguistic levels. Therefore, the current study tested the main hypothesis that greater relative speech input in adverse conditions is associated with more robust speech recognition abilities.

**Methods:** Seventeen post-lingually deafened adult CI users with ≥1 year of CI use participated in the current study. CI users’ speech input in quiet and noise was captured directly from datalogging; speech input in adverse conditions was defined as the average daily time in speech in noise relative to the total time in speech (i.e., speech in noise/total speech). To assess robust speech recognition, speech recognition performance was assessed across multiple linguistic levels, including vowels, words, and sentences. Materials were produced by a female and male talker, and were presented both in quiet and multi-talker babble. Correlation analyses were carried out between speech input in adverse conditions and vowel, word, and sentence recognition scores.
Results: Adult CI users varied substantially in average daily speech input experienced in quiet (0.1 - 2.7 hours) and in noise (0.2 - 4.3 hours); speech input in adverse conditions (relative to total speech input) ranged from .43 to .93. Partially consistent with our hypothesis, speech input in adverse conditions was weakly to moderately correlated with speech recognition scores across measures ($r$'s = 0.19 - 0.62); it was most strongly correlated with word recognition in quiet ($r = 0.62$), followed by vowel ($r = 0.47$) and sentence recognition in quiet ($r = .44$)

Conclusion: These preliminary findings demonstrate that adult CI users’ everyday experiences with speech input relate to their speech recognition outcomes. CI users with greater relative experience with speech input in adverse listening conditions show better speech recognition scores across challenging speech recognition tasks, and particularly for word recognition. While this finding may suggest that communication in adverse conditions has a beneficial effect on speech recognition outcomes, it is also possible that CI users with stronger speech recognition abilities are more willing to engage in communication in adverse conditions. Future longitudinal research should be carried out to determine if speech input in adverse conditions predicts long-term speech recognition outcomes. These findings have implications for identifying CI users at risk for poor outcomes, and counseling patients about types of communication experiences that best promote robust speech recognition abilities.
stimuli reflects listening in real-world environments, which demands a greater amount of cognitive resources serving working memory and attention compared to listening in a quiet and controlled sound booth. The current study examines neural speech tracking of natural audiovisual conversations in the presence of multi-talker background noise.

**Methods:** Video and audio segments from a dialogue-based television show were presented to 15 adult CI listeners in high (SNR+5 dB), moderate (SNR+10 dB), and low (SNR+15 dB) levels of background noise while electroencephalography (EEG) was concurrently recorded. Cortical tracking of the speech envelope was measured using temporal response functions, and self-reported ratings of cognitive demand for each listening condition were collected using the NASA Task Load Index. Differences in auditory and parietal alpha power between listening conditions were assessed. The change in alpha power from the low background noise condition was correlated with change in listening demand.

**Results:** Self-reported listening demand significantly decreased as background noise levels increased. Listening demand also significantly increased when listening without visuals, compared to attending to audiovisual stimuli presented at the same noise-level. The amplitude of late speech tracking component significantly differed as an effect of background noise, along with non-significant parametric changes in earlier components. Parietal alpha power was found to be significantly higher in the Audio-Only condition, compared to the audiovisual conditions. Change in ipsilateral auditory alpha power from the Low-Noise condition was moderately correlated to changes in demand ratings the Audio-Only condition.

**Conclusion:** Results suggest that visual speech cues assist in speech recognition and inhibition of irrelevant background stimuli. The suppression of the late speech tracking component implicates diminished cortical speech tracking at higher-noise levels in CI listeners. Increased parietal alpha power when listening without speech cues suggests the suppression of audiovisual integration processes, while changes in auditory cortical alpha power may indicate changes in listening demand. Overall, these results suggest that meaningful information about the cochlear implant listening experience can be extracted from brain responses using continuous “ecological” stimuli such as a normal conversation.
Title: Use of Auditory Training and Its Influence on Early Cochlear Implant Outcomes in Adults

Authors: James R. Dornhoffer MD, Priyanka Reddy BS, Cheng Ma BS, Kara C. Schwartz-Leyzac AuD, PhD, Judy R. Dubno PhD, Theodore R. McRackan MD, MSCR

Introduction: Cochlear implantation is an effective treatment for patients with significant sensorineural hearing loss. After implantation, it is recommended that recipients invest a significant amount of effort to learn how to communicate using their cochlear implant (CI). Various forms of patient-directed, at-home auditory training are available to expedite this process. However, there is a lack of available data to guide patients towards the most effective available strategies. As such, adult CI recipients’ use of various auditory training resources is often self-driven and irregular. To address this knowledge gap and clinical need, this study examines associations between different forms of post-CI auditory training and early outcomes related to speech recognition and CI quality of life (CIQOL).

Methods: This study was performed at a tertiary academic center and included a longitudinal, prospective cohort of 72 adults undergoing cochlear implantation for bilateral severe-to-profound hearing loss. Data included self-reported use of three categories of auditory training post-CI activation: (1) face-to-face auditory training (e.g., speech pathologist), (2) passive home-based auditory training (e.g., listening to audiobooks), and (3) computer-based auditory training (e.g., interactive software). Outcomes were change in Consonant-Nucleus-Consonant phoneme (CNCp), CNC word (CNCw), AzBio sentences in quiet, and CIQOL-35 Profile global and domain scores from pre-CI to 3-month post-CI.

Results: Of 72 patients, 52 (72.2%) used an auditory training resource. Of all patients, 18.4% used face-to-face training, 58.3% passive home-based training, and 33.3% computer-based training. At 3 months post-CI, use of any training was associated with greater improvement in speech recognition (d-range=0.57-0.85) and global and domain-specific CIQOL scores, except entertainment (d-range=-0.33-0.77) than non-use. Use of computer-based training was associated with larger improvements in speech recognition (CNCp:d=0.69[0.03,1.35]; CNCw:d=0.80[0.14,1.46]; AzBio:d=1.11[0.44,1.77]) and global and all domain-specific CIQOL scores (d-range=0.05–1.35), compared to those who did not use computer-based training. Controlling for age, sex, household income, and use of multiple training resources, computer-based training remained the strongest positive predictor of speech recognition and CIQOL improvement, with significant associations with CNCp (β=33.07[1.43,64.72]), AzBio (β=33.03[5.71,60.35]) and CIQOL-global (β=10.92[1.15,20.70]) score improvements.

Conclusions: Auditory training, especially self-directed computer software, resulted in improved speech recognition and CIQOL outcomes after 3 months and these resources
are widely available for CI users. These findings provide preliminary evidence-based recommendations for the use of specific auditory training resources by newly implanted adult CI recipients.

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**Control Number:** 2022-A-279-ACI

**Complete Status:** Complete

**Presentation Number:** CS2-1.2

**Publishing Title:** Cochlear Implantation in Infants: Evidence of Safety

**Author Block:** Nicholas L. Deep, MD\(^1\), Patricia L. Purcell, MD\(^2\), Karen A. Gordon, PhD\(^3\), Blake C. Papsin, MD\(^3\), J. Thomas Roland, Jr., MD\(^4\), Susan B. Waltzman, Jr., PhD\(^4\);

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**Introduction:** To investigate surgical, anesthetic, and device-related complications associated with cochlear implantation (CI) in children younger than one year of age.

**Methods:** Multicenter, retrospective chart review of all children with severe-to-profound sensorineural hearing loss who underwent cochlear implantation before one year of age. Endpoints included perioperative course, major and minor surgical, anesthetic and device-related complications, and 30-day readmission rates.

**Results:** 136 infants (242 ears) met criteria. The mean age at implantation was 9.4 months (SD 1.8). Six-month follow-up was reported in all patients. There were no major anesthetic or device-related complications. Adverse events were reported in 34 of implanted ears (14%) (7 major, 27 minor). Sixteen adverse events occurred ≤30 days of surgery, and 18 occurred >30 days of surgery. The 30-day readmission rate was 1.5%. The rate of adverse events did not correlate with pre-existing medical comorbidities or duration under anesthesia. There was no significant difference detected in complication rate for patients below 9 months of age versus those 9 to 11 months of age.

**Conclusion:** This study demonstrates the safety of CI surgery in infants and supports reducing the indication for cochlear implantation to below one year of age for children with bilateral, profound sensorineural hearing loss.

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Introduction: This study was conducted to establish a radiological classification of the location of the vertical segment of the facial nerve (VSFN) and to see if this has implications on the surgical technique needed to access the round window niche (RWN) in cochlear implant (CI) surgery.

Methods: One hundred twenty-seven patients underwent CI surgery, and high-resolution computed tomography (HRCT) of 140 temporal bones was studied. The data that were collected consisted of the patient’s age, sex, radiological inner ear malformations (IEM), and the surgical technique used to access the RWN. Main Outcome Measures: The radiologic location of the VSFN in relation to the lateral semicircular canal in the coronal plane of HRCT and its implication on the surgical approach used to access the RWN in CI surgery.

Results: A statistically significant association is present between the radiological location of the VSFN and the surgical approach used (p<0.001). There was insignificant correlation between the locations of the VSFN and the patient’s age, sex, and IEM as the p>0.05.

Conclusion: On HRCT (0.6mm) in the coronal plane, the position of the VSFN in relation to the lateral semicircular canal is correlated with the alternative approaches that must be taken during CI surgery.
Introduction: Electrical single-channel stimulation is widely used to record auditory brainstem responses (eABR) in cochlear implant (CI) recipients. In contrast to recordings of acoustic brainstem responses (ABR), which typically use broadband stimuli, single channel stimulation activates only sub-regions of the cochlea. To enable maximal coverage of the cochlea by electrical stimulation, an ongoing study is to design and validate an optimized multi-channel stimulation pattern. The optimization aims to compensate for site-specific neural delays of different cochlear areas.

Methods: eABRs are measured intra-operatively via the inserted CI array. To generate a spatially broad activation, pulses are emitted from a basal and an apical channel. A delay is introduced between pulses from the basal and apical channel, which is successively changed in a series of eABR measurements. The amplitude of the wave eV is determined for each measurement of the series and presented as a function of the delay.

Results: The data acquisition of the study is still ongoing. The preliminary results show that a maximum amplitude of the wave eV can be achieved depending on the duration of the delay. The optimal delay for all subjects so far has been in the range of 250 µs to 1000 µs.

Conclusion: From the data collected so far, it could be shown that optimized multi-channel stimulation can lead to greater activation than single-channel stimulation. It is assumed that this effect reflects the simultaneous activation of broad cochlear areas. Similar to intra-operative ABR measurements via active middle ear implants, such stimulation patterns could be used in the future to determine the location of the CI array during implantation.
Introduction: In every cochlear implantation the surgeon faces the challenge to insert the electrode array as atraumatically as possible to preserve cochlear structures and residual hearing. In cochlear implantation, very good hearing preservation rates (pre-postoperative hearing loss <15dB) can be achieved in around 60% of the patients with current soft surgical techniques. However, to guarantee hearing preservation results in the majority of patients (> 90%) those techniques still have to be improved. Computer aided and robot assisted systems (CAS and RAS respectively) have the potential to overcome the limitations of manual interventions (i.e., electrode insertion speed, tremor, blind insertion), improve outcomes, broaden patient indication criteria and enable outpatient treatment to broad mass of patients. The aim of the current study was to implement different CE marked products into the surgical workflow of hearing implant interventions and identify parameters in surgery that can be optimized with those systems.

Methods: Different surgical navigation systems (CAS: Scopis, Fiagon, Brainlab) were used to preplan and determine optimum insertion trajectory and location of implant bed (n = 12), robot assisted surgery (RAS: Robotol) was conducted to improve structure and hearing preservation (n = 21). In order to integrate CAS and RAS, a new robot assisted system for minimal invasive and high precision cochlear implantation on a low-cost base was developed and used in both cadaver experiments and a clinical feasibility study.

Results: The use of navigation systems requires additional preparation time but provides important additional information during the surgical procedure. The use of robotic tools achieves slower and smooth electrode insertions with the potential of better structure preservation. The novel system integrates both CAS and RAS. It achieves high precision at the posterior tympanotomy and a deviation of < 10° for the angle of insertion.

Conclusion: Surgical assisting systems allow for an improvement of single surgical steps towards high precision. However, the systems today are limited to specific tasks during the surgical process. In order to be widely used they must be integrated into the routine surgical workflow and add only minor additional costs to the procedure.
Pediatric Datalogging: Understanding Clinical Factors Influencing Cochlear Implant Use

Shreya Chidarala, BS, Nicolas Poupore, BS, Theodore McRackan, MD, Kara Schavartz-Leyzac, AuD, PhD; Department of Otolaryngology - Head and Neck Surgery, Med. Univ. of South Carolina, Charleston, SC.

Introduction: Cochlear implantation (CI) is the gold-standard approach to treating children with significant sensorineural hearing loss (SNHL). While it is recommended that recipients use their CI most of the day, the average awake time in children varies based on age, thus affecting their overall awake hours per day. Hearing Hour Percentage (HHP) is a more accurate method to analyze pediatric CI use. There is limited data regarding factors and clinical characteristics (including comorbid otologic diseases), that could potentially influence CI use as defined by HHP. Understanding these factors can increase both patient/parent and provider awareness and improve counseling.

Methods: Datalogging information was extracted for 103 children (ages 0.69 -15.4 years) who were utilizing Cochlear™ devices. Demographic factors (age, gender, age of implantation, etiology), Preschool Language Scales (PLS) scores, and otologic diseases, including acute and chronic otitis media, were retrospectively collected. Analysis was only completed on a cohort of patients who had both pre- and post- operative PLS available (N=35; ages 0.69 - 11.8 years). We stratified Hearing Hour Percentage (HHP) to high-use (>0.8) and low-use (<0.8). HHP was calculated from median sleep time from the American Academy Sleep Medicine based on patient age. Chi-square and Mann-Whitney analyses were used for nominal and non-normal continuous variables, respectively.

Results: Mean age was 1.85 ±1.42 years and male to female ratio was 1.5:1. Mean length of datalogging was 2.27±1.74 years. The most common SNHL etiology was idiopathic (n=9, 45.7%), followed by cochleo-vestibular pathologies (n=6, 17.1%). 30 patients (85.7%) had bilateral CI. Older patients were more likely to use their CI >0.8 (7.47 ± 3.82 vs. 4.94 ± 3.02, p<0.001). Patients who used their CI >0.8 HHP had a significant gain from pre- to postop in PLS Receptive Language standard score (19.86 ± 23.11 vs. 2.78 ± 23, p=0.037), PLS Receptive Language percentile (30.14 ± 33.94 vs. -0.35 ± 12.16, p=0.040), and PLS Expressive Language percentile (17.86 ± 24.27 vs. -1.22 ± 17.82, p=0.025).

Conclusion: Older patients at implantation were more likely to use their CI >0.8 HHP. In our study, patients who utilized their CI >0.8 HHP had significant improved receptive and expressive language outcomes, but long-term benefit is unknown. Further stratification by age group, preferred form of communication (i.e total communication, ASL, spoken language) and investigation of pre-operative characteristics may help contextualize factors or barriers influencing high and low CI use.
Abstract Body: A case study of a pediatric patient with bilateral cochlear implants and intractable migraine.

**Introduction:** Cochlear implantation has widely been accepted as a safe and effective means to achieve better hearing and speech outcomes for pediatric patients with congenital, bilateral severe-to-profound hearing loss. This is a case study of a typically developing female diagnosed with congenital, bilateral profound sensorineural hearing loss that suffered intractable migraine.

**Methods:** This is a case study of a 13-year-old female with bilateral cochlear implants and intractable migraine approximately 11 years post-initial stimulation.

**Results:** This patient was implanted simultaneously with bilateral Cochlear Nucleus CI512 internal devices at approximately 18 months of age. She has been a consistent user of her implants and with excellent benefit. This child suffered significant discomfort described as ‘hot’ with throbbing pain on the right side approximately 11 years post-initial stimulation. Within a couple of days, the pain had encompassed the left side of her head as well. She was brought into the clinic to determine if it was an external device issue (i.e., magnet strength, processor overheating, mapping issues, etc.) or possibly a problem with the internal device. The only relief she received was by removing the processors and putting ice bags on both magnet sites. An integrity test revealed no problems with either internal device. The surgeon prescribed steroids and antibiotics with no relief and imaging was conducted. The patient was referred to neurology where she was diagnosed with an intractable migraine and depression.

**Conclusion:** With medication and therapy, this patient has been able to return to her usual activities wearing her processors full time without return of symptoms.
Intraoperative electrophysiological and radiological changes after CI electrode pullback

Philipp Mittmann, MD, Arneborg Ernst, MD, Gina Lauer, MD; Unfallkrankenhaus Berlin, Berlin, Germany.

Introduction: The position between the cochlea implant electrode array and the neural structures is crucial for the audiological outcome in CI surgery. Using the pullback technique, an electrode position closer to the modiolus can be achieved in perimodiolar electrode arrays. An approximation to the modiolus could be demonstrated by improved electrophysiological recordings after finalizing the pullback.

Methods: Nineteen patients were implanted with Nucleus Slim perimodiolar electrode arrays (Cochlear Pty, Sydney). After complete insertion of the electrode, a controlled pull-back by about 1.5mm was performed. Electrophysiological measurements were performed before and after the pullback. Radiological examination was performed one day after Implantation.

Results: Significant lower threshold neural response telemetry (t-NRT) data were found between electrode 7 and 11 after the pull-back. Impedances remained unchanged during this procedure. Significant changes were seen radiologically after the pullback.

Conclusion: The hearing benefit with cochlear implant as rehab strategy has been successful documented over the last few decades. In this series, a pullback of the CI electrode after full insertion showed an improved electrophysiological pattern of NRT data intraoperatively. It remains a matter for further studies to correlate those data with long-term audiological outcome data.

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Intracochlear pressure changes during cochlear implant electrode insertion - a temporal bone study

Gina Lauer, MD, Arne Ernst, MD, Philipp Mittmann, MD; Unfallkrankenhaus Berlin, Berlin, Germany.
Abstract

Body:

Introduction: Different factors influence the atraumatic insertion of CI electrode arrays. The intracochlear pressure changes influence the preservation of residual hearing. A smooth and slow insertion is as important as a careful opening of the round window membrane. A lot is known about intracochlear pressure changes from research in an artificial cochlear model. The aim of our study was to investigate how the intracochlear pressure changes during the insertion of the cochlear implant electrode array.

Methods: Insertions were performed in fresh temporal bones with two different electrode arrays. Intracochlear pressure changes were recorded with a micro-optical pressure sensor in the apical part of the cochlear and the vestibule.

Results: Significant differences were measured with different electrode arrays. Pressure changes with small voluminous electrodes are smaller than pressure changes in voluminous electrodes. Furthermore, pressure changes within the cochlear appear higher than in the vestibule.

Conclusion: Preservation of residual hearing and the audiological outcome after cochlear implantation are important factors in modern cochlear implant surgery. Intracochlear pressure changes should therefore be kept small to preserve intracochlear structures and hence residual hearing. Reduced volume of the electrodes is one key factor to preserve intracochlear structures. Nevertheless, co-factors such as insertional speed, opening of the round window and moistening of the electrode array have to be considered.

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Presentation Number: CS5-2.1

Publishing Title: Preservation of residual hearing: Long-term results with a mid-scala electrode

Author Block: Gina Lauer, MD, Martin Gerbert, MD, Arneborg Ernst, MD, Philipp Mittmann, MD; Unfallkrankenhaus Berlin, Berlin, Germany.

Abstract

Body:

Introduction: The long-term preservation of residual hearing after cochlear implantation has become a major goal over the last few years. The aim of the present study was to evaluate residual hearing in the long-term follow-up using mid-scala electrodes.

Methods: In this retrospective, single-center study, we collected data from 27 patients who were implanted between 2014 and 2015 with residual hearing in the low frequency range using a mid-scala electrode. Measurements of the hearing thresholds were carried out directly post-operatively (day 1 after surgery) and in the long-term follow-up (up to
43.7 months on average). The calculation of the extent of audiological hearing preservation was determined using the HEARRING group formula.

**Results:** Post-operative preservation of residual hearing was achieved in 69.2% of the cases in the low frequency range between 250 Hz and 1 kHz, of which 89.5% of the patients had frequencies that suggested an audiological benefit using electroacoustic stimulation (EAS). In the long-term follow-up, 26.9% of the patients showed residual hearing; however, 57.1% had apparently benefited from EAS.

**Conclusion:** Preservation of residual hearing is feasible in the long-term using mid-scala electrodes. Post-operatively, there is a high proportion of patients who benefit from an EAS strategy. The long-term follow-up shows a certain decrease in residual hearing, which, however, is comparable to studies relating to other types of electrodes. Further research should be conducted in future to better evaluate hearing loss in long-term follow-up, compared to direct post-operative audiological results.

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**Control Number:** 2022-A-295-ACI

**Complete Status:** Complete

**Presentation Number:** CS2-1.4

**Publishing Title:** Longitudinal Analysis of Academic Achievement and Language in Pediatric CI Users

**Author Block:** Ivette Cejas, PhD¹, Alexandra Quittner, PhD², David Barker, PhD³, Christina Sarangoulis, BA⁴;

**Introduction:** Pediatric cochlear implants are the treatment of choice for children with bilateral severe to profound hearing loss who have selected a listening and spoken language approach. CIs have proven to positively impact children’s overall functioning in terms of communication and social and emotional functioning. However, few studies have directly evaluated the longitudinal development of children’s academic functioning post-implantation and how this relates to spoken language development. The current study will utilize the Childhood Development after Cochlear Implantation (CDaCI) study to evaluate academic achievement in children using CIs and its relationship to language development.

**Methods:** The CDaCI study is a longitudinal multicenter study of the effectiveness of pediatric cochlear implants. This study enrolled 188 children, with a mean age of 2 years
who were undergoing cochlear implantation and 97 hearing peers. All children were under 5 years at enrollment and completed a variety of assessments including measures of language and academic functioning. Children from the CDaCI study were followed from pre-implantation to 15 years post-implantation. Data for the current study will utilize follow-up visits from Wave 2 (48 to 96 months post-implantation) and Wave 3 (108-156 post-implantation) of the study. The Comprehensive Assessment of Spoken Language (CASL) and the Woodcock Johnson Tests of Achievement were used to evaluate children’s spoken language and educational outcomes. Data from the following subscales will be presented: passage comprehension, reading fluency, math computation, math fluency, writing samples, and writing fluency.

**Results:** Results of mixed effects models found that children implanted prior to 18 months of age performed significantly better across all spoken language and academic achievement subtests than those implanted later than 18 months of age (p<.05). Specifically, in the area of reading comprehension, children implanted earlier performed commensurate with the mean of the general population (M = 100.6; SD= 2.17), while those implanted later scored below the average range (Mean = 85.2; SD=1.42). This pattern of scores was consistent across all areas of academic functioning, including writing, math, and fluency. Interestingly, the overall CI group scored below average on the CASL composite despite performing at grade-level on measures of academic functioning; however, children implanted earlier (M = 90.9; SD=3.1) continued to outperform those implanted later (M = 73.3; SD=2.1). Future analyses will further disentangle the relationship between language and academic functioning across 15 years post-implantation.

**Conclusion:** Consistent with prior research these data highlight the benefits of earlier implantation on both spoken language and academic functioning. Children implanted prior to 18 months of age were performing at grade-level on measures of academic achievement and these scores were maintained from 4 to 15 years post-implantation.
American Cochlear Implant Alliance Task Force Guidelines on Benefits of Cochlear Implantation for Adults with Single-Sided Deafness

Armine Kocharyan, MD; Ghazal S. Daher, MD; William H. Shapiro AuD; Hillary A. Snapp AuD, PhD; Jill B. Firszt PhD; Matthew L. Carlson, MD; Margaret T. Dillon, AuD

Introduction: Most studies reporting outcomes of cochlear implant (CI) use for adults with single-sided deafness (SSD) are investigations with small sample sizes, thereby limiting the generalizability of the data and recommendations. This study aims to establish an evidence-based clinical practice guideline via a systematic review of published studies on hearing, tinnitus, and quality of life benefits of CI in adults with SSD.

Methods: PubMed, MEDLINE, Embase, Cochrane Central Register of Controlled Trials, Web of Science, and Scopus databases were searched from January 2008 to September 2021. Inclusion criteria were formulated to capture studies reporting outcomes in adult patients (≥18 years old) with SSD undergoing CI. SSD was defined as documented single-sided moderate to profound hearing loss and normal or near-normal hearing (defined as PTA<35 dB HL) in the contralateral ear. The initial search yielded 1147 articles for review. Of those 42 studies reporting outcomes on hearing, tinnitus, and quality of life met criteria for inclusion. Each study was assessed for level of evidence and categorized based on the type of reported data: hearing (29 studies), including speech recognition in quiet, speech recognition in noise and sound source localization; tinnitus (18 studies); and quality of life outcomes (21 studies). To summarize the outcomes of the studies for guideline formulation, four ordinal categories of probability were defined: “high probability” of the effect of CI use on the outcome of interest (i.e., hearing, tinnitus, or quality of life) defined by >75% to 100%, “moderately high probability” defined by >50% to 75%, “moderately low probability” defined by >25% to 50%, and “low probability” defined by 0% to 25%.

Results: A high (>75%) probability of significant improvement in speech recognition in quiet in the implanted ear, sound source localization, patient-reported tinnitus severity, and tinnitus- and hearing-related quality of life was found at 12-months post-activation for adult CI recipients with SSD. For speech recognition in noise, the probability of improvement was dependent on the target-to-masker configuration. Data were inconsistent as to whether age at implantation or duration of hearing loss were associated with CI outcomes; these findings may have been due to the limited age range, lack of individual patient data on durations of hearing loss and performance in the available samples.

Conclusion: Cochlear implantation is an effective treatment option for adults with SSD. The systematic review of published studies found CI use improves speech recognition in quiet, sound source lateralization, tinnitus, and quality of life in patients...
with SSD. However, the probability for significant improvement in speech recognition in noise varies on the directionality of the sound and noise.
In addition, implications for the future of teletherapy use with parents of young children who are deaf or hard of hearing will be discussed.

**Conclusion:** Overall, teletherapy services are positively perceived by both early intervention providers and parents of young children who are deaf or hard of hearing when specific models of family-centered coaching are applied to the teletherapy sessions. To overcome potential challenges of teletherapy services, providers of teletherapy services should take care to prepare specifically for the provision of virtual services ahead of the onset of service delivery and ensure that parents are also adequately prepared to receive services through virtual platforms.

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**Control Number:** 2022-A-298-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-3.1

**Publishing Title:** Audiologists Approaches to Psychosocial Care of Cochlear Implant Users

**Author Block:** Autumn L. Barron, B.S., Sarah E. Warren, AuD, PhD, MPH; School of Communication Sciences and Disorders, Univ. of Memphis, Memphis, TN.

**Introduction:** Hearing loss is associated with a reduction in quality of life related to withdrawal from social activities, interpersonal problems, more significant emotional difficulties at work, and higher levels of anxiety, depression, and interpersonal sensitivity (Veiga et al., 2007; Most, 2009; Pronk et al., 2014; West, 2017). Audiologists should be aware of anxiety, depression, or other psychosocial stressors as these factors affect all aspects of life, including adherence to the intervention prescribed by audiologists (Muñoz et al., 2017; West, 2017; Bennet, 2020). While the provision of psychosocial support of individuals with hearing loss is perceived to be beneficial, it is rarely observed in the clinical setting (Bennet, 2020). Audiologists describe the reluctance to provide these services to be driven by a lack of skill, time, and uncertainty about the scope of practice (Bennett, 2021; Weinstein, 2016). Although professional organizations such as ASHA and AAA endorse emotional counseling as within the scope of practice for audiologists, they do not provide a protocol for providing these services or establish when to refer patients to a professional of another discipline such as psychology or social work. Evaluating current clinical practice patterns will allow a better understanding of how psychosocial factors are being addressed by cochlear implant audiologists and suggest gaps in literature which could be addressed with further research.
Methods: Audiologists who work with pediatric and adult cochlear implant users in the United States were recruited to participated in an online survey to understand practice patterns related to psychosocial counseling in this population. Participants completed a cross-sectional survey which asked questions pertaining to demographic information, education materials, psychosocial counseling practices, and referral patterns.

Results: Data collection is ongoing but is expected to be completed in March of 2022. Preliminary data (n=16) indicates audiologists spend approximately 30-60 minutes per appointment counseling their cochlear implant patients, and there is no standardized approach to psychosocial counseling. Few respondents indicated the consistent use of validated questionnaires to guide clinical practice. All surveyed audiologists indicate the opinion that psychosocial counseling from a social worker or psychologist could be beneficial to the average cochlear implant users; however, half of the respondents reported never referring a patient to social work and all respondents reported referring cochlear implant users to a psychologist infrequently or never. No respondents indicated a standard clinical protocol for determining if a patient should be referred to outside psychosocial services. More data is being collected to interpret factors which influence counseling and referral patterns in this population.

Conclusion: Preliminary results indicate that there is no clinical practice consensus on psychosocial counseling practices or referral patterns for cochlear implant users. Factors influencing current practice patterns are being investigated and are pending more data collection for analysis. Preliminary results support the establishment of guidelines for psychosocial counseling and referrals in the field of cochlear implants.
gap detection, auditory figure ground, filtered words, time compressed sentences, and pitch patterning. Cochlear implants have been shown to provide excellent benefit for children with sensorineural hearing loss particularly with consistent use of the equipment, intensive Auditory-Verbal Therapy and parental support. However, some children demonstrate difficulties when advanced language skills are required to progress and thrive in more complex academic and social environments. Parents and school personnel notice failure to progress with reading comprehension, spelling, and language acquisition.

Methods: This study is a retrospective chart review of pediatric patients with bilateral cochlear implants who have undergone APD testing due to concerns for language development following years of consistent cochlear implant use and intensive therapy. Concerns with language development, reading comprehension, spelling, etc. were raised by the families and/or schools. The APD battery along with a speech and language evaluation was completed to specify target areas for additional therapy in these children.

Results: Recommendations based on APD testing, as well as, speech/language evaluations will be discussed and evaluated in terms of improvement in speech and language development, reading comprehension, spelling, etc.

Conclusion: Results for children with cochlear implants will be discussed in terms of improvement in reading comprehension, spelling and speech and language development overall.

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Control Number: 2022-A-300-ACI

Complete Status: Complete

Presentation Number: CS4-2.8

Publishing Title: Music evaluation in adults, adolescents, and children following cochlear implantation

Author Block: Luis Lassaletta, MD¹, Miryam Calvino, MD¹, Isabel Sánchez- Cuadrado, MD¹, Alejandro Zuazua, MD², Javier Gavilán, MD¹;

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Introduction: Music perception remains as one of the most difficult challenges for implantees. While many pediatric cochlear implant (CI) users participate in musical activities (singing, playing instruments⋯), late-deafened adults gradually lose interest in music even
following implantation. The benefit of a CI is goes beyond the development of language abilities. Evaluation of music skills can be a valuable tool in the assessment of the daily benefit of CI, the results being also helpful for the rehabilitation process. The aim of this study was to evaluate different music tasks through the Meludia music platform in experienced CI users and compare the results among three age groups.

**Methods:**
Inclusion criteria were: postlingually deaf adults and prelingually deaf children using one or two CIs with at least 10 active electrodes, and at least 12 months of hearing experience with CIs. Subjects were divided in three age groups: adults ≥17 years (A); children 6-10 years (B); and adolescents 11-16 years (C). The evaluation test was the “Discovery” level of Meludia, an online interactive music web designed for developing musical skills. Four music tasks were evaluated including Rhythm (how many beats are recognized), Spatialization (distinguish between a lower or a higher note), Stable/Unstable (the sound feels stable or unstable), Melody (the melody is ascending or descending), and Density (sounds that are played at the same time, one or more than one). Each task comprises five levels of difficulty. Testing was performed through a direct connection from the CI audio processor to the sound source of a laptop. Participants were tested around 1-hour session. The scoring system for each task was 1, 2 or 3 points.

**Results:**
69 implantees underwent the complete testing: 41 adults, 14 children and 14 adolescents. The percentage of participants that completed the five levels of the task Spatialization was higher in adolescents (100%), when compared to adults (63%), and children (76%). In a similar way, a higher percentage of adolescents (50%) completed the five levels of the task Melody when compared to adults (7.3%), and children (14%). Adolescents needed less attempts to complete successfully the former tasks. Considering the mean score for each task, children and adolescents performed better than adults in Stable/Unstable (2.5 vs 2.0); and adolescents performed better than children in Rhythm (2.3 vs 1.4) and Melody (1.6 vs 0.9).

**Conclusion:**
Meludia is an adequate tool to evaluate music performance in CI users. Adolescents perform better than children and adult CI users in some musical tasks, maybe due to their higher music exposure. More studies with normal hearing peers are needed to define the role of this online platform as a rehabilitation tool.
Introduction: Active middle ear implants are widely used to treat adults and children with sensorineural, conductive, and mixed hearing loss. Depending on type of hearing loss and pathology, the acoustic transducer of the system can be coupled to different structures of the middle ear. Thereby, hearing improvement is highly dependent on the coupling efficiency. An auditory brainstem response (ABR) based method is well suited to intraoperatively measure aided thresholds for verifying the coupling efficiency. Recently, a further improved method was introduced which is now to be presented.

Methods: ABRs were measured intraoperatively via the active middle ear implant Vibrant Soundbridge. For this purpose, a standard ABR system was used to stimulate the actuator of the implant and record ABR. The ABRs were evoked by chirp-sounds presented at different stimulation levels. ABR thresholds were estimated by identifying wave V of the ABR.

Results: Intraoperative ABR thresholds were determined in more than 30 patients. In the majority of cases, three recordings are sufficient to estimate the aided hearing threshold. The recoding of one complete ABR series takes about five minutes. ABR wave V amplitudes could be identified in all patients and allowed determination of aided hearing threshold. Hearing thresholds were close to preoperative bone conduction thresholds from which they were not significantly different.

Conclusion: The presented method for performing ABR measurements in patients with an active middle ear implant offers easy handling and stimuli transmission with high quality. This allows reliable estimation of the coupling efficiency between the actuator of the implant and the middle ear structure.
**Publishing Title:** Efficacy of Cochlear Implantation in Single-Sided Deafness and Asymmetric Hearing Loss on Speech Outcome and Quality of Life Measures

**Author Block:**

Allen Derina, Au.D.¹, Anna Louthan, Au.D.¹, Mikayla Huestis, MD², Stephanie Moody-Antonio, MD¹;
¹Ear, Nose & Throat Surgeons, Eastern Virginia Med. Sch., Norfolk, VA, ²Audiology, Eastern Virginia Med. Sch., Norfolk, VA.

**Introduction:** Cochlear implantation in individuals diagnosed with single-sided deafness (SSD) and asymmetric hearing loss (AHL) gained approval from the Food and Drug Administration in July 2019. Our aim is to present our initial experience with adults undergoing cochlear implantation for asymmetric SSD and AHL.

**Methods:** Post-lingually deafened adults (N=10) unilaterally implanted for single-sided deafness and asymmetric hearing loss at our facility were studied as a retrospective chart review. Open-set monosyllabic words and the AzBio corpus (quiet and noise) were utilized for pre- and post-operative speech outcome measures. Quality of life data were collected using the Nijmegen Cochlear Implant Questionnaire (NCIQ), Performance Inventory for Profound and Severe Loss (PIPSL), and Cochlear Implant Quality of Life (CIQOL) surveys both prior to and after implantation.

**Results:** We will review the preoperative criteria for implantation and audiological data as well as postoperative outcomes with respect to audiological data, use, and quality of life surveys.

**Conclusion:** Results demonstrate the effectiveness of unilateral cochlear implantation for patients with single-sided deafness and asymmetric hearing loss by evaluating speech understanding ability and overall quality of life. Our early experience is very encouraging that patients outside of clinical trials, selected based on FDA approved criteria, are performing well and demonstrating improved quality of life.

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**Control Number:** 2022-A-305-ACI

**Complete Status:** Complete

**Presentation Number:** 030

**Publishing Title:** A Simple Method for Optimising the Position of Perimodiolar Electrodes within the Cochlea

**Author Block:** Rolf Salcher, MD¹, Martina Nullmeier, PhD², Silas Ewald, Master engineering¹, Nick Pawsey, PhD³, Thomas Rau, PhD¹, Thomas Lenarz, Prof.¹;
**Abstract**

Introduction: Perimodiolar electrodes are designed to sit close to the spiral ganglion neurons, to minimise spread of excitation and so to improve electrode discrimination and speech understanding. However this design intent is not met if the electrode is not inserted to the correct depth, resulting in either a shallow insertion and failure to delivery stimulation to more apical neurons, or overinsertion that pushes the middle of the array away from the modiolus towards the lateral wall of scala tympani.

Methods: A simple method of determining the optimum insertion depth for a perimodiolar electrode for an individual patient has been developed. The distance from the round window to the ‘turning point’ of the modiolar wall is measured from a pre-operative X-ray or CT scan. The turning point is defined as the point on the modiolar wall that has the greatest distance, measured parallel to the line of insertion of the electrode, from the round window. This distance is used to determine the point on the electrode body, relative to its insertion depth markers, that should be positioned at the round window at the end of the insertion, to minimise the distance of the electrode contacts from the modiolus. This point is determined using knowledge of the shape of the electrode array in its unstressed state. The method has been demonstrated in cadaveric temporal bones. Cochlear implant surgeons from our institution, with a range of levels of experience, participated in a study in which each initially performed an insertion of a slim perimodiolar electrode according to their normal clinical practice in a randomly assigned temporal bone. The bone was then imaged using cone beam CT, and the electrode was removed. Each surgeon was then instructed in the new method, then applied it by measuring the turning point distance from a cone beam CT image of the bone without an electrode inserted and calculating the optimum insertion depth. Each then performed a second insertion in the same bone, attempting to achieve the planned insertion depth using the three insertion depth markers. The bone was then imaged again with the electrode in place. The positions of the electrode in the cochlea for the two insertions were compared. First clinical experience applying the method has also been gathered, planning the insertion depth by measuring the turning point distance from the routine pre-operative CT scan.

Results: Insertions made to a pre-planned insertion depth achieved consistent perimodiolar placement in a range of cochlea sizes, while insertions made using the surgeons’ standard practice exhibited a range of intracochlear positions that were affected by the cochlea size. Pre-operative planning of the insertion depth of slim modiolar electrodes based on clinical CT imaging was found to result in good perimodiolar positioning, confirmed using intra-operative fluoroscopy.

Conclusion: A simple method of planning optimum insertion depth for an individual patient’s cochlea size for perimodiolar electrodes has been developed, based on measurement of the cochlea ‘turning point’ distance in a pre-operative CT image. The method has been demonstrated to result in consistent perimodiolar placement in temporal bones as well as in patients.
Abstract Body:

Introduction: Cost-utility studies depend on accurate estimation of health state utility, a measure of health-related quality of life. Currently available utility measures have a narrow conceptualization of hearing function with the notable omission of disabilities associated with unilateral hearing. As a result, existing cost-utility evidence may be underestimating the cost-effectiveness of cochlear implantation, particularly in expanded indications such as bilateral implantation and single-sided deafness.

Methods: The Health Utilities Index Mark 3 (HUI3), the most commonly used utility instrument in hearing loss, was redesigned to better characterize the abilities and disabilities of hearing-impaired patients. An exhaustive list of items describing the quality of life impact of varying types and severities of hearing loss was generated using multiple sources: A systematic review was conducted to identify studies that qualitatively explored health-related quality of life of cochlear implant users from MEDLINE, EMBASE, Cochrane, PsycINFO, and CINAHL databases. The extracted item list was supplemented by clinical experts through focus group discussion and by 26 patients with a wide spectrum of hearing impairments and treatment experience through individual hour-long semi-structured interviews. Items were organized into domains according to the World Health Organization International Classification of Functioning, Disability, and Health brief core set for hearing loss framework, and domains and items were selected by considering (1) their relative importance to health-related quality of life according to survey of 108 patients with hearing impairment, (2) response burden, and (3) structural independence.

Results: The search yielded 2,783 articles and items were extracted from 57 studies that met inclusion criteria, which included 1,088 cochlear implant users. After expert focus
group and patient semi-structured interview supplementation, a final list of 106 items had been generated. Relative item importance scores were obtained for each item by a group of 108 patients with varying hearing loss backgrounds, and these item importance scores served as the primary consideration in the selection of items for the novel HUI Hearing attribute.

The novel HUI Hearing attribute classifies hearing status according to 7 hearing-related domains: speech recognition, environmental sounds, sound localization, listening effort, tinnitus, music appreciation, and reliance on assistive hearing devices. It is capable of describing 25,920 unique hearing states, substantially improving the granularity for measuring utility in patients with hearing impairment compared with existing utility measures.

**Conclusion:** Combined with the other HUI3 attributes, the HUI-Hearing is a comprehensive health status classification system that aims to facilitate appropriate health resource allocation through more accurate discrimination of health states that are important to patients with hearing loss. Future work involves assessment of measurement properties of the HUI-Hearing health state classification system and valuation of its defined health states.

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**Control Number:** 2022-A-307-ACI

**Complete Status:** Complete

**Presentation Number:** 033

**Publishing Title:** Facial Nerve Stimulation after Cochlear Implantation in Children

**Author Block:** Heredio B. Sousa, MD, Pedro Vaz Pinto, ENT Resident, Luisa Varao, Audiologist, Nicole Santos, Audiologist, Ezequiel Barros, MD; ENT, Hosp. de Dona Estefânia, Lisbon, Portugal.

**Introduction:** Facial nerve stimulation (FNS) after cochlear implant activation is one of the possible complications when performing this surgery. It's incidence is estimated to be between 1 and 14% of all cases. The cause of FNS is not well known and although there are many purposed theories, there is still no consensus regarding its physiopathological mechanisms. FNS can be frequently resolved with minimal alterations in speech processor programming, but this may lead, in some cases, to a reduction in the outcome.

**Methods:** Retrospective review of 151 children implanted between 2007 and 2021 in Hospital Dona Estefânia. The following variables were analyzed: sex, age, side of the
implant, etiology of hearing loss, brand of the implant; type of electrodes, time until facial stimulation and complete or incomplete electrode insertion.

**Results:** The incidence of FNS was 6% with a total of nine cases. With an average age of implantation of 5.3 years old, the etiology of hearing loss was idiopathic in the majority of the cases, still there were two cases of connexin 26 mutation, one case of cochlear nerve hypoplasia and one case of meningitis. Two of these cases were managed by changing the programming strategy and the other seven required electrode deactivation. MED-EL was the brand of the cochlear implant in 8 of the cases and Advanced Bionic in one. So, the incidence of FNS with MED-EL cochlear implants in our hospital is 12%, with Advanced Bionic is 6% and with Cochlear is 0%.

**Conclusion:** FNS is one of the most frequent cochlear implant complications; it can lead to patient discomfort and limit the use of the implant. It should be managed promptly with programming modifications or electrode deactivation even though this can decrease the outcome. In our study, strait electrode of MED-EL cochlear is more associated with facial nerve stimulation.

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**Control Number:** 2022-A-309-ACI

**Complete Status:** Complete

**Presentation Number:** 172

**Publishing Title:** Hunting for audiological markers of cochlear fibrosis in cochlear implant users

**Author Block:** Robert Pike, MAud¹, Catherine M. Sucher, BSc, DipAud, MAud (Research), AuD², Cecilia Prêle, PhD³;
³School of Human Sciences, Univ. of Western Australia, Crawley, Australia, Ear Sci. Inst. Australia, Subiaco, Australia, Ear Sci. Inst. Australia, Nedlands, Australia.

**Abstract Body:** Cochlear implantation outcomes can be variable and at times unpredictable. One possible cause of variability is the development of cochlear fibrosis post implantation which has been proposed as a possible cause for soft implant failure. At present it is almost impossible to accurately identify cochlear fibrosis whilst the implant remains in situ unless the recipient is undergoing explantation. The aims of the current study were to 1) perform a literature review to identify potential audiological markers previously associated with cochlear fibrosis, and 2) retrospectively review these measures in a group of cochlear implant (CI) users to identify the prevalence, and any association between these three audiological markers.
Methods: A literature search was performed within the PubMed Database. Clinical data, including impedance levels, hearing thresholds and speech outcomes, pre- and up to 12 months post operatively were collected from 113 ears implanted with the MedEl Synchrony implant.

Results: A Pubmed search identified 183 articles, 24 were included in the final review. Audiological markers associated with cochlear fibrosis were; increased impedance levels, hearing threshold changes, and reduced speech perception. Our retrospective analysis showed a drop in impedances in the apical and medial regions, with an increase in the basal region of the electrode array over 12 months. Hearing thresholds dropped significantly 3 months post-operatively with no significant change in hearing beyond this time. Phoneme scores increased significantly between pre- and 3 months post-operatively with no further change following this time. Analysis of the combined audiological markers is currently under way.

Conclusion: Audiological markers previously associated with cochlear fibrosis were found to be significantly altered within our cohort. Further analysis is required to determine if these changes in audiological markers are useful in identifying individuals at risk of developing CI-induced fibrosis.

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Control Number: 2022-A-311-ACI

Complete Status: Complete

Presentation Number: CS1-1.1

Publishing Title: Binaural hearing benefits with a cochlear implant in adults with single-sided deafness: a prospective study following a consensus protocol

Thomas Wesarg, Dr.-Ing.1, Iris Kuntz, Dipl.-Phys.1, Konstantin Wiebe, B.Sc.1, Susan Arndt, Prof. Dr.2;

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Introduction: Options for treatment of single-sided deafness (SSD) include conventional contralateral routing of signal (CROS) hearing aid, bone conduction implant (BCI), and cochlear implant (CI). However, restoration of binaural hearing can only be achieved with a CI. While the advantages of binaural hearing with CI were shown in several studies, it is impossible to compare their results due to the heterogeneity of applied methods. Our prospective study aimed at assessment of binaural benefits with CI in adults with SSD and
was based on a consensus protocol for unified testing designed for application in mono- and multicenter studies to allow comparison and pooling of data, respectively.

**Methods:** Twelve adult subjects with SSD participated in our study. Hearing performance was assessed preoperatively unaided and with a CROS and BCI trial device, as well as with CI at 1, 3, 6, and 12 months after CI activation. Speech reception thresholds (SRTs) were measured for sentences of the Oldenburg sentence test (OLSA) in unaided condition, with CROS and BCI as well as with CI over time for two different maskers, speech-shaped noise (OLnoise) from the OLSA and two-talker babble (TTB), in five presentation conditions (SssdNah, S0Nah, S0N0, S0Nssd, SahNssd).

**Results:** Six months after CI activation, subjects showed significant large improvements in SRT in TTB revealing median head shadow effects of 8.4 dB for SssdNah and 4.7 dB for S0Nah, a median summation effect of 3.8 dB for S0N0, and median squelch effects of 3.6 dB for S0Nssd and 4.1 dB for SahNssd compared to preoperatively unaided. In OLnoise, significant head shadow effects of 10.1 dB for SssdNah and 4.8 dB for S0Nah, and a significant summation effect of 1.1 dB were found with CI at six months. Compared to preoperatively unaided, subjects’ SRT with the CROS was significantly lower (better) for the head shadow condition SssdNah, but significantly poorer for both squelch conditions, S0Nssd and SahNssd, for OLnoise and TTB. For both maskers, there was no significant difference in speech performance between the BCI and unaided conditions for both head shadow and squelch presentation conditions. Compared to both CROS and BCI, SRTs with CI at six months were significantly better for each of the five presentation conditions for both maskers.

**Conclusion:** Our results show significant improvements in speech understanding in noise with CI in all five presentation conditions revealing advantages of binaural hearing with CI such as head shadow, summation and squelch effect. The benefit with CROS was limited to one head shadow condition, while for both squelch conditions detrimental effects were found.
Abstract

Introduction: Whilst perimodiolar electrode arrays are not traditionally considered to be the electrode of choice when attempting to preserve residual hearing, there is anecdotal evidence of hearing preservation with these devices. The aim of the current study was to assess the hearing preservation outcomes of cochlear implant recipients implanted with the Cochlear Ltd CI632 perimodiolar electrode array.

Methods: The study was a retrospective review of clinical data obtained of 50 individuals implanted with the Cochlear Ltd CI632 perimodiolar cochlear implant for whom post-operative pure tone audiograms were available.

Results: One hundred percent (n=50) had measurable hearing pre-operatively, of these 45% (n=23) had functional pre-operative low-frequency (LF) hearing (≤70 dB average at 250 and 500 Hz). Measurable residual hearing was present post-operatively for 63% (n=32) recipients at their first post-operative audiogram (ranging between 1 and 6 months post-operatively). Of those with functional low frequency hearing pre-operatively, 35% (n=8) retained functional LF hearing post-operatively. The median decrease in hearing at the first measured audiogram was 27.5dB (LF3FAHL, i.e., average at 250, 500 and 1000Hz) for all recipients, and 25 dB for those with functional LF hearing pre-operatively. Similar, but slightly better results were noted when comparing pre to 3-month post-operative results.

Conclusion: Audiological markers previously associated with cochlear fibrosis were found to be significantly altered within our cohort. Further analysis is required to determine if these changes in audiological markers are useful in identifying individuals at risk of developing CI-induced fibrosis.

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Control Number: 2022-A-314-ACI

Complete Status: Complete

Presentation Number: 078

Publishing Title: Implementing an Evidence-Based Cochlear Implant Delivery Model in a Private Practice

Author Block: Sandra Porps, Au.D.¹, Danielle Bennett, Au.D.¹, Jan Gilden, M.A.², Sherri Taxman, M.S.², Kimberly Ravelo, Au.D.³;
Introduction: Cochlear implantation is a proven tool to help our patients with moderate to profound hearing loss that could not otherwise be fit with hearing aids. However, it can also be time intensive for both the patient and the clinic with numerous visits, particularly in the first year. The goal of this study was to use an evidenced-based model to reduce the number of visits overall, while maintaining patient satisfaction and outcomes.

Methods: Five experienced clinicians, across three private practices participated in this study along with seventeen newly implanted cochlear implant recipients. The subjects had the following characteristics.

Age at Implantation: 64.76 years (+/- 12 years) Range - 33-80 years. Duration of Hearing Loss: 19.05 years (+/- 14 years). Pre CI CNC word score: 12.88% (+/- 15%). Pre CI AzBio +10 Signal to Noise Ratio: 32.71% (+/- 24%)

These subjects were seen on the following schedule with the stated tasks and milestones, which was a deviation from the clinics’ typical 5-7 visits in the first year.

Initial Activation: Fit Device/Basic Use, Acclimate to sound, Review hearing goals - COSI - Patient hearing goals.

Within 1 month: Assess audibility, Introduce accessories, Confirm device use - <= 25dB HL 250-6000Hz, Time on air across environments.

Within 3 months: Assess performance, Assess hearing satisfaction - Hearing satisfaction survey, COSI, >/=/ 20% improvement on CNC words.

Within 6 months: Assess performance, Assess hearing satisfaction, Re-evaluate 2nd ear, Baseline remote check if possible - Hearing satisfaction survey, COSI, >/= 30% improvement on CNC words, Remote check if possible.

Follow Up Care: Timing based on remote check and/or patient outcome/need, Stable performance - Hearing satisfaction survey, COSI, < /= 15% reduction to understanding of CNC word scores, Remote check if appropriate.

Results: While there was some deviation from the protocol, the majority of patients were able to stay on schedule with 1 subject requiring an additional appointment between initial activation and 1 month and 2 subjects requiring an additional visit between 3 months and 6 months. The subjects scored an average of 56.85% on CNC words and 61.5% on AZ Bio +10 SNR testing at 3 months. At 6 months the subjects scored an average of 71.71% on CNC words and 61.5% on AZ Bio +10 SNR testing. These scores are consistent with those of the clinics’ average results. Patient satisfaction with service was rated as excellent by 13 of the 17 patients. Hearing satisfaction was rated as “very satisfied” or “satisfied” by greater than 50% of the subjects for telephone use, listening and appreciating music, small group listening, and TV understanding.

Conclusion: Results from this study confirm that patients are able to be serviced with fewer clinic visits and less chair time thereby increasing clinic efficiency. There is no detriment to the patients in terms of results, satisfaction with service, or satisfaction in hearing ability. As a result of this study, one clinic has changed their care model to reduce the number of visits required in the first year.
Self-Efficacy on Social-Emotional and Auditory Learning in Children with Hearing Loss

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Introduction: Children with hearing loss exhibit greater difficulty making and maintaining friendships, higher rates of loneliness or isolation, poorer quality friendships, and higher rates of peer victimization (i.e., getting bullied) compared to children with typical hearing. Most studies looking at rates of bullying behavior have focused on typically developing youths with far fewer investigations focusing on bullying among students with developmental disabilities. Research regarding children who are deaf or hard of hearing shows that (a) language age - but not the mode of communication - predicts social competence; (b) speech intelligibility impacts psychosocial functioning, and (c) auditory status and type of auditory technology mitigates social competence and peer interactions. The purpose of this research was to investigate the perception of self-advocacy and social-emotional skill development in caregivers of children who are deaf or hard of hearing. Caregiver perspective and child self-report surveys were developed to accomplish this purpose.

Methods: Participants will include (a) children (8-12 years of age) who are deaf or hard of hearing; (b) children (8-12 years of age) with typical hearing and typical development; and (c) parents of infants and children (3 to 12 years of age) with any auditory status (i.e., deaf or hard of hearing; typical hearing and typical development). All participants will complete the Social and Emotional Learning Survey (SEALS) to assess different aspects of social-emotional development (e.g., grit, social awareness, self-management, emotion regulation). This presentation will focus on data from the parent proxy perspective. Analysis of results includes the relationship of social-emotional learning to the age of onset, use, and type of technology, self-efficacy skills, as well as the language of the home.

Results: Data collection is ongoing. Currently, there are fifteen completed questionnaires with nine of those being from caregivers of children with typical hearing and six
completed questionnaires being from caregivers of children with hearing loss. Currently, caregivers of children with hearing loss have judged their children to have more overall difficulties than peers with typical hearing ($M=17.5$ vs. $10.6$). Caregivers rated children in the group with hearing loss as being more hyperactive and having more emotional, conduct, and peer problems than children with typical hearing. Parents reported that when their children felt safe, they also experienced fewer emotional problems, fewer conduct problems, decreased social stress, and decreased social withdrawal.

**Conclusion:** Given how data for this study currently trend, there are key points that should be considered by professionals working with children with hearing loss. Our data suggest that speech perception at a distance can have a profound impact on social-emotional learning; therefore, it should be targeted directly as part of a comprehensive intervention program. Practitioners need to be mindful of signs of withdrawal or social distress that could be impacting more a child’s feeling of safety at school and realize that children with hearing loss may have these feelings more frequently than their peers with typical hearing. As always, a holistic approach that includes making referrals for support services such as counseling or social work is warranted when working with children with hearing loss.

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**Control Number:** 2022-A-316-ACI

**Complete Status:** Complete

**Presentation Number:** CS2-1.3

**Publishing Title:** Children with Cochlear Implants Experience Linguistic Environments with Substantially Different Quantity and Quality

**Author Block:** Meisam Arjmandi, Ph.D.\(^1\), Derek Houston, Ph.D.\(^2\), Laura Dilley, Ph.D.\(^3\);

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**Introduction:** Despite more than a decade of research on factors contributing to enormous variability in language outcomes of children with cochlear implants (CIs), a large portion of this variability remains unexplained. Properties of early language input is an under-studied factor that may contribute to this large difference in language outcomes. The present study aimed to understand the extent to which early-implanted children with CIs differ in quantity and quality of language input they experience in their natural linguistic environments.
Methods: Day-long Language ENvironment Analysis (LENA) recordings, derived from home environments of 14 early-implanted children (Mean age at implantation=14.97 mo), were analyzed during the first year following implantation to understand individual differences in quantity and quality of language input. Quantity of language input was defined as the number of words experienced and quality of language input was defined as whether the words were child-directed or overheard. The properties of language input were further quantified in terms of the number of words per day, type-token ratio (TTR), and mean length of utterance (MLU) in morpheme in adults’ speech.

Results: The results demonstrated that children with CIs varied largely in the number of total words (mean±SD = 25,134±9,267 words) and the number of high-quality child-directed words (mean±SD = 10,817±7,187 words) they experienced in a day in their home environments during the first year after implantation. Children also experienced highly different environments in terms of lexical diversity (as measured by TTR) and morphosyntactic complexity (as measured by MLUₘ) of language input. The patterns of variability across children in quantity and quality of language input changed depending on whether the speech was child-directed or overheard speech. Children who experienced linguistic environments with higher total numbers of words per day did not necessarily hear the most child-directed words per day as high-quality language input. None of the demographic factors such as parental socioeconomic status (SES), preoperative hearing status, age at implantation, and communication mode (oral or total communication) explained the differences among children in their language input.

Conclusion: Findings from this study provide new evidence on substantially variable language input that children with CIs experience early after implantation, which are potential sources of individual differences in outcomes of children with CIs. More importantly, variability across children was substantial in amount of high-quality child-directed speech they experienced. Unlike distal family variables such as parental SES that are less clinically adjustable, proximal family variables such as the amount of words experienced in a day can be clinically modified to maximize the benefit of CIs. Further studies are warranted to elucidate the impact of this substantial variability in language input on children’s language outcomes.

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Control Number: 2022-A-318-ACI
Complete Status: Complete
Presentation Number: CS3-2.1
Title: Effects of Early Intervention Frequency on Expressive Vocabulary Growth Rates of Very Young Children who are DHH: How Much is Enough?

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Introduction: The aims of this study were to explore expressive vocabulary growth rates of children who are deaf or hard of hearing (DHH) during critical periods of brain development (birth to three), as well as the factors which influence the trajectories of vocabulary growth in these early years of development. Of primary interest was the effect of intervention frequency on expressive vocabulary growth.

Methods: Hierarchical linear modeling was used to investigate trajectories of expressive vocabulary growth using multiple measures of longitudinal vocabulary scores. A total of 417 assessments across 105 participants were analyzed to determine the average rate of lexical growth achieved in a young population of children who are DHH receiving early intervention before age three. Expected growth trajectories were constructed based on varying amounts of early intervention services received during the critical period of brain development prior to age three.

Results: Results indicated average growth rates of 5.21 new words expressed per week. Expected growth trajectories were steeper for children who received more hours of intervention services per week before age three.

Conclusion: The findings of this study suggest that children who are DHH under three years of age would achieve faster expressive vocabulary growth from greater doses of intervention hours than the current field-recommended dose frequency of 1-2 hours per week.

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Publishing Title: Effective Masking Method(s) for Aided Speech Testing with Cochlear Implant Users who have Single Sided Deafness

Author Block: Sarah Weinstein, B.A.¹, Nicole Nguyen, AuD¹, Larissa Curry, AuD¹, Joshua Bernstein, PhD¹, Elicia Pillion, AuD², Matthew Goupell, PhD¹;
Introduction: Aided speech testing is an important tool for determining cochlear-implant candidacy and quantifying a patient’s benefit post-operatively. The FDA recently expanded cochlear-implant candidates to include patients with single sided deafness (SSD) and asymmetric hearing loss. Unlike traditional cochlear-implant users, SSD patients have a normal to near-normal hearing ear; thus, for aided testing this ear likely needs to be attenuated or masked appropriately to determine the aided sentence recognition for only the poorer ear. However, it is unclear what are the most appropriate masking methods for these clinical populations. Is it sufficient to plug-and-muff the better ear? Do you need masking noise, and if so, how much is appropriate? To investigate the best way to complete aided testing for SSD patients both pre-op and post-op, we will evaluate the most common methods currently being used in the field. The underlying principle is that there must be sufficient attenuation to prevent speech information from being detected in the acoustic-hearing ear, while not so much noise that acoustic crossover masks speech cues in the test ear. It was hypothesized that: (1) The plug-and-muff method will not provide enough attenuation to mask the good ear in all individuals, such that masking noise will be required; and (2) There will not be a single level of masking noise that universally appropriate, and an individualized method or formula based on hearing thresholds will be required.

Abstract Body: Methods: We will test eight SSD participants who do not have a cochlear implant (the “pre-op group”), and eight SSD participants with cochlear implants (the “post-op group”). To eliminate the possibility that incomprehensible speech information that is detectable in the acoustic ear could nevertheless augment speech scores in the CI ear, we will use speech awareness thresholds instead of speech-understanding scores. Each participant’s speech awareness threshold in their poorer ear will be measured with the following masking conditions in the non-test ear: (1) earplug, (2) plug-and-muff, (3) insert earphone with speech spectrum noise from 0-80 dB HL, (4) insert earphone with speech spectrum noise from 0-80 dB HL also with an earmuff.

Results: Measuring speech awareness thresholds with different masking levels and conditions will create each participant’s individual masking plot. The level at which the threshold reaches a plateau across masking levels will be identified as the effective masking plateau where neither undermasking nor overmasking are occurring. The effective masking levels will be compared across participants to determine which masking methods, if any, can be successfully used to mask the non-test ear for all SSD users.

Conclusion: If there is a method(s) that effectively masks the non-test ear for all of the participants across groups, this can be identified as an appropriate method to use with SSD cochlear-implant candidates and existing users.
Introduction: Variability in cochlear implant (CI) outcomes exists across patients, implant centers, surgeons, and electrode types. Previous studies have shown that robotics-assisted insertion tools can reduce insertion force variability and force peaks when compared to manual by-hand insertions. By providing a slow and steady insertion speed of the CI electrode array, these tools may improve individual outcomes as well as insertion procedure consistency. In this study, a robotics-assisted CI insertion system was evaluated as part of human factors design validation testing using commercially available CI electrodes and a standard mastoidectomy surgical approach.

Methods: 16 ENT surgeons across varying experience levels (residents, fellows, neurotologists) participated in cadaveric cochlear implantations with circulator nurse assistants to assess the usability and safety of the robotics-assisted CI insertion system. The testing involved brief device training on synthetic and cadaveric temporal bones, a period of training decay, and a cadaveric use testing session in which participants performed a robotics-assisted CI electrode array insertions of lateral wall electrodes from three different manufacturers (n=16) in a simulated real-world CI surgery environment. A combination of independent moderator observations, post-use surveys, and surgeon exit interviews were utilized to assess all tasks essential for both the successful use of the system and those critical to patient safety.

Results: Each CI surgeon participant successfully performed all essential tasks and no critical task errors related to patient or user safety were encountered. Moderator observation results revealed that participants were successfully able to load the electrode array, control the desired insertion speed, and insert the electrode array in a slow and consistent manner without significant difficulties. Surgeon exit interview and post use survey indicated surgeons were able to effectively insert CI electrode arrays with the robotics-assisted system using a standard mastoidectomy facial recess approach. Non-critical use errors observed included difficulty securing the unit to the mastoid and improper positioning of the unit by 4 surgeons. These were subsequently mitigated and resolved via updates to training and device design.

Conclusion: CI surgeons were able to consistently insert electrode arrays across varying
experience levels using the miniaturized robotics-assisted insertion system and a standard facial recess approach. The system design effectively accounts for human factors encountered during simulated surgical use with electrodes from multiple manufacturers. Robotics-assisted insertion techniques, which use current surgical approaches with minimal training, have the potential to improve outcomes and reduce variability across CI surgeons, centers, and recipients.

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Control Number: 2022-A-324-ACI

Complete Status: Complete

Presentation Number: 031

Publishing Title: Radiation-free Estimation of Cochlear Implant Electrode Insertion Depth using Impedance Telemetry: Preliminary results on short-term accuracy and long-term stability

Author Block: Stephan Schraivogel, M. Sc.1, Philipp Aebischer, M. Sc.1, Georgios Mantokoudis, Prof. Dr. med.2, Stefan Weder, PD Dr. med.2, Marco Caversaccio, Prof. Dr. med.2, Wilhelm Wimmer, PD Dr.1;

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Abstract Body: Introduction: Reliable identification of cochlear implant (CI) electrode positions offers promising clinical applications. For example, anatomy-based fitting paradigms can be applied to program audio processors based on the individual tonotopy of the patients. To estimate electrode positions, readily available impedance telemetry recordings can be used instead of costly and radiation-based imaging. The primary aim of this retrospective analysis is to validate the intraoperative linear and angular accuracy of a previously published impedance-based electrode insertion depth estimation method. The secondary aim is to assess the long-term stability of the estimation method over time.

Methods: Ground-truth electrode insertion depths were measured in 70 cases implanted with the same lateral wall CI model from computed-tomography (CT) images. For all cases, impedance telemetry recordings were retrieved for the implantation date up to a minimum follow-up of 1 year. Based on the telemetry recordings, linear and angular electrode insertion depths were estimated by a phenomenological model. The obtained estimates were then compared to the ground-truth to calculate the accuracy for the intraoperative and follow-up telemetry recordings.

Results: Preliminary intraoperative accuracy was calculated for 39 cases. The insertion
depths of all electrodes were estimated with an average absolute linear error of 0.65 ± 0.54 mm and angular error of 17 ± 16° (mean plus/minus standard deviation) with respect to the postoperative ground-truth. To assess the stability of the estimation method, data from 20 cases were analyzed over a period of 14 months to 67 months (7 to 18 telemetry recordings per subject). We found a mean absolute linear error of 0.61 mm and angular error of 20°.

**Conclusion:** We proposed a radiation-free impedance-based method for an objective assessment of electrode array placement during and after CI insertion. Our data suggests that the method provides stable estimates for long-term follow-up periods. Our method could enable novel clinically relevant applications including anatomy-based fitting paradigms or postoperative electrode migration monitoring without imposing additional radiation to patients.

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**Control Number:** 2022-A-325-ACI

**Complete Status:** Complete

**Presentation Number:** Publishing

**Publishing Title:** Neuroimaging Resting State Markers in Children who Have Cochlear Implants and Disparate Language Outcomes

**Author Block:**

*Jace Wolfe, Ph.D.*,1, Vince Gracco, Ph.D.*,2, Mickael Deroche, Ph.D.*,3, Nabin Koriala, Ph.D.*,2, Muthuraman Muthuraman, Ph.D.*,4, Sara Neumann, Au.D.*1;

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**Introduction:** A high level of variability exists in the listening and spoken language outcomes of children with cochlear implants (CI). A portion of this variability may be attributed to differences in brain development associated with auditory deprivation secondary to hearing loss. Functional near-infrared spectroscopy (fNIRS) and high-density electroencephalography (EEG) are non-invasive functional neuro-imaging techniques that are used to evaluate the activity of the brain. In the current study, fNIRS and high-density EEG were used to record brain activity in children with normal hearing and children who have CIs and disparate spoken language outcomes as they were engaged in a battery of various functional tasks. This presentation will highlight the findings of this study with a focused on coherence/connectivity measures that were used to evaluate brain networks that were active during the resting state condition. The primary objective was to
determine whether underlying differences in brain activity are related to spoken language outcomes.

**Methods:** Fifty CI recipients, ages 7 to 17 years old, and 25 age-matched children with normal hearing were evaluated with fNIRS and high-density EEG. Twenty-six of the children with CIs had age-appropriate spoken language development (as indicated by a standard score of 100 or greater on the Core Language portion of Clinical Evaluation of Language Fundamentals [CELF] test), whereas twenty-four of the children with CIs had delays in their spoken language development (CELF score < 85). Age of implantation was different for the two groups with, on average, earlier implantation for the age-appropriate group. FNIRS and high-density EEG measures were used to record brain activity while the children were involved in auditory, visual, auditory-visual, resting-state, somatosensory, and motor tasks. Connectivity/coherence analysis was completed to evaluate brain networks that were active during the resting state condition.

**Results:** Significant differences existed in the brain activity of the children with delayed spoken language outcomes compared to the children with age-appropriate spoken language outcomes. Children with better spoken language outcomes were more likely to more robust (greater amplitude) and a higher number of connectivity regions during the resting state condition indicating more sophisticated neural networks than their peers with poorer language outcomes. The connectivity responses of the children who had cochlear implants and age-appropriate spoken language outcomes were more similar to that of their peers with normal hearing. Greater levels of connectivity were associated with better language outcomes.

**Conclusion:** The current data show functional differences in the neural networks of children who have cochlear implants and good language outcomes when compared to children who have cochlear implants and poor language outcomes. More sophisticated and complex neural networks are associated with better language outcomes.

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**Control Number:** 2022-A-326-ACI

**Complete Status:** Complete

**Presentation Number:** 063

**Publishing Title:** Cochlear Implantation at Less Than 1 Year of Age: Safety, Speech Perception, and Language Outcomes

**Author Block:** Masanari G. Kato, MD¹, Prashant S. Malhotra, MD²;
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Introduction: Cochlear implantation candidacy and evaluation have recently undergone significant evolution in regard to the younger pediatric population. This study, therefore, aimed to characterize the safety, speech perception, and language outcomes of early cochlear implantation in a large pediatric-only cohort.

Methods: At our institution, we performed a retrospective review of infants who underwent cochlear implantation at less than one year of age for either unilateral or bilateral severe to profound sensorineural hearing loss or auditory neuropathy between the years of 2010 and 2021. Demographics, medical, and surgical information, including incidence of peri- and post-operative complications were examined. Developmentally appropriate speech awareness and speech perception tasks were recorded pre- and post-operatively, along with available vocabulary (Expressive and Receptive One-Word Picture Vocabulary Tests) and speech and language outcomes (Receptive-Expressive Emergent Language Test or Clinical Evaluation of Language Fundamentals).

Results: A total of 43 infants (30 males, 13 females) encompassing 83 ears were included. Forty children (93%) underwent bilateral simultaneous implantation for varying etiologies of severe to profound sensorineural hearing loss, the most common being Connexin gene mutation (36%, 30/83 ears). The average age at implantation was 10.3 months (range 8.5-12.0 months). No immediate intra- or post-operative major complications were observed, though two ears experienced wound complications within 30 days post-operatively. The average speech awareness threshold improved from 96 dB (unaided, 68 dB aided) pre-operatively to 25 dB at 6 months and 24 dB at 12 months post-operatively. Speech reception threshold at 3 years of age was available for 13 ears (16%, 7/43 patients) with an average of 25 dB. Last known word recognition scores were available for 22 ears (26%, 11/43 patients) with an average score of 80% (range 28-96%). Expressive and receptive picture vocabulary scores and core language scores improved over time and are described. All patients were utilizing their implants and most (83%, 37/43) were communicating orally at their last documented Audiology visit.

Conclusion: Cochlear implantation in infants at less than 1 year of age appears to be a safe and effective intervention for patients with early identification of unilateral and bilateral severe to profound hearing loss. Post-operatively, speech perception scores are high, and positive effects on vocabulary and language measures are seen.

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Control Number: 2022-A-327-ACI
Complete Status: Complete
Initial Outcomes of a Clinical Trial Investigating Expanded Indications for Cochlear Implantation

Andrea B. Overton, AuD¹, Meredith Rooth, AuD², English King, AuD¹, Sarah Dillon, AuD¹, Margaret Richter, AuD², Matthew Dedmon, MD, PhD², Kevin Brown, MD, PhD², Margaret Dillon, AuD²;
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Introduction: Candidacy for cochlear implantation is currently limited to patients with poor hearing detection and speech perception in both ears. Initial investigations of cochlear implant (CI) recipients whose preoperative hearing detection or speech perception in either ear exceeded the current candidacy criteria demonstrate a significant improvement in speech perception with CI use as compared to preoperative abilities. The present report is a prospective evaluation of subjects on measures of speech perception and quality of life whose unaided hearing detection and aided speech perception in the ear-to-be implanted and/or the contralateral ear exceed current candidacy criteria.

Methods: Twenty subjects enrolled and underwent cochlear implantation at our site as part of a multi-center investigation. Preoperatively, subjects presented with moderate-to-profound sensorineural hearing loss and aided word recognition between 10-60% in the ear-to-be implanted and ≤70% in the contralateral ear. The test battery included behavioral measurement of unaided hearing detection, quality of life measures (e.g., Speech, Spatial & Qualities of Hearing Scale; SSQ), and aided speech perception in quiet and noise. Aided speech perception was assessed in two listening conditions: 1) CI alone, and 2) best-aided (CI plus contralateral hearing aid). The aided speech perception test materials were CNC words and AzBio sentences. The test battery was completed preoperatively with appropriately fit amplification and at 1, 3 and 6 months post-activation of the CI.

Results: Subjects demonstrated a significant improvement in speech perception with CI use as compared to preoperative performance with a hearing aid, particularly in the noise condition. Subjects also reported a significant improvement in quality of life with CI use as compared to their preoperative report.

Conclusion: Patients who exceed the current candidacy criteria for cochlear implantation may experience a significant benefit from CI use as compared to alternative treatment options, such as conventional amplification. There is a need for critical evaluation of who may benefit from cochlear implantation in both the adult and pediatric populations to support optimal outcomes and improved quality of life.
Abstract Body:

Introduction: Electrocochleography (ECoG) recorded from intracochlear CI electrodes is emerging as a tool for assessing residual acoustic hearing in EAS cochlear implant recipients. The ECoG can be recorded in the operating room during insertion of the intracochlear array in order to monitor possible cochlear trauma. Additionally, ECoG may be useful in predicting post-operative residual hearing and performance. Cochlear implant manufacturers must provide the recording system needed to make these intracochlear ECoG measures. Until recently, an ECoG system from Med-El has not been available. This presentation describes our first experiences using the Med-El system to record ECoG both intraoperatively and postoperatively.

Methods: Continuous ECoG recordings to 500Hz tone bursts were measured intraoperatively during cochlear implant insertion. Additional continuous recordings were also obtained postoperatively from existing Med-El cochlear implant users. In the postoperative group, deliberate disruptions to stimulus presentation and/or recording connection were implemented in order to observe the system’s response. Amplitude growth functions were recorded in both the intraoperative and postoperative groups. Finally, audiometric thresholds and thresholds to the Med-El ECoG stimuli were collected.

Results: Continuous recordings resulted in reliable responses with a recording noise floor comparable to other systems. Amplitude of responses varied as expected in both real and simulated scenarios. ECoG thresholds were obtained using amplitude growth function measures.

Conclusion: The technical quality of the ECoG responses recorded using the Med-El system was good. The system allows for expanding ECoG research to subject populations that includes Med-El CI recipients.
Health-related quality of life in children using cochlear implants: longitudinal findings of the CDaCI study

**Abstract Body:**

**Introduction:** Introduction: A number of studies have demonstrated that pediatric cochlear implantation (CIs) has substantial benefits for listening and spoken language, as well as cognitive, social and behavioral development. Few studies, however, have examined whether these improvements are also observed in measures of health-related quality of life (HRQoL). The current investigation utilized data from the Childhood Development after Cochlear Implantation (CDaCI) to examine longitudinal changes in both generic and condition-specific HRQoL measures using parent and child reports. Longitudinal changes in HRQoL scores in the CDaCI cohort were evaluated for those implanted before versus after 18 months of age (i.e., early versus later implantation).

**Methods:** Methods: The CDaCI study is a longitudinal, multicenter study evaluating the effects of early cochlear implantation on a variety of developmental outcomes. The study enrolled 188 children and 97 typical hearing peers. All children were under 5 years of age at enrollment and assessments of health-related quality of life (HRQoL) were completed by parents as proxy measures or by children, themselves, in a battery of assessments. Follow up visits occurred at 48 - 96 months post implantation (Wave 2) and 108 - 156 months post implantation (Wave 3). Both generic (e.g., PedsQL) and condition-specific (e.g., Child Health & Illness Profile-Children, Visual Analog scales for health and development) quality of life were analyzed for the CDaCI cohort. Longitudinal data on HRQoL will be presented using both Wave 2 & 3 follow-up assessments.

**Results:** Results: Results of mixed effects longitudinal modeling indicated that on average, most children with CIs were scoring in the normal range on these HRQoL measures across both Waves 2 and 3, using t-scores and standardized scores. T-scores ranged from 47.7 on the CHIP-Parent Family Involvement Domain to 58.3 on the CHIP-Parent Comfort domain (e.g., positive physical, emotional functioning). Similarly, standardized scores ranged from a low of 69.5 on the Youth Quality of Life Participation scale to a high of 97.9 on the EQ-5D Health scale (parent report). Condition-specific measures appeared to be more sensitive to potential decrements in HRQoL than generic measures. Comparisons of early vs. later implanted children in Wave 2 revealed...
statistically significant differences on the following measures: VAS Parent Development, the CHIP-Resilience domain, and the CHIP-Parent Achievement Domain, in favor of those implanted by 18 months of age. By Wave 3, few differences were found on HRQoL between early vs. later-implanted children, suggesting “catch-up” growth in daily functioning across these measures.

Conclusion: Conclusions: Measures of HRQoL indicated that on average, children with CIs were functioning in the normal range. Condition-specific measures revealed a few areas of vulnerability (youth participation), whereas generic measures reflected normal functioning. Children implanted earlier had significantly better HRQoL on a few domains 4-8 years post-implantation, however, by 9 to 13 years post-implantation, no significant differences were found. Overall, children with CI’s scored in the normal range of functioning on a majority of HRQoL measures by both parent and child report.

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amplitudes across the electrode array, and (2) the effect of location of the electrode array within the cochlear partition (lateral wall vs. perimodiolar electrode array) and hearing preservation outcomes.

**Methods:** Retrospective study of adult CI recipients implanted from 2015-2019 who met candidacy for hearing preservation surgery (defined as a pre-operative low frequency pure-tone average of better than 80 dB). Eighty-six recipients who met these criteria and had intraoperative eCAPs recorded at the same stimulus level (225 CL probe level, 25 μs pulse width) were included in this study. Intraoperative eCAPs were recorded from electrodes 1, 4, 7, 10, 13, 16, 19, and 22. Electrode type (slim lateral wall or perimodiolar) and unaided low frequency pure-tone thresholds were also collected.

**Results:** Intraoperative eCAP maximum amplitudes progressively increased from basal to apical electrodes. Maximum amplitudes did not differ as a function of electrode type (slim lateral wall, perimodiolar) and post-operative hearing preservation outcomes.

**Conclusion:** Larger eCAP maximum amplitudes were recorded from apical cochlear regions which is consistent with better low frequency thresholds in this sample of CI recipients who met hearing preservation candidacy. In addition, the type of implanted electrode and post-operative hearing preservation outcomes did not impact eCAP maximum amplitudes. This finding may be related to the acute nature of intraoperative eCAP recordings before fibrous tissue growth. Future research should investigate whether performance can be predicted from intraoperative eCAP recordings in hearing preservation CI recipients.
challenging listening situations, such as in the presence of background noise or when listening to rapid speech. While the performance of older adult cochlear-implant listeners in understanding time-compressed speech has been assessed, the benefit of training measures in improving such performance has not, particularly for older users. The purpose of this research study is to evaluate whether adaptive training improves recognition of fast speech in older versus younger cochlear-implant users. We hypothesize that older cochlear-implant listeners will demonstrate improved understanding of rapid speech after completing the training.

Methods: Participants for this study will include adults who use cochlear implants, aged 18 to 85 yrs. They will be post-lingually deafened, have at least 12 months of cochlear-implant experience, have no usable residual acoustic hearing, and speak English as their first language. Participants will complete pre- and post-test measures in which they will hear time-compressed IEEE sentences, as well as Az Bio sentences presented with multi-talker babble in the background. There will also be a five-session training where participants will listen to IEEE sentences with an adaptive procedure that assesses the time compression ratio at which they score 50% correct. They will repeat the sentences and will receive feedback after each response.

Results: We expect all participants to demonstrate improved performance (higher time compression thresholds indicating speech recognition is maintained at higher speech rates, and higher scores on Az Bio sentences) when comparing pre- and post-training measures, and more improvement with increasing age.

Conclusion: Such results would support the evidence of auditory training and perceptual learning for time-compressed speech. This might suggest that auditory learning due to neural plasticity is possible in response to targeted training with these materials for adult cochlear implant listeners. Promising results would indicate the potential for such training in adult cochlear implant aural rehabilitation.

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Control Number: 2022-A-366-ACI

Complete Status: Complete

Presentation Number: 128

Publishing Title: Socioemotional functioning and language
Elizabeth Adams Costa, Ph.D., Dorothy White, Ph.D., Nancy Mellon, MS, Meredith Ouellette, MS, Sharlene Wilson Ottley, Ph.D.; Department of Psychology, The River Sch./RiverREACH Clinic, Washington, DC.

Abstract Body:

Introduction: Published literature on outcomes for children with CIs has been highly variable (Niparko et al., 2010). Children with CIs have demonstrated varying degrees of speech comprehension and understanding; predictive variables include age of implantation, degree of residual hearing prior to implantation, maternal sensitivity, socioeconomic status, and nonverbal cognitive abilities (Cruz et al., 2013; Niparko et al., 2010; Nittrouer, 2016). Studies investigating the cognitive profiles of children with CIs also document variability; some studies report lower scores on measures of verbal abilities (Geers & Moog, 1989; Geers & Sedey, 2011) compared to hearing peers. Currently literature suggests that auditory deprivation can have a multitude of effects on brain development, and may impact factors of cognition that extend beyond the auditory system. It has been proposed that hearing loss can be considered a connectome disease, with individual differences in response to auditory deprivation accounting for variability in outcomes (Kral et al., 2016). The dynamic systems theory indicates that areas of development are interconnected with one another, suggesting that deficits in one area of development have cascading effects on others. The current study hypothesized that language outcomes would be significantly related to parent and teacher report of student socioemotional functioning, with higher language scores predicting better socioemotional functioning.

Methods: This study examined parent and teacher forms of the BASC-3 for preschool (ages 2-5) and childhood (ages 6-11). Additionally, language data from the CELF-5, PPVT-5, EVT-2, and CASL-2 were used. These measures were collected as a part of annual evaluations for children who have hearing loss and attended an inclusive education program (N=35). Analyses were conducted using RStudio in R version 3.6.3 (R Core Team, 2020).

Results: Overall language scores (Core and GLAI) were significantly correlated with parent report of adaptability (r=.43), inattention (r=-.40), and functional communication (r=.52), as well as teacher report of anxiety (r=.44) and functional communication (r=.60). Receptive vocabulary (PPVT and ROWPVT) was significantly correlated with parent and teacher report of inattention (r=-.38; r=-.44), functional communication (r=.70; r=.77), and social skills (r=.33; r=.42), as well as parent report of atypicality (r=-.33). Expressive vocabulary (EVT and EOWPVT) was significantly correlated with parent report of adaptability (r=.39), teacher report of inattention (r=.34), and parent and teacher report of functional communication (r=.60; r=.69). Pragmatic language was significantly correlated with teacher report of inattention (r=-.55) and functional communication (r=.68).

Conclusion: As would be expected, functional communication was significantly and positively related to language outcomes. However, report of inattention was negatively related to language outcomes, potentially highlighting the importance of identifying and separating which components of a child’s presentation are related to behavioral challenges, auditory access, and processing or working memory.
Introduction: A 28-month-old boy was referred from another children’s hospital in 1997 because of bilateral uncontrolled otitis media and hearing loss, onset with chemotherapy for acute lymphocytic leukemia diagnosed at age 18-months of age. Our presentation of his story at the Seventh Symposium on Cochlear Implants in Children in 1998 in Iowa City resulted in criticism for us being too aggressive.

Methods: Review of one team’s experience with this patient. We will describe the surgical method used in this challenging case.

Results: Despite withstanding a device failure in one year and having a keratin-filled cyst marsupialized into the fundus of a closed external ear canal, the patient has thrived as a listening-speaking communicator. He attended college on a lacrosse scholarship, completed a master’s degree in accounting, and now works as an accountant.

Conclusion: Calculated pushing the risk-benefit envelop proved rewarding for this challenging cochlear implant case.
Assessing Electrode Compatibility and Audiologic Outcomes in Adult Cochlear Implant Recipients with Longer Electrode Arrays

Brittany Wilson, AuD, Sara Funatake, AuD, Holden Richards, MD Candidate, Hunter Kellerman, BS, Sachin Gupta, MD; Audiology, Oregon Hlth. and Sci. Univ., Portland, OR.

Introduction: Apical nerve stimulation is important for sound quality and speech perception with a cochlear implant (CI). However, there are noted risks of residual hearing loss and of poorer performance with improper electrode placement inside the scala tympani. An individual’s cochlear duct length (CDL) can now be estimated by CT and MRI to reduce these risks by allowing for in-depth preoperative electrode planning. Therefore, the goal of the current study is to retrospectively compare audiologic outcomes of CI patients in relationship to their CDL. Moreover, we sought to evaluate the appropriateness of the CI electrode length, specifically the MED-EL Flex Soft 31.5mm and Flex 28 28mm, in these individuals.

Methods: Adults > 18 years old who received a MED-EL Flex Soft or Flex 28 electrode at a tertiary hospital audiology clinic were included. Individuals who had a revision or concern for a failure were excluded. Flex 28 recipients were matched to the smaller Flex Soft group by age at CI, preoperative low frequency pure-tone average (PTA), and preoperative AZ Bio scores in the implanted ear. CDL was calculated using MED-EL OTOPLAN software and the compatibility of the chosen electrode was estimated by comparing preoperative CDL length to manufacturer-specified electrode length. Postoperative audiometric thresholds, speech perception scores, and rates of disabled electrodes were compared by electrode type and CDL groups.

Results: Preliminary analysis revealed no significant differences in loss of residual hearing in the low frequency PTA (p= 0.4) or speech perception scores (AZ Bio p=0.27) between the two electrode groups. CDL calculations were available for 2 recipients at the time of preliminary analysis and results revealed adequate CDL length for both a Flex 28 (CDL= 30.7mm, electrode activation stimulation range= 23.1mm) and Flex Soft recipient (CDL= 30.0mm, electrode activation stimulation range= 26.4mm).

Conclusion: Preliminary data showed equal hearing preservation rates and postoperative speech perception scores among electrode groups, and good electrode compatibility for 2 recipients of differing arrays. Future analysis will explore the relationship between electrode compatibility, rates of complete or impartial insertion, and speech perception scores postoperatively. Better understanding electrode compatibility will inform clinical decisions regarding electrode choice and may help explain variability in CI performance.
Introduction: Optimal access to auditory stimulation is crucial for the success of children with hearing loss. In center-based early intervention programs, the acoustic environment can be designed to support best practices for this population, but many children attend typical daycares while their parents are at work. Although state early intervention programs support the education of childcare staff through Individualized Family Service Plans (IFSPs), there is not enough funding to acquire the necessary technology and ongoing training widely supported by research.

Methods: In an effort to meet the needs of very young children with hearing loss, a soundfield loaner program was developed and implemented. Through grant funding, children attending childcare centers and receiving services through early intervention had access to Phonak Roger DigiMaster Soundfield Speaker Systems. The loaner project was created and run by a specialized program for children with hearing loss. Three children participated in this pilot project. They varied in age from 18 months to three years of age and used either hearing aids or cochlear implants (CI=2, HA=1). Of the children with CIs, one was bilaterally implanted and the other was unilaterally implanted.

Abstract Body: The children’s childcare settings were located in three different counties within one state. Education for the childcare staff members, as well as family members, to understand and use this technology was a critical component and an ongoing effort, also supported by the grant. An initial in-service was provided by an educational audiologist along with ongoing check-ins. In addition, services listed on the child’s IFSP (speech therapy and/or Teacher of the Deaf) were provided.

Results: Clinical observation along with family feedback indicated that this program had a positive impact on the children’s environment and subsequently their outcomes. Conversations with caregivers indicated that the technology was easy to use, and the support and training was helpful. Funding, childcare participation, and staff turnover presented obstacles throughout the pilot program.

Conclusion: This presentation will discuss the design and implementation of the loaner program and support services that were provided. Successes and challenges, including considerations during the COVID-19 pandemic, will be shared along with individual case studies for each participant. Alternative options for those who did not participate will be discussed as well.
Vibrant Soundbridge Short Process Coupler in Patients with Aural Atresia

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Introduction: Different options are available for hearing restoration in patients with aural atresia. Middle ear implantation with the Vibrant Soundbridge (VSB) has been used successfully in many patients with aural atresia with conductive or mixed hearing loss. The aim of the current study was to assess the safety and the efficiency of VSBs coupled to the short process of the incus in patients with aural atresia with conductive or mixed hearing loss.

Methods: The study was a retrospective chart review conducted at a tertiary university hospital. Audiological and surgical data from six ears with aural atresia implanted with VSBs coupled to the short process of the incus were analyzed. The audiological results were compared with previously reported results obtained after the utilization of different coupling techniques.

Abstract Body: Results: All six atretic ears were successfully implanted using the short process coupler, and there were no major complications. Postoperative bone conduction thresholds did not differ substantially from preoperative thresholds. The respective mean preoperative pure-tone average 4, speech reception threshold, and word recognition score values were 56.7 dB, 61.7 dB, and 44%. Postoperative pure-tone average 4 thresholds (25 ± 3.5 dB) and speech reception thresholds (20.8 ± 8 dB) were significantly improved. The maximum postoperative word recognition score achieved was 100%. The audiological outcomes obtained were similar to previously reported outcomes after classic stapes placement.

Conclusion: Coupling of the floating mass transducer to the short process of the incus in patients with aural atresia resulted in significant audiological improvements that were comparable to previously reported improvements after placement via other methods.
Introduction: Many families of children with cochlear implants at our center face obstacles to accessing service due to geographical distance or medical challenges. There are few tele-audiology technologies for cochlear implant patients and most require an audiologist to use a camera or video system to connect to a facility closer to the child’s location or ship necessary software/programming equipment directly to the patient’s home requiring setup. We were fortunate to participate in the pre-market release of a synchronous remote care tool, which allowed us to pilot new technology. The synchronous remote care tool allows our staff to engage and connect with patients through a live video, audio, or chat session directly from the fitting software and connect to the sound processor via the patient’s smartphone app. This has removed historical barriers and equipment needs that have proved daunting to many centers. Using this technology, our center has been able to overcome remote connection hurdles and securely provide quality remote hearing care to more patients by leveraging existing connectivity features of the fitting software, sound processors, and app technology.

Abstract Body: Methods: All eligible recipients were asked if they would like to participate in the pre-market release of the synchronous remote care tool. Once they expressed interest, patients were enrolled and guided through the process of what to expect. The clinician activated the synchronous remote care feature through the patient’s app. The clinician and patient agreed upon a time to connect virtually, similar to scheduling a typical in-clinic appointment. Once connected at the agreed upon time, the audiologist had the ability to make programming adjustments, enable processor settings, and provide counselling via live video. Any changes to the patient’s MAP are saved remotely to the patient’s sound processor. The virtual appointments typically take the same amount of time as an in-clinic visit. Utilizing this new technology, the child and family can connect with our team from the comfort of their home for remote programming and counseling.

Results: We have successfully implemented this process using the direct connection from the fitting software to the patient’s smartphone app. It has removed technology barriers, as patients with cochlear implants already have access to the app. Additionally, there is no need for less tech-savvy families to manage the setup of tablets or programming pods/cables. This has provided more streamlined access to virtual care. For the majority
of our families, a follow-up synchronous remote care appointment is sufficient to resolving patient issues and increased patient satisfaction of care. Synchronous remote care using this app-based technology has been a crucial tool for families who are unable or unwilling to return to the clinic for an appointment. These families have been thankful for the opportunity to connect with their audiologist virtually to receive video counseling and have programming changes made to their MAPs. This technology has saved many families a 2+ hour trip to the clinic to make programming changes that take less than 10 minutes.

**Conclusion:** While many professions have been able to move quickly into providing telehealth, audiologic efforts have stalled at institutions around the country. This new synchronous remote care tool provides a valuable and effective way to connect virtually with our patients, allowing for increased access to care and success in use.
to your baby’s brain development and builds a foundation for learning, spoken language and literacy. ● Because of the importance of hearing, your baby will have a hearing screening at birth. ● If your baby fails the NBHS, follow-up is urgent. Starts Hear directly targets pregnant women, ages 18-39, with various income levels, education, and ethnicities using social media, pregnancy websites, retargeting ads, search, and automated emails. A website, videos, banner ads, and direct emails were also developed. To increase the reach of the Starts Hear campaign partnerships with organizations with similar audiences of pregnant women and new moms were established: American Academy of Audiology (AAA), BabyCenter, Brazelton Touchpoints Center, Bright by Text, Reach Out and Read, Thirty Million Words, What to Expect, and Zero to Three.

**Results:** Starts Hear was piloted for 10 weeks in 4 cities. Results were: Campaign ads were shown over 20 million times; 4.1 million campaign video views and Videos averaging 15 and 30 seconds were watched on YouTube for almost 5,000 hours. Starts Hear launched in the US February 17, 2021. Results as of October 17, 2021: Campaign ads were shown **152,931,382** times; **16.4** million campaign video views; Videos averaging 15 and 30 seconds have been watched on YouTube for **18,423** hours; **658,479** emails sent to expectant and new moms sharing valuable information on newborn hearing screening and hearing health and **7,730** moms shared the results of their baby’s screening. Starts Hear continues through 2022.

**Conclusion:** Approximately 3.6 million babies were born in the United States in 2020. The Starts Hear campaign to date has delivered over 152 million impressions to expectant mothers to make them aware of the newborn hearing screening and that in the case of a failed screening, follow-up is urgent. This campaign has reached pregnant women with key messages across multiple channels resulting in them reporting the results of their baby’s NBHS. Mothers are more likely to engage with campaign messages closer when giving birth and in the first 4 weeks after. Campaign optimizations will be made to target mothers with babies ages 0-6 months. Campaign performance data will be used to determine continuation in 2023 and beyond.

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**Author Block:**

**Introduction:** Cochlear implant candidacy has evolved and expanded greatly in recent years. This includes the most recent FDA approval for SSD/AHL with the MED-EL cochlear implant system (SYNCHRONY and SYNCHRONY 2) in July of 2019 in the United States. Asymmetric hearing loss or single-sided deafness can have a negative impact on the normal development of the auditory cortex in young children putting them at risk for cognitive, emotional, social, and speech/language problems relative to their normal-hearing peers.

**Abstract Body: Methods:** Results of cochlear implantation in children with SSD/AHL show evidence of rehabilitation of binaural hearing in both quiet and noise with improvement in localization. This study is a chart-review of pediatric patients with single-sided deafness that meet FDA criteria for cochlear implantation and have been implanted.

**Results:** The clinical battery of tests utilized to determine candidacy and document benefit will be discussed within and across subjects.

**Conclusion:** Children with SSD/AHL show benefit from cochlear implantation in noise backgrounds, localization, and speech perception.

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**Control Number:** 2022-A-376-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-1.5

**Publishing Title:** Application of 60/60 Cochlear Implant Referral Criteria for a Diverse Patient Population

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**Introduction:** Cochlear implant (CI) candidacy has expanded over the past decade to include patients with lesser degrees of hearing loss. While expansions in candidacy allow for increased access to CI, there continue to be challenges in the candidacy referral and determination process. As a result, only 1-7% of adult CI candidates who need a CI pursue cochlear implantation. In 2020, Zwolan and colleagues recommended a “60/60 Guideline” for referring potential CI candidates for an evaluation. The study recommends that hearing healthcare providers should refer patients with >60 dB HL pure tone average
and <60% unaided word recognition score (in the better hearing ear) for a full cochlear implant candidacy evaluation. Our study evaluated the effectiveness of the “60/60” referral criteria to identify appropriate CI candidates in a diverse center where patients are often tested in either English or Spanish for CI candidacy.

**Methods:** Data were collected for adult (18 years and older) patients who underwent a standard CI evaluation between January 2016 and March 2021. A total of 433 traditional CI evaluations were completed. CI evaluations for SSD and 2nd ear implant were not included in the study. Half of the sample was female (52%) with a mean age at CI evaluation of 65.09 years (SD = 16.77). 130 patients (30%) completed the CI evaluation in Spanish. Most participants identified themselves as White (90.7%) and 41.7% of the sample identified as Hispanic.

**Results:** Descriptive analyses were conducted to examine effectiveness of utilizing the “60/60” referral criteria to identify CI candidates. Analyses revealed that 67.7% of all participants who underwent a standard CI evaluation met 60/60 criteria and 54.1% met traditional unaided CI candidacy. Additionally, only 50.6% received a CI and of those who did not receive a CI, reasons included patient chose not to proceed (54.6%), patient was not considered an audiological candidate (20.4%), patient was not considered a medical candidate (4.1%), insurance denial (1%), and other (19.9%). Interestingly, of those who met the 60/60 criteria, 67% met traditional unaided CI criteria, 64.8% were later found to be traditional CI candidates and 62.6% were found to be Medicare candidates based on both aided and unaided criteria. 59.7% of those who met 60/60 criteria received a CI. Of patients who did not meet 60/60 criteria, only 26.9% met traditional CI criteria unaided, 24.8% met traditional aided and unaided criteria, 20.9% met Medicare aided and unaided criteria, and 31.5% of those received a CI. When separating English vs Spanish CI evaluations, there was no significant differences seen between the groups.

**Conclusion:** Application of the “60/60” CI referral criteria was an effective means of identifying potential CI candidates in a CI center that services a large Hispanic population. While the majority of both Spanish and English-speaking patients who qualified for cochlear implantation also met the “60/60” criteria, half chose not to proceed with CI surgery. It is unclear why patients were reticent to move forward with surgery, however, results from our study suggest the “60/60” referral criteria may have clinical utility across diverse patient populations.
Effects of auditory status and temperament on social well-being in adolescents

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Introduction: Historically, children who are deaf or hard of hearing have more difficulty making and maintaining friends and exhibit higher rates of social isolation and peer rejection than peers with typical hearing (TH). The impact of hearing loss on social well-being may become exacerbated in adolescence when friends take a more prominent social role over family. Few studies to date examine both positive and negative aspects of social relationships in a contemporary group of adolescents who are DHH and use cochlear implants (CIs). This study explores the effect of auditory status (CI vs. TH), communication skills, and temperament on four aspects of social well-being in adolescents.

Methods: Participants included adolescents (13-17 years) who had TH (n=50) or used CIs (n=23). The CI group had a mean implantation age of 3.2 years and long-term CI experience (M=10.6 years). All adolescents completed an online study assessing (a) self-rated communication skills (e.g., speech perception, speech intelligibility); (b) temperament via the Early Adolescent Temperament Questionnaire-Revised; and (c) social well-being (i.e., loneliness, companionship, friendship, perceived rejection) via the NIH Toolbox Emotional Domain.

Results: Both groups achieved mean social well-being ratings within the normative range, with the TH group having slightly more positive ratings for friendship and emotional support compared to the CI group. However, the DHH group had a higher proportion of children achieving scores more than one standard deviation from the normative mean for loneliness (33% vs. 24%) and friendship (42% vs. 16%; p<.01) compared to the TH group. In the CI group, higher ratings of friendship coincided with younger age at CI (p<.05) and lower rejection ratings co-occurred with better self-rated speech perception in noise (p<.05). For the TH group, higher depressive mood was associated with more loneliness and peer rejection as well as lower friendship and emotional support ratings. Most social well-being measures significantly correlated with speech in noise ratings.

Conclusion: Social well-being measures correlate with self-rated communication skills and temperament in adolescents with TH and CI. Group mean comparisons may not capture nuanced differences in social well-being between adolescents with CI and TH, particularly proportional differences in children whose scores warrant heightened concern (i.e., scores >1 standard deviation from the normative mean). A higher proportion of adolescent CI users reported concerning levels of low friendship and high loneliness compared to TH peers. Thus, professionals working with adolescent CI users should pay close attention to warning signs of poor social well-being and make
appropriate referrals to trained mental health professionals to foster higher quality of life in CI recipients.

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**Control Number:** 2022-A-380-ACI

**Complete Status:** Complete

**Presentation Number:** CS6-2.2

**Publishing Title:** Intra-operative Fluoroscopy during Vestibulocochlear Implantation

**Author Block:** Joost J. A. Stultiens, MD\(^1\), Marc van Hoof, MD\(^1\), Alida A. Postma, MD, PhD\(^2\), Nils Guinand, MD, PhD\(^3\), Angélica Pérez Fornos, MD, PhD\(^3\), Hermanus Kingma, PhD\(^1\), Elke Devocht, MD, PhD\(^1\), Raymond van de Berg, MD, PhD, PhD\(^1\); \(^1\)Otorhinolaryngology & Head and Neck Surgery, Maastricht Univ. Med. Ctr., Maastricht, Netherlands, \(^2\)Department of Radiology and Nuclear Medicine, Maastricht Univ. Med. Ctr., Maastricht, Netherlands, \(^3\)Otorhinolaryngology & Head and Neck Surgery, Geneva Univ. Hosp., Geneva, Switzerland.

**Abstract Body:**

**Introduction:** A vestibulocochlear implant was designed to aid patients with bilateral vestibulopathy. Previous research showed the feasibility of a vestibular implant in humans. However, unaided vestibular electrode insertion is inaccurate, while precise placement is important for adequate stimulation. A cadaveric study showed that intra-operative fluoroscopy might improve the accuracy of the electrode placement in the semicircular canals. The aim of this study is to investigate the use of fluoroscopy to improve electrode placement during a vestibulocochlear implantation trial in humans.

**Methods:** Patients with bilateral vestibulopathy and profound hearing loss in at least one ear were implanted with a vestibulocochlear implant, as part of the VertiGO! trial (NCT04918745). After fenestration of the bony semicircular canals, the electrodes were inserted towards the ampullae. Fluoroscopy was utilized to place the tip of the electrode in the ampulla. Consequently, a 180° scan was made with the C-arm to create a 3D-reconstruction. One week postoperatively, a cone-beam CT scan was performed. The distances from the tips of the electrodes towards their intended locations were calculated.

**Results:** Eight patients were implanted with a vestibulocochlear implant using fluoroscopy to determine the vestibular electrode end position. The number of the electrodes that were implanted at the intended location, i.e., within the semicircular canal ampulla, and the mean distance to the target will be shown.
Conclusion: Intra-operative fluoroscopy is feasible to guide vestibular implant electrode-insertion. This technique might therefore be used to visualize the electrodes and target location in order to deliver accurate placement.

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Control Number: 2022-A-381-ACI
Complete Status: Complete
Presentation Number: 144
Publishing Title: Examining Audiologists' Knowledge of Pediatric Spanish Speaking Measures
Author Block: Chrisanda M. Sanchez, AuD¹, Jennifer Coto, PhD¹, Alliete Alfano, PhD², Ivette Cejas, PhD¹; ¹Otolaryngology, Univ. of Miami, Miami, FL, ²Florida Intl. Univ., Miami, FL.

Introduction: As the world continues to become more culturally diverse and multi-lingual, there is a growing need for clinicians to utilize tools to better serve bilingual patients and families. From a pediatric clinical setting, the availability of diagnostic tools for children with limited English proficiency is extremely limited. Further, there is a paucity of research on Spanish audiological tools. Established reviews of leading journals reveal very few articles on this specific topic over the course of 30 years. The purpose of this national survey was to determine what tools are being used for children who speak Spanish in an audiology setting. Additionally, this survey aimed to highlight the barriers providers face across the nation in accessing or utilizing existing Spanish tools and measures.

Methods: Audiologists practicing in the United States who see children who speak Spanish or are bilingual (n = 153) were asked to complete a survey regarding their knowledge of audiology tools and test protocols that exist for Spanish speakers. The majority of participants reported they have been practicing for 0-5 years (44.4%) followed by over 10 years (34%) of experience. Participants were monolingual English speaking (68.6%) or bilingual English and Spanish speaking (31.4%). Work setting varied with 43.1% of participants working in an outpatient clinic, 31.4% in a children’s hospital, 21.6% in a university clinic, 17.6% in a private practice, and 16.4% in another setting. Most audiologists reported seeing 20 or more patients per week (71.2%) and carrying at least a 50% pediatric schedule (54.2%)

Results: Overall, 28.2% of audiologists reported using Spanish measures with children who speak Spanish. However, 20.6% of audiologists reported that they are unaware of Spanish measures, 15.9% did not feel comfortable using these measures because they do
not speak Spanish, and 10.4% administer the English version either interpreting it themselves or with a colleague. Interestingly, there was a significant difference in audiologists' knowledge and comfort of utilizing Spanish measures based on the child’s age. Over 43% of audiologists comfortably utilize Spanish tools for children who are 7 years of age or older. This is likely due to the application of adult Spanish-speaking measures to children who are 7 years or older and have developed Spanish speaking language abilities. In contrast, audiologists were least knowledgeable about currently available measures for children 0-3 years old. Despite 10.4% of audiologists administering English measures and interpreting them in Spanish, 70% of this group reported feeling uncomfortable or extremely uncomfortable with the validity of the results.

**Conclusion:** This survey was the first of its kind to examine the existing resources available for bilingual and monolingual Spanish speaking children in the audiology setting. Our data highlighted that the majority of audiologists reported that they are either unaware or do not administer tools or appropriate measures for Spanish speaking children, despite working with this population. Though providers are aware that some Spanish resources exist, audiologists around the nation still report discomfort with the validity or the ability to administer these measures and/or questionnaires. Based on our results, there is a growing need to implement a standardized and age-specific clinical consensus on how to appropriately manage children with hearing loss who speak Spanish.

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**Control Number:** 2022-A-382-ACI

**Complete Status:** Complete

**Presentation Number:** CS2-3.2

**Publishing Title:** Creation of a Publicly Accessible Database from the Childhood Development after Cochlear Implantation (CDaCI) Study

**Christine M. Mitchell, ScM**, Nae-Yuh Wang, PhD, Andrea D. Warner-Czyz, PhD, Alexandra L. Quittner, PhD, Ivette Cejas, PhD, Ann E. Geers, PhD, Laurie S. Eisenberg, PhD;

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**Introduction:** The Childhood Development after Cochlear Implantation (CDaCI) Study, a multicenter, longitudinal cohort study of pediatric cochlear implant recipients, involved extensive data collection of multiple domains of development over 15 years. Public sharing of research data offers a range of benefits, including increased scientific transparency and opportunities for new discoveries. This study, however, commenced prior to the NIH requirements for research data sharing, and participants did not provide consent to share their data at the time of enrollment. As a result, it is necessary to take extreme care to safeguard participants’ privacy before releasing any study data.

**Methods:** After navigating challenges related to longitudinal data collection (changes in age-appropriate measures, the evolving science of cochlear implantation and corresponding changes in data collection instruments, and changes in database platforms over time), a master study database was created. The database will be de-identified first by removing all known direct identifiers (e.g., dates). The next step in de-identification will be to thoroughly examine the database for variables with data occurring at low frequencies that could potentially be used to identify participants. These variables will have values grouped, recoded, or removed as necessary to minimize the risk of re-identification.

**Results:** The de-identified datasets and corresponding documentation detailing the available data from the CDaCI Study across the domains of auditory performance and speech recognition, spoken language and speech production, parent-child interactions and cognitive, behavioral, and social functioning, and health-related quality of life will be made available for download by cochlear implant researchers and clinicians.

**Conclusion:** Proper de-identification of research data is a challenging but worthwhile endeavor. Public data sharing of the extensive CDaCI Study database of multidisciplinary outcomes following pediatric cochlear implantation will offer a scientifically valuable resource for researchers and clinicians in the cochlear implant field.
**Introduction:** Results from cochlear implantation in patients with long term post lingual auditory deprivation have been mixed in the literature with longer duration of auditory deprivation (i.e., greater than ten years) being associated with worse outcomes when compared to patients with more recent onset hearing loss. The patient presented in this report with over twenty years of post-lingual monaural auditory deprivation demonstrated excellent response to cochlear implantation within a very short time period after implantation, and with continued improvement over time. This report adds to the growing evidence for good patient outcomes after implantation of auditory deprived cochleae, even those deprived for greater than ten years.

**Methods:** 1) Chart review and report of a 54-year-old patient with a history of profound left sided sensorineural hearing loss secondary to Meniere’s disease with auditory deprivation for over twenty years who underwent unilateral cochlear implantation with excellent result. 2) Review of the current literature regarding cochlear implantation for patients with long term post-lingual monaural auditory deprivation.

**Results:** Cochlear implantation was performed on a 54-year-old male with left sided post-lingual monaural auditory deprivation of at least twenty years resulting from Meniere’s disease, with aidable right sided sensorineural hearing loss. Preimplantation aided audiogram showed 0% word recognition. Patient underwent implantation with a slim electrode. Speech testing with the cochlear implant alone 2 weeks post implantation showed 68% AzBio score. Speech testing with the cochlear implant alone at 1-month post implantation showed 92% AzBio score.

**Conclusion:** Patients with long term post-lingual monaural auditory deprivation, even those with greater than ten years of deprivation, can achieve excellent functional results after cochlear implantation similar to those with short term post-lingual hearing loss.
Abstract

Introduction: Telehealth has allowed clinics to better serve populations who live farther from clinic, are unable to safely attend an in-person visit, and/or cannot incur travel costs. CI remote programming, a form of telehealth, has been deemed feasible for adults, but has yet to be evaluated in pediatrics. The current study examined the efficacy and feasibility of remote CI programming for adults and pediatric patients and its effects on visit satisfaction and overall burden.

Methods: Data was collected examining the feasibility, efficacy, and family/patient satisfaction of remote CI programming. Currently, this study is in its initial stages and results highlight the baseline in-person appointment. However, data will also be presented following the remote programming appointments which are scheduled 3-8 months post-baseline visit. All patients/families who participated completed baseline demographics, measures of mental health (anxiety and depression), treatment satisfaction, and family burden related to appointment attendance (e.g., cost, time off, etc.).

Results: The current pediatric sample consists of 9 patients with a mean age of 7.78 years (SD = 3.63). The majority of pediatric parents completed the survey in English (66.7%) and reported their ethnicity as non-Hispanic (55.6%). Race varied with 44.4% of parents identifying themselves as white, 33.3% as African American, 11.1% as Asian, and 11.1% as Other. The current adult sample consists of 7 patients with a mean age of 54 years (SD = 21.11). All adults completed the survey in English, more than half (57.1%) reported their ethnicity as non-Hispanic, and 85.7% reported their race as White. Although patients and families reported being satisfied with their appointment, 50% of pediatric families and 72% of adult patients indicated that they would prefer their next visit to be remote. This is likely due to the ease of attending a virtual visit, which decreases the need to take extended time from work or school. Overall, patients and families indicated that they incurred substantial costs during their clinic visits, including travel, childcare, and parking. More importantly, parents reported a substantial amount of time missed from work and/or school ranging from full days to several hours. Similarly, over 42% of adult patients had to miss 3-5 hours of work due to attending an audiology visit and on average had to travel 75.8 miles to attend their in-person visit. For those adult patients who have completed the remote visit thus far, all reported that they were “very satisfied” and experienced little to no difficulties with connectivity, despite only 28.9% considering themselves as “tech savvy.” Future data is currently being collected for the remaining adult and pediatric families who have enrolled in the remote care study.

Conclusion: Although, in general, patients and families report being satisfied with in-person clinical visits, remote care provides an opportunity to lessen family and patient burden. Our data highlights the significant amount of time that children and adults remain out from school and work, which may affect overall outcomes and/or affect family/patient earnings. Inclusion of remote CI visits into standard CI protocols will increase access and decrease barriers to hearing healthcare for adults and families of children with CIs.
Introduction: Individuals with cochlear implants (CIs) still struggle to understand speech in noisy environments and often restrict their participation in these environments. These studies explored an approach to address this problem. Current CIs provide very poor frequency (spectral) resolution that impairs speech understanding, especially in noise. The spread of CI excitation within the cochlea causes significant channel interference reducing spectral resolution and the potential for more channels in a single ear. Bilateral CIs could be integrally programmed with more channels spread across both CIs to decrease channel interference and improve spectral resolution. The impact of interleaving different frequency channels to bilateral CIs has not been extensively examined. Such programming could significantly impact the spatial cues bilateral CIs provide and could require significant time for acclimatization to reach maximum performance. This research examined the effects of interleaved processing with and without deactivated channels on spectral resolution, spatial hearing, speech recognition, and changes in performance with training compared to traditional bilateral CI programming.

Methods: The effects of interleaving frequency bands across ears were tested using 12-channel CI simulations in normal-hearing listeners with traditional non-interleaved channels and interleaved channels, with odd channels presented to one ear and even to the other. Two conditions of interleaving were tested. The first deactivated channels in each ear to reduce within-ear masking but keep the same total number of channels at 12. The second narrowed the input frequency bands sent to each channel with all simulated electrodes active for a total of 24 channels.

In Study 1, participants completed three experiments: adaptive spectral-temporally modulated ripple test (SMRT), sound localization in the rear-hemifield, and speech recognition in co-located and spatially-separated conditions. Spectral resolution and speech recognition were tested in both unilateral and bilateral condition to examine binaural integration with and without interleaved processing. In Study 2, the effect of short-term training using vowel and consonant stimuli in quiet were tested for traditional and interleaved CI simulations with and without frequency shifts to simulate basal shifts in CI electrodes.
Results: Study 1 revealed that interleaved processing can increase spectral resolution. Both studies revealed that listeners could integrate interleaved frequency bands across ears for better speech recognition. Degree of sound localization error was slightly worse with interleaved processing compared to traditional processing. Spatial release-from masking (SRM) was somewhat impaired with interleaved frequency channels across ears, especially with deactivated channels. Finally, training improved performance in all CI simulations, with trends to more time required for shifted and interleaved simulations. Conclusion: Interleaving frequency bands for CIs may increase spectral resolution but will likely sacrifice some spatial-hearing benefits including sound localization and SRM for speech. Listeners with CI simulations can integrate interleaved frequency bands across ears for speech perception, although the benefit was small. Interleaved processing might require more time for listeners to obtain maximum performance and integrate cues between ears.
cochlear implantation at a single tertiary care center from 2008 to 2019. Patients younger than 50 years old were excluded from the study. Remaining patients 50 years and older were split into a younger cohort aged 50-74 (mean age = 66.9 years) and an older cohort aged 75-99 (mean age = 80.6 years). Results of AzBio word recognition scores were tracked at pre-operative, 3 months post-operative, 6 months post-operative, and 12 months post-operative time points. Mean scores were compared between both cohorts with a student’s t-test. Significance was set to p < 0.05.

**Results:** One hundred twenty-nine patients were included in the study. Fifty-seven patients were aged 50-74 years old, and 72 patients were aged 75-99 years old. There was no significant difference in pre-operative AzBio scores (p=0.32) amongst the two cohorts. Both cohorts experienced significant improvement compared to their initial pre-operative scores at all post-operative time points. However, the older group had lower average AzBio scores at every post-operative time point compared to the younger cohort. There was an insignificant trend at the 3 month (p=0.51) time point, but this difference was significant at the 6 month (p=0.01) and 12 month (p=0.02) post-operative time points.

**Conclusion:** Our findings indicate that there is variability of outcomes after CI in a population aged over 50, with patients aged 50-74 having significantly higher post-operative speech recognition scores than patients aged 75-99. This information addresses the approach to treating aging adults with hearing loss and suggests that it may be more beneficial for clinicians to consider CI earlier in older adult populations. Regardless, CI may be considered at any age with expected improvement in hearing and speech perception.

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**Control Number:** 2022-A-389-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS4-2.3  
**Publishing Title:** Pediatric and Adult CI Users’ Outcomes with an Automatic Scene Classifier and Direct Bluetooth Streaming  
**Author Block:** Smita Agrawal, PhD¹, Sabrina Lenglet, PhD², Anne Michels, MSc³, Martina Brendel, M.Engg.⁴, Fatema Jagmaag, MSc⁵, Shabeena Backer, MASLP⁵, Aninda Banik, PhD⁶, Aravind Nair, MSc⁶; ¹Advanced Bionics, LLC, Valencia, CA, ²Western Switzerland University Cochlear Implants Center, Geneva Univ. Hosp., Geneva, Switzerland, ³European Research Center, Advanced...
Abstract

Body:

Introduction: Directional microphones and noise reduction algorithms can significantly improve cochlear implant (CI) users’ ability to communicate in difficult listening situations. Automatic steering between such settings based on ongoing analysis of the listener’s sound environment can alleviate the need for manual selection of optimal program in varying situations, which can be challenging and burdensome. Additionally, direct Bluetooth Streaming (BTS) allows for improved signal-to-noise-ratio and clearer sound quality. This presentation summarizes the end-of-study outcomes from experiments conducted on such technologies with a new sound processor (SP) in adults and children.

Methods: In one study with 12 bilateral and bimodal adults (29 to 72 yrs), speech source location was varied randomly to 1 of 4 speakers with continuous noise from 4 speakers (S0/90/180/270N0,90,180,270). The objective was to compare speech perception (French Matrix test) across 3 conditions: (1) automatic recognition of target focus direction (2) manual selection of focus direction by user, and (3) omni-directional mic. The study also evaluated impact of BTS and the listeners’ ability to adjust the environmental balance of input via an app on speech perception in noise (n=11). In a second study, 15 CI recipients (ages 6.5 to 22 yrs; 14 children) used the new SP for up to a year. Outcome measures included speech perception scores (PB words), user ratings via custom questionnaires (5-point rating scale), open-ended reports, and datalogging. Subjects used an automatic, scene-classifier based program enabled with BTS.

Results: Study 1: Speech understanding in noise significantly improved with the automatic algorithm as compared to omni-mic (p<0.005) and manual selection of focus direction (p<0.05). Speech scores also increased significantly when listeners used BTS and adjusted the environmental balance from the default of 50/50 (p<0.005). Study 2: The automatic program was acceptable for daily use to all subjects with 7 needing reduced directivity in mic settings. Suitability of the program was confirmed via subjective feedback and datalogs. Mean speech scores were greater with study SP than baseline SP (p=.0033). Real-world speech perception, soft sound perception, sound quality, and ease of listening were rated higher with study SP (between 4.5 to 4.68; 5 =study SP much better). Perception of online learning audio was rated highly without (4.33/5) and with BTS (4.72/5). Parents reported observing improved awareness and responsiveness to incidental speech, increased engagement in conversations and perception of new environmental sounds. They also reported increased confidence in their child’s ability to attend online school (w/o and w/ BTS) independently.

Conclusion: Automatic classifier-based adjustment of front-end, noise management features and BTS can provide measurable and clinically relevant improvements in speech perception in the sound booth and in the real world in adult and pediatric CI users.
**Introduction:** Quality of life (QoL) reflects the physical, social, and emotional health of an individual. Traditionally, QoL includes self-ratings of perceived well-being across different dimensions, but several measures also include proxy report of QoL (e.g., parent report of the child’s QoL). Parent proxy can afford an appropriate, reliable representation of a child’s psychosocial well-being, but alignment of parent and child perceptions of QoL varies by domain. For example, previous studies show divergence in parent versus child report of QoL, specifically in less visible domains (e.g., school, friends) and in older children (e.g., adolescents). Differences in parent proxy and self-report of QoL in children may be exacerbated in groups with disabilities, such as children with hearing loss who wear a cochlear implant (CI). This study compares parent proxy and child self-report of QoL across three measures of generic quality of life to examine broad patterns in respondent differences in QoL assessment and correlations with demographic characteristics.

**Methods:** Participants include 234 parent-child dyads in which the pediatric CI user had a chronologic age range between 8-11 years or 12-16 years. Age at implantation ranged from 8 to 64 months and duration of CI use varied from 9 to 156 months. This presentation compiles data from participants enrolled in two larger studies: one from the primary author’s research (n=84) and the Childhood Development after Cochlear Implantation study, a multi-center longitudinal project evaluating multiple aspects of development - including quality of life - in pediatric CI users (n=150). Participants completed at least one of the following measures of generic QoL: Pediatric Quality of Life Inventory (PedsQL), KINDL, or Child Health and Illness Profile (CHIP), using age-appropriate versions for the child that had a corresponding parent proxy version. Correlational analyses evaluated relationships among demographic characteristics and QoL ratings by parents and children in each age group. Paired t-tests compared parent and child ratings of QoL by specific domains and globally.

**Results:** Younger age at implantation and longer duration of experience consistently
corresponded to more positive quality of life across domains, measures, and respondent (i.e., parent proxy, child self-report). Significant positive correlations emerged between parent and child report of QoL across all three measures in both the 8-11- and 12-16-year age ranges (p<.05). However, paired comparisons revealed significant differences (p<.05) by respondent with parents assigning more positive QoL ratings than their child’s self-report, particularly for risk aversion on the CHIP for both age groups, the school domain on the KINDL and PedsQL for both age groups, global QoL for the younger and older group on the CHIP and PedsQL, respectively.

**Conclusion:** Parents and pediatric CI users generally rate well-being similarly across domains of generic QoL measures. However, parents may overestimate their child’s life satisfaction, especially in areas in which they have less direct access to their child’s life (e.g., friendship, school). Thus, clinicians and researchers should carefully consider significant differences by respondent in interpreting the QoL of children and adolescents using CIs.

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**Control Number:** 2022-A-392-ACI

**Complete Status:** Complete

**Presentation Number:** 133

**Publishing Title:** Patient self-reported outcomes following implantation of the Cochlear Osia 2 System in a cohort of adult patients with conductive or mixed conductive hearing loss using the SSQ instrument

**Author Block:** Mary Rose Goldstein, Doctor of Audiology, Stephanie Bourn, Au.D., Abraham Jacob, MD; Ear & Hearing, Ctr. for Neurosciences, Tucson, AZ.

**Introduction:** Bone conduction hearing devices are a well-established treatment option for conductive or mixed hearing losses. The Osia™ 2 System is an active osseointegrated device where a surgically implanted titanium fixture supports a piezoelectric actuator that is placed under the skin. This presentation will cover a discussion and review of pre- and post-implantation patient self-reported outcomes on the Speech Spatial and Quality questionnaire, also known as SSQ, in a cohort of adult subjects. The purpose of this study was to assess subjective benefit obtained by through comparison of pre- and post-implantation SSQ results.

**Methods:** Nationwide data obtained during a multi-center post-market interventional cohort study of the Cochlear™ Osia™ 2 System will be reviewed. For 20 adult subjects, the SSQ was administered pre-operatively to obtain baseline data and then again at three
months after implantation to gather data on the self-reported improvement of the subject’s hearing since implantation.

**Results:** Subjective patient outcomes from comparison of pre- and post-operative SSQ will be discussed. This post-market interventional cohort study is currently ongoing and expected to close by the end of 2021. This presentation will report results as the study closes and review subjective improvement following implantation.

**Conclusion:** The Cochlear™ Osia™ 2 System represents significant technological advancement in auditory osseointegrated implants. The digital piezoelectric stimulation of this active auditory osseointegrated implant delivers effective improvements in speech understanding necessary for engendering high levels of subjective patient satisfaction.

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**Control Number:** 2022-A-393-ACI

**Complete Status:** Complete

**Presentation Number:** 112

**Publishing Title:** Hearing Outcomes in A Cohort of Adult Patients with Conductive or Mixed Conductive Hearing Loss Receiving an Active Osseointegrated Implant System: Cochlear Osia 2 System

**Author Block:** Stephanie S. Bourn, Au.D., Mary Rose Goldstein, Au.D., Abraham Jacob, MD; Ear & Hearing, Ctr. for Neurosciences, Tucson, AZ.

**Introduction:** Bone conduction hearing devices are a well-established treatment option for conductive or mixed hearing losses and single-sided deafness. The Osia™ 2 System is an active osseointegrated device where a surgically implanted titanium fixture supports a newly developed piezoelectric actuator that is placed under the skin. This presentation will cover review of audiometric outcome data including unaided and aided sound field threshold measures and speech perception in an adult population with conductive or mixed conductive hearing impairment. The purpose of this work was to demonstrate additional clinical evidence of the efficacy of the Osia 2 system by comparing unaided vs. aided performance in this cohort.

**Methods:** Nationwide data were obtained from a group of 20 adult subjects that participated in a multi-center sponsored post-market interventional cohort study. All subjects were diagnosed with conductive or mixed conductive hearing impairment and were implanted with the Cochlear Osia 2 implant system. Audiometric outcome data including unaided and aided sound field threshold measures, speech in quiet with monosyllabic word lists, and speech in noise testing with the Quick Speech-in-Noise
(Quick SIN) test was obtained pre-operatively and at one-month, three-month, and six-month intervals post implantation.

**Results:** Study is currently ongoing and expected to close by the end of 2021. Presentation will cover results as the study closes and showcase clinical improvement as measured by unaided and aided sound field threshold measures, speech in quiet with monosyllabic word lists, and speech in noise testing with the Quick SIN.

**Conclusion:** The Cochlear™ Osia™ 2 System represents significant technological advancement in auditory osseointegrated implants. The digital piezoelectric stimulation of this active auditory osseointegrated implant (OSI) delivers effective high-power output and the high frequency gain necessary for optimal sound access and speech perception.

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**Control Number:** 2022-A-394-ACI

**Complete Status:** Complete

**Presentation Number:** 091

**Publishing Title:** Racial Disparities in Outcomes After Cochlear Implantation

**Author Block:** Siddhant Tripathi, BS¹, Edward Doyle, MD², Jed Grisel, MD³, Brian Earl, PhD², Reena Dhanda-Patil, MD², Ravi Samy, MD²; ¹Univ. of Cincinnati Coll. of Med., Cincinnati, OH, ²Univ. of Cincinnati Med. Ctr., Cincinnati, OH, ³Texoma ENT & Allergy, Wichita Falls, TX.

**Introduction:** The existence of racial disparities in healthcare has been extensively studied and well documented. However, this is no existing literature investigating this phenomenon in the context of cochlear implantation (CI). In this study, we utilized the HIPAA-secure, Encrypted, Research, Management and Evaluation Solution (HERMES) database to explore this clinical question. The HERMES database is a large, multi-center database of CI cases throughout the United States. It contains information regarding patient demographics along with longitudinal speech recognition scores. Our goal was to utilize this tool to better understand how a patient’s race could affect their speech recognition outcomes after CI.

**Methods:** We included the CI cases available in the HERMES database in this study and excluded patients if there was no race data available. Based on the data for race, patients were divided into white and non-white cohorts. The non-white cohort consisted of patients with the variables “African American”, “Hispanic”, “Asian”, “Native American”, or “other” in the race category, while the white cohort only included patients with the
variable “White”. We collected the results of Consonant Nucleus Consonant (CNC) and AzBio speech recognition scores pre-operatively and at the 1 month, 3 month, 6 month, 12 month, and 24 month post-operative time points for both cohorts. A student’s t-test was utilized to compare scores at each time point. Significance was set to p < 0.05.

**Results:** There were 3461 cases of CI recorded in the HERMES database at the time of this study. Of these, 2422 patients had racial data available. We categorized 2040 patients into the white cohort (998 female, 1042 male; mean age = 63.8) and 382 patients into the non-white cohort (190 females, 192 males; mean age = 61.6). There was no significant difference in CNC (p=0.868) or AzBio (p=0.252) scores between the two cohorts at the pre-operative baseline. The post-operative CNC scores were significantly higher in the non-white cohort at the 1 month (p=0.008), 3 month (p=0.004), 6 month (p<0.001), 12 month (p<0.001), and 24 month (p=0.028) time points. The post-operative AzBio scores were significantly higher in the non-white cohort at the 1 month (p<0.001), 3 month (p=0.002), and 6 month (p<0.001) time points, with an insignificant trend at 12 months (p=0.056) and 24 months (p=0.481).

**Conclusion:** Our findings indicate that despite similar pre-operative speech recognition scores, non-white patients in the HERMES database had significantly superior post-operative outcomes across most time points. These results are surprising because they conflict with most existing literature on racial disparities in healthcare. However, the number of patients in the white and non-white cohorts was disproportionate to the general population, which may suggest that these findings are skewed by differential access to CI. We encourage future studies to consider income, education level, and location in the context of race when comparing outcomes after CI.
**Introduction:** Individuals with vestibular schwannoma (VS) usually experience some degree of hearing loss in the affected ear, either related to the tumor itself or its management. Patients with a history of VS who have severe-to-profound sensorineural hearing loss may benefit from a cochlear implant (CI). However, speech understanding in such patients may be limited due to impaired cochlear nerve function in addition to sensory loss. Consistent with this, previous research indicates that performance in VS CI users tends to be poorer than in non-VS CI users. One limitation of these studies, however, is that patients with a history of VS may differ on pre-implant factors known to influence performance in CI users, such as unaided hearing ability or age at implantation. This study aimed to provide further insight regarding outcomes in VS CI users by comparing their performance to those of clinically matched non-VS CI users.

**Methods:** Retrospective chart review was conducted for 13 adult patients with a history of VS who received a CI in the ipsilateral ear. The etiology of VS was either Neurofibromatosis Type 2 (NF2; n = 6) or sporadic (n = 7). Management approaches for VS included surgical resection (n = 6), stereotactic radiosurgery (n = 4), or watchful waiting (n = 3). Each VS CI user was matched to 5 non-VS CI users based on age at implantation and pre-CI unaided four-frequency pure tone average (PTA; 0.5, 1, 2, 4 kHz). Outcome measures included the most recent post-CI aided PTA, speech reception threshold (SRT), monosyllabic words in quiet score, and sentences in quiet score.

**Results:** As expected, there were no significant differences in pre-CI unaided PTA or age at implantation between VS and matched non-VS CI users. Post-CI aided PTAs and SRTs ranged from 14 to 50 dB HL for all patients and did not significantly differ across groups. Post-CI aided word and sentence recognition in quiet were highly variable for both VS and non-VS CI users, ranging from 0% to >90% correct. There was no significant between-group difference for post-CI aided word recognition in quiet. There was, however, a small but non-significant difference in aided sentence recognition in quiet whereby VS CI users achieved slightly poorer scores than non-VS CI users on average (mean$_{VS}$ = 43%, mean$_{non-VS}$ = 68%; 95% CI [-51.60, 0.43], p = 0.05). Post-CI outcomes for patients with a history of VS will be further discussed within the context of other factors that may influence performance, such as tumor characteristics and management approach.

**Conclusion:** While there is substantial variability in post-CI performance, the results of this study suggest that VS CI users can achieve 1) similar aided audibility to non-VS CI users, and 2) aided speech-recognition scores that approximate those of non-VS CI users. These results support ipsilateral cochlear implantation as a viable option for patients with a history of VS. Tumor-specific factors may, however, impact CI outcomes and should therefore be considered when counseling patients.
Reducing Gaps in Aural Rehabilitation Services for Adult Recipients through Collaborations Among the Hospital CI Center, the University Department, and Manufactures

Eun Kyung (Julie) Jeon, Au.D., Ph.D.¹, Leigh Ann Monthey, AuD², Camille Dunn, Ph.D.³; ¹Communication Sciences and Disorders, Univ. of Iowa, Iowa City, IA, ²Clinical Territory Manager, Cochlear, Lone Tree, CO, ³Otolaryngology, Univ. of Iowa, Iowa City, IA.

Abstract Body:

Introduction: Unlike for children with cochlear implants (CIs), aural rehabilitation is not typically provided for adult CI recipients in the United States. Due to time restraints, poor reimbursement, and lack of data to encourage specific rehabilitation methodologies, CI audiologists rely on the CI recipients’ self-training on listening. Most self-training is accomplished through methods using Apps, audiobooks, or web-based tools, etc. All CI manufactures offer accessories designed to improve communication in challenging listening conditions, phone use, and watching TV. Self-training and accessory use require motivation and technical skills from adult CI recipients. Our CI center is working with our audiology graduate program to help our CI recipients and their communication partners with device use and auditory training. To improve the quality of life of CI recipients and their communication partners, this project examined the interprofessional collaboration among the CI center, manufacturers, and the audiology graduate program.

Methods: In the year 2020, five adult CI support groups, two CI informational sessions, and one teen CI gathering were provided by the audiology graduate students collaborating with the CI center and the manufacturers. Initial sessions were provided virtually, and later sessions were in-person with a virtual option. Each support group consisted of 2 hours, group sharing and discussions on the device understanding and training methods for the 1st hour, followed by individual support for the specific device help. For any recipients who need extra support for successful CI use and auditory training, the audiology graduate clinicians followed them in the department clinic. For the CI educational sessions, the CI center, manufacturers, and the department have also worked together to provide candidacy, expectations of post-operative outcomes, the procedures, as well as rehabilitation strategies after the activation with support by the team. The teen support group was provided one time in summer to share experiences and tips for successful virtual education.

Results: Over seventy CI recipients and their communication partners benefited from the exploratory sessions provided by the audiology graduate clinicians with collaborations with the CI center and the manufacturers. Interestingly, the frequent communication partners expressed great satisfaction with the sessions and many reported that they have been set up a regular audiology training time with their CI recipients or use the hearing accessories, a remote microphone and TV link. These sessions serving CI recipients as a group and individually became one of the rotations for audiology students and students
provided positive feedback having better understanding in CI rehabilitation before their CI rotation at the hospital CI center.

**Conclusion:** Adult CI recipients and their communication partners need a lot of support and hands-on training to maximize the outcomes and benefits from hearing accessory use. All information became easy to get via Apps and Websites; however, the use of the resources varied among CI recipients based on motivation, understanding, and technical skills. We found collaborations of the CI center, the manufacturers, and the graduate department clinic can provide adult CI recipients and their communication partners the one voice, emphasizing the rehabilitation, most effectively with device use.

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**Control Number:** 2022-A-397-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-3.5

**Publishing Title:** Understanding Patient Utilization Patterns of Cochlear Implant Processors

**Author Block:** Eric E. Babajanian, MD\textsuperscript{1}, Meghan M. Cervantes, BS\textsuperscript{2}, Kathryn M. Johnson, AuD\textsuperscript{1}, Mary Leigh Horn, AuD\textsuperscript{1}, Neil S. Patel, MD\textsuperscript{1}, Richard K. Gurgel, MD, MSCI\textsuperscript{1}; \textsuperscript{1}Otolaryngology-Head and Neck Surgery, Univ. of Utah, Salt Lake City, UT, \textsuperscript{2}Communication Sciences and Disorders, Univ. of Utah, Salt Lake City, UT.

**Introduction:** Patients with cochlear implants (CI) require an external sound processor that captures and transmits sound signals to the internal receiver. Institutional contracts differ in providing patients one versus two processors at the time of implantation or activation. The purpose of this study is to evaluate the extent of benefit the second processor provides and to better understand utilization patterns regarding CI sound processors. Understanding the utility of the second processor could help guide future institutional contract negotiations, specifically focusing on whether patients need one versus two sound processors.

**Methods:** A close-ended, multiple-choice survey was mailed to all patients over the age of 18 years who underwent cochlear implantation between 2016-2020 at a tertiary academic medical center. Patients who received their CI hardware prior to 2018 were provided 2 processors, whereas those who received their hardware in 2018 or later were provided one processor.

**Results:** A total of 263 patients received surveys. 100 surveys were returned for a response rate of 38.0%. Of those who responded, 64 patients received one processor
whereas 36 patients received two processors. The median age at the time of survey was 73.0 years (IQR 20.5 years). Of the cohort with one processor, 29.9% experienced a period without a functioning processor and access to sound. Of the cohort with two processors, 24.3% noted that they often or always utilize their second processor while 27.0% noted that they sometimes utilize their second processor. When asked how important having a second processor was, 62.9% of the two-processor group responded that it was very important, 20.0% percent responded that it was important, while 17.1% responded that they were neutral (p=0.001). The most common reason for utilizing the second processor was a damaged primary processor.

**Conclusion:** Patients who have two CI external processors identify this as being very important to them. As institutional contracts often dictate whether a patient will receive one or two sound processors with their CI hardware, it is important to understand patient preferences and utilization patterns in order to guide patient-centric policies.

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standardized questions regarding the usability of feasibility of incorporating such testing into the process.

**Results:** All patients participated in the usability questionnaire. The majority of patients (71%) were either motivated or willing to participate in testing, with 0% being resistant to testing. All hearing professionals were extremely comfortable (76%) or somewhat comfortable (24%) in introducing the purpose of testing to patients. Ninety-four percent of hearing professionals rated the effort required to engage the patient in testing as extremely easy. Ninety-four percent of hearing professionals also rated the patient’s ability to use the cognitive screening device as extremely easy or somewhat easy.

**Conclusion:** This feasibility study demonstrated that incorporating a self-administered, automated cognitive test as a routine part of cochlear implant care is well-tolerated by hearing professionals and patients alike.

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**Control Number:** 2022-A-399-ACI

**Complete Status:** Complete

**Presentation Number:** CS4-3.2

**Publishing Title:** Institutional Experience with Cochlear Implants Falling Under Recent FDA Corrective Action

**Author Block:** Zachary G. Schwam, MD, Kevin Wong, MD, Samuel Oh, BA, Caleb Fan, MD, Lisa Goldin, MS, MPhil, CCC-A, Enrique Perez, MD, MBA, George B. Wanna, MD, Maura K. Cosetti, MD; Otolaryngology-Head and Neck Surgery, Mount Sinai Hlth. System, New York, NY.

**Abstract Body:**

Institutional Experience With Cochlear Implants Falling Under Recent FDA Corrective Action

Zachary G. Schwam MD, Kevin Wong MD, Samuel Oh BA, Caleb Fan MD, Lisa Goldin MS MPhil CCC-A, Enrique Perez MD MBA, George B. Wanna MD, Maura K. Cosetti MD

Introduction in early 2020, one of the major cochlear implant companies instituted a voluntary field corrective action on certain models due to device failure secondary to fluid ingress into the electrode. An explant rate of <0.5% was described in the initial Food and Drug Administration announcement. Herein we present our experience with the models of interest.

Methods The devices were placed years 2016-2020. Conventional cochlear implantation using a transmastoid, facial recess approach was performed on eligible patients. Standard follow-up was performed with a neurotologist and cochlear implant audiologist.
Devices suspected of failure and those with specific impedance profiles were identified clinically or with proprietary company algorithms to risk stratify patients. Devices were categorized into high, moderate, or no risk for failure. High- and moderate-risk patients then underwent integrity testing with the company. Of note, many patients were not able to follow up reliably during the COVID-19 pandemic.

**Results** The devices of interest were implanted in 90 ears. Thirteen of 90 (14.4%) were confirmed as a hard device failure; 7/13 (53.8%) were SlimJ and 6/13 were (46.2%) mid-scala electrodes. Mean/median age of patients with device failure at time of initial implantation was 36.0/10.0 years (range 7 months-86 years). Mean follow-up duration was 42.3 months from time of initial implantation to last appointment. Mean time from initial implantation to integrity testing was 36.0 months. Among the confirmed device failures, all patients had full insertions with good placement on an intraoperative X-ray. Five (38.4%) had a lack of expected progress, 7 (53.8%) had a sudden decline in performance, and the mean number of defective electrodes was 7.25 (range 4-16). Ten patients have been reimplanted, with 3 awaiting reimplantation. Of these, 7 were reimplanted with a similar electrode, one had a contralateral implant from another manufacturer and only underwent explantation of the defective device, and one underwent reimplantation with another manufacturer. All reimplanted patients are receiving benefit from their new devices.

**Conclusion** At our institution, the hard device failure rate was 14.4%, which is significantly higher than the previously described explantation rate from the manufacturer/FDA. Patients may experience either a sudden or gradual decline in performance or may have slower-than-expected progress. All patients who underwent implantation with the devices of interest should undergo close clinical follow-up with a low threshold for integrity testing. Due to the COVID-19 pandemic and the resultant obstacles encountered, time frames for identification and reimplantation should be extended.

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**Control Number:** 2022-A-400-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS2-2.1  
**Publishing Title:** Patients' Perspectives on the Decision to Pursue Cochlear Implantation
**Introduction:** Cochlear implants provide many recipients with improved speech perception, sound access, and quality of life. Despite the remarkable benefits associated with cochlear implantation, outcomes remain highly variable and unpredictable creating difficulty in pre-operative counseling. Poor management of realistic expectations prior to surgery may lead to dissatisfaction with cochlear implant performance despite objective improvements in hearing. The perceived shortcomings of an invasive, yet elective, surgery may lead to a negative emotion of regret. Decision regret is a recognized medical term describing the feeling of regret reported following elective surgeries. The objective of this study was to investigate if cochlear implant recipients experience decision regret.

**Methods:** Cochlear implant recipients with a minimum of 12 months experience were surveyed on their expectation of the implant and their decision to pursue cochlear implantation as treatment for their hearing loss. One statement pertaining to expectations was administered along with a validated 5 statement Decision Regret Scale. Participants were asked to rate how strongly they agree or disagree with each statement. The results regarding the recipients’ feeling of decision regret was compared to post-operative speech perception scores.

**Results:** A total of 173 surveys were analyzed from the University of Miami and the University of Kansas Medical Center. The cochlear implant met the recipients’ expectations in 75% of the respondents with 14% reporting the cochlear implant did not meet expectations. The majority of respondents showed no or mild regret while 15% showed moderate to strong regret. Age (p=0.15), duration of deafness (p=0.95), duration of cochlear implant use (p=0.12), and change in speech perception score (p=0.24) were not associated with decision regret.

**Conclusion:** Given that decision regret exists in cochlear implant recipients and is not associated with speech perception scores, hearing healthcare providers must consider alternative contributing factors that may lead to this negative emotion. Those who experience decision regret report poorer quality of life, and it is important to identify resources to support these patients.
Author Block:
Kari Smilsky, M.Cl.Sc.

Introduction: Single sided hearing loss poses significant challenges to communication despite having one normal hearing ear. Individuals with single sided deafness (SSD) report decreased hearing in the presence of background noise, and poor localization ability. Traditional treatments for SSD involve contralateral routing of sound via a conventional acoustic CROS hearing aid or via bone conduction. These treatment modalities offer little in the way of improving localization or squelch. Candidacy criteria for cochlear implants (CI) have expanded considerably over the past thirty years and patients with SSD are now an emerging population of candidates for cochlear implantation.

Methods: The study group included 54 adults aged 25-74 with a profound unilateral sensorineural hearing loss of less than ten years and no derived benefit from standard amplification. Subjects were evaluated pre-operatively, and at 1, 3, 6, and 12 months post CI activation. At each of these time points, subjects underwent speech perception testing, and completed subjective questionnaires. Speech perception abilities were assessed using CNC words and AzBio sentences in quiet as well as testing in noise with speech and noise correlated in location and separated at 0, +90 or -90 degrees. Subjects completed the Health Utilities Index (HUI-3), Tinnitus Handicap Inventory (THI), and the Speech and Spatial Qualities of Hearing Questionnaire (SSQ).

Results: Significant improvements over time were realized for CNC words and AzBio sentences in quiet and benefits were noted for head shadow. Significant improvements were also recorded for all subscales of the SSQ and the THI questionnaires. No significant differences were demonstrated for the HUI-3.

Conclusion: Cochlear implantation for SSD is an effective treatment for restoring at least partial bilateral hearing. Patients must be suitably motivated to commit to auditory training and there is likely a critical period of single sided deafness after which adaptation to a cochlear implant becomes difficult. Subjective benefits as measured via a standardized questionnaire do not always mirror objective benefits.
Neural correlates of visual stimulus encoding and verbal working memory differ between cochlear implant users and normal hearing controls

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Neural correlates of visual stimulus encoding and verbal working memory differ between cochlear implant users and normal-hearing controls

A common concern for individuals with severe-to-profound hearing loss fitted with cochlear implants (CIs) is difficulty following conversations in noisy environments. Recent work has suggested that these difficulties are related to individual differences in brain function, including verbal working memory and the degree of cross-modal reorganization of auditory areas for visual processing. However, the neural basis for these relationships is not fully understood. Here, we investigated neural correlates of visual verbal working memory and sensory plasticity in 14 CI users and age-matched normal-hearing (NH) controls. While we recorded the high-density electroencephalogram (EEG), participants completed a modified Sternberg visual working memory task where sets of letters and numbers were presented visually and then recalled at a later time. Results suggested that CI users had comparable behavioural working memory performance compared to NH. However, CI users had more pronounced neural activity during visual stimulus encoding, including stronger visual-evoked activity in auditory and visual cortices, larger modulations of neural oscillations, and increased frontotemporal connectivity. In contrast, during memory retention of the characters, CI users had descriptively weaker neural oscillations and significantly lower frontal-temporal connectivity. We interpret the differences in neural correlates of visual stimulus processing in CI users through the lens of cross-modal and intra-modal plasticity. This study demonstrates that although behavioural measures between NH and CI were similar, the underlying neural networks vastly different suggesting that different neural strategies are adopted in CI users compared to NH.

Kevin D. Brown, MD, PhD, Lisa A. Park, Aud, Morgan A. Selleck, MD, Matthew M. Dedmon, MD, PhD, Harold R. Pillsbury, MD, Margaret T. Dillon, Aud; Otolaryngology - Head and Neck Surgery, Univ. of North Carolina Sch. of Med., Chapel Hill, NC.

Introduction: Adults and children with sensory unilateral hearing loss have both been demonstrated to have substantial difficulty with speech perception in noise. We wished to determine differences in speech perception in noise in adults and children with unilateral sensory hearing loss (UHL) prior to and after cochlear implantation (CI).

Methods: Adults and children with UHL were recruited prospectively into two separate, independent FDA-approved clinical trials evaluating the benefits of cochlear implantation in these populations. Inclusion criteria was severe to profound hearing loss and less than 30% speech perception on CNC word testing in the affected ear. Adult and pediatric subjects underwent speech testing in quiet (CNC word score) or in noise (BKB-SIN in summation, squelch and head shadow conditions) prior to surgery (CNC only) and at 6 months, 12 months and 24 months following cochlear implantation (CNS and BKB-SIN).

Results: Both adults and children achieved significant gains in speech perception after CI in quiet by 24 months (59±13% and 59±15% respectively), although adults approached this outcome earlier. Speech perception without a CI was much poorer in children in all noise conditions than adults, suggesting they are more significantly affected by the lack of binaural hearing in noise. Restoration of binaural hearing with a CI led to substantial improvements in speech perception in noise in summation, squelch and head shadow conditions in children, while adults showed benefits primarily in head shadow conditions only.

Conclusion: Children with UHL perform more poorly than adults in noise without a cochlear implant, requiring a much higher signal to noise ratio. Children with UHL show substantial benefits in noise from a cochlear implant in all noise conditions (summation, squelch and shadow), while adults show benefits primarily in head shadow.

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Control Number: 2022-A-406-ACI
Complete Status: Complete
Presentation Number: CS4-3.7
Electrode Positioning after Cochlear Reimplantation with Same Device

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Introduction: With increasing prevalence and longer duration of cochlear implant device use, rates of revision cochlear implantation continue to rise. The purpose of this study was to investigate whether revision surgery with the same device results in a change in three key indicators of electrode positioning: scalar location, mean perimodiolar distance (M), and angular insertion depth (AID).

Methods: Retrospective analysis of a cochlear implant database at a university-based tertiary medical center from 2017 to 2021. Intra-operative CT scans were obtained after initial and revision implantation. Electrode position was calculated using auto-segmentation techniques. Initial and revision scalar location, M, and AID were compared for all combinations of initial and revision electrodes using paired t-tests.

Results: Sixteen patients underwent revision cochlear implantation with same device. Mean change in M for all ears was -0.07 (95% CI [-0.18, 0.03]) (P = 0.16). The mean change in AID for all ears was -5⁰ (95% CI [-35⁰, 25⁰]) (P = 0.72). Overall, there was no significant difference in M or AID for any of the initial and revision electrode combinations studied. Three initial implantations with pre-curved electrodes resulted in a translocation from Scala Tympani (ST) to Scala Vestibuli (SV). Two remained translocated after revision, while one was corrected when revised with a straight electrode. An additional 5 translocations occurred only after revision.

Conclusion: In this study examining revision cochlear implantation with a single device, we demonstrated no significant change in key indicators of cochlear positioning, even when revising with a different style of electrode. However, the revision electrode is not necessarily confined by the initial trajectory and additional translocations can occur. There may be an increased risk of translocation during revision cochlear implantation, although this requires further study.
Introduction: Individuals disabled by adult-onset bilateral vestibular hypofunction suffer chronic disequilibrium and inability to maintain stable vision and posture during head movement. To determine whether prosthetic electrical stimulation is feasible, safe and effective, we performed a first-in-human clinical trial of continuous, long-term, 24hr/day motion-modulated prosthetic stimulation using a unilaterally implanted multichannel vestibular implant system (MVI) developed by Labyrinth Devices LLC and MED-EL GmbH.

Methods: Ten subjects (5 male, 5 female, age 55-65 years) with adult-onset bilateral vestibular hypofunction (also called bilateral vestibulopathy) underwent unilateral implantation from 2016 to 2021. Seven had ototoxic loss; 3 had idiopathic loss. Duration since symptom onset ranged from 3-24 years. We assessed pre- and post-op/post-activation performance using vestibulo-ocular reflex (VOR) responses to head rotation about each of the three semicircular canal axes, pure tone and speech audiometry, dynamic visual acuity, objective clinical tests of posture and gait, and validated patient-reported outcome instruments for disability (Dizziness Handicap Inventory[DHI], Vestibular Activities of Daily Living [VADL]) and health-related quality of life (SF6 utility [derived from SF36] and Health Utilities Index [HUI]).

Results: Every participant has worn the system’s external component daily since device activation. Six wear it 24 hr/day; 4 now take it off while in bed. All have electrically-evoked VOR responses for at least one electrode for each of three implanted canals. With the head fixed, VOR responses typically range from 5-50°/s and align approximately with the prosthetically stimulated canal’s axis. With the head moving, VOR responses are significantly greater with motion-modulated stimulation than without. Motion perception thresholds are below VOR thresholds. Six of ten implanted ears retained hearing sufficient for unaided communication, an outcome apparently more likely when ampullotomies are limited in size, deferred until other drilling is complete, and covered with gel or fascia to limit egress of labyrinthine fluids and mixture with balanced salt solution used for mastoid irrigation. Posture, gait, dizziness handicap, vestibular disability and health-related quality of life (SF36-derived SF6 utility) improved significantly compared to preop for the group.
**Conclusion:** Outpatient vestibular implantation can be performed safely. Improvements in postural stability, gait, patient-reported disability and quality of life indicate that prosthetic vestibular stimulation is an effective treatment for bilateral vestibular hypofunction. Preservation of useful hearing is possible and appears more likely when intralabyrinthine fluid spaces are isolated from the mastoid. Support: NIDCD R01DC013536, U01DC019364; Labyrinth Devices, LLC; MED-EL GmbH

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**Control Number:** 2022-A-408-ACI

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**Presentation Number:** 061

**Publishing Title:** The effects of patient and device related characteristics on electrically-evoked stapedial reflex thresholds (eSRTs) in adults with cochlear implants

**Author Block:** Mary Laing Holland, BS, Elizabeth L. Camposeo, AuD, PhD, Kaylene King, AuD, Christine Strange, AuD, Theodore R. McRackan, MD, MSCR, Kara Schwartz-Leyzac, AuD, PhD; Otolaryngology, Med. Univ. of South Carolina, Charleston, SC.

**Introduction:** The electrically-evoked stapedial reflex threshold (eSRT) is a valuable and objective measure to assist with programming of cochlear implants (CIs). Generally, studies have shown that eSRT levels correlate with subjective estimates of loudness as measured using loudness scaling, thus helping to validate appropriate programming levels for individual patients. However, underlying factors that contribute to variability in eSRT levels are largely unknown. The present study reviewed demographic and device related characteristics to better understand factors that influence eSRT responses in adult CI patients.

**Methods:** Retrospective analysis of a prospectively maintained database of adults (≥18 years old) who were implanted in either ear at a tertiary hospital clinic. Patients who underwent revision surgery were excluded. Patients were implanted with all three commercially available manufacturers. Data were first selected for analysis if reliable eSRT levels were available; this resulted in a cohort of 138 patients (Average age = 67.77; Males = 74). Among this cohort, 70 individuals had post-operative computerized tomography imaging available which allowed for additional analyses of electrode factors such as medial-lateral distance and scalar location. All eSRT values were converted to charge units (nC) to equate levels across manufacturers. Linear mixed regression models were constructed to evaluate how patient and device related factors were related to eSRT values (nC).
**Results:** Across all patients and electrodes, the average charge required to elicit eSRT was 15.74 nC (SD: 4.31). For each manufacturer, the average charge required to elicit eSRTs across all electrodes was 16.62 (Advanced Bionics), 15.25 (Cochlear), and 19.90 (Med-El), however these values were not significantly different (p>0.05). Males showed significantly higher eSRT levels, and there was a correlation between age at cochlear implantation and eSRT levels with older patients demonstrating higher eSRT levels. However, the average age for males in our cohort was slightly, but significantly higher (70.11 years) compared to females (64.97 years). Therefore, a model including both age and gender as factors demonstrated that age at implantation was the primary variable contributing to eSRT levels. For patients with CT-based CI location data, higher eSRT values were associated with electrodes located further from the modiolus, but were independent of scala tympani/scala vestibuli location. There was no significant difference in eSRT values between lateral and perimodiolar arrays.

**Conclusion:** Results show that age at implantation and medial-lateral distance of electrode array influence eSRT values in adult CI recipients. It is logical that higher charge levels would be required to elicit eSRTs if the electrode is located further from the targeted neural population. However, further work is needed to better understand why age at cochlear implantation might influence these results.

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**Control Number:** 2022-A-409-ACI

**Complete Status:** Complete

**Presentation Number:** 143

**Publishing Title:** Aural Rehabilitation in Adult, Non-English Speaking Cochlear Implant Recipients: A Feasibility Case Series

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**Introduction:** Aural rehabilitation following cochlear implantation (CI) has been shown to improve speech recognition outcomes in postlingually deafened adults. Unique challenges arise when considering post-CI rehabilitation non-English speaking adult recipients and this endeavor has been a largely undocumented within the United States. Our urban, tertiary referral center in New York City affords a unique opportunity for
primarily English-speaking clinicians to tailor the rehabilitation process to the patient’s language of preference. We present our experience with post-CI aural rehabilitation using non-English discrimination tasks in an adult patient's preferred language.

**Methods:** Protocols employed for English-based aural rehabilitation were adapted for non-English language and employed using a video-based online interpreter service. Using the functional listening framework of Contrasts for Auditory & Speech Training (CAST), individualized closed set discrimination tasks were developed in partnership with each patient. Progress was tracked longitudinally and advanced to modified open-set speech perception testing when appropriate. Weekly sessions were held for an average of 8 weeks and were a combination of virtual and in-person.

**Results:** 6 non-English speaking, postlingually deafened adult Cochlear implant recipients implanted from 2018-2021 were included. Languages included Mandarin Chinese (n=3), Yiddish (n=1), Punjabi (n=1) and Spanish (n=1). All patients met traditional candidacy criteria and aural rehabilitation sessions began an average of 2 months post-activation (range 1-9 months). All included patients were able to progress beyond closed set discrimination to individualized language-specific, modified open-set tests.

**Conclusion:** Non-English-speaking hearing-impaired individuals face a unique set of barriers to hearing healthcare, including challenges related to speech and language assessment and aural rehabilitation. Relatively few resources exist for non-English speaking post-lingually deafened adults following cochlear implantation and current therapy relies on developing individualized, patient-specific testing. Aural rehabilitation by an English-speaking clinician in a patient’s language of preference is feasible, and participating patients may see benefit in speech understanding. Future studies examining the adaptation of existing resources and development of language-specific assessment and rehabilitation tools are necessary and highlight an unmet need in the US hearing impaired population.

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**Control Number:** 2022-A-410-ACI

**Complete Status:** Complete

**Presentation Number:** CS8-1.3

**Publishing Title:** Neural correlates of auditory working memory in cochlear implant users are related to speech perception in noise ability
Neural correlates of auditory working memory in cochlear implant users are related to speech perception in noise ability.

A common concern for individuals with severe-to-profound hearing loss fitted with cochlear implants (CIs) is difficulty following conversations in noisy environments. Previous work has shown that clinically measured speech perception in noise scores yield high degrees of variability in CI users where 10-22% of variance can be explained by age and duration of hearing and even less can be explained by surgical factors leaving a majority of the variance unaccounted for. A possible factor contributing to the wide range of speech perception scores is individual differences in the recruitment of cognitive resources including working memory and attention. In this study, we investigated behavioural and neural correlates of auditory working memory in 13 CI users using high-density electroencephalogram (EEG) while participants completed an N-back task consisting of two conditions, 0-back and 2-back. The behavioural outcomes and neural activations from this task were then correlated with speech perception in noise scores. The auditory stimuli presented in each trial was ten double-digit numbers (DDN). In the 0-back control condition, the participants were primed with one DDN and were instructed to indicate with button press when the double numbers were heard. The 2-back experimental condition was similar to 0-back except that the task was to identify DDN matches from two pairs in the sequence. Behavioural results yielded significant correlations between the 2-back task performance and speech in noise perception in CI users with higher speech perception scores perform more accurately on the 2-back condition compared to CI users with lower speech perception scores suggesting higher degrees of working memory ability in this group. Electrophysiology showed that auditory encoding (P1/N1) were significantly related to speech in noise perception. Significant correlations between neural oscillations (alpha, 8-12 Hz and theta, 4-6 Hz) and speech perception in noise ability were observed. These results suggest that both bottom-up (encoding) and top-down (attention and working memory) processes contribute to the observed variability in speech in noise perception in CI users.
Intrascalar Electrode Position Correlates with Hearing Preservation using a Perimodiolar Electrode


Introduction: The objective of the present study is to evaluate the effect of intrascalar electrode position within scala tympani on acoustic hearing preservation (HP) after cochlear implantation. Recent design modifications to perimodiolar arrays have achieved consistent scala tympani insertion, although there remains variability in HP. The purpose of this study was to evaluate if position of the electrode array within ST could account for the variability in HP. We hypothesized that electrode positioning along the cochlear floor and in a more perimodiolar position, away from the Organ of Corti and basilar membrane would result in improved HP.

Methods: A retrospective cohort study was conducted of adult patients at a tertiary academic center with preoperative low frequency (125, 250 & 500 Hz) pure tone average (LFPTA) of less than 80 dB HL, with available postoperative computed tomography (CT) imaging demonstrating all electrodes within ST and available 1-month postoperative audiograms between July 2016 and September 2020 following cochlear implantation with slim modiolar electrode. The primary outcome evaluated was LFPTA at 4-week post op audiogram and electrode position on post-op CT imaging.

Results: The mean proportion of anti-modiolar and apical electrode displacement from the modiolus and cochlear floor both within subjects (across electrodes) and across subjects demonstrates moderate and significant correlations with the degree of hearing loss identified at 1-month postoperatively.

Conclusion: Variability of intrascalar positioning is an important factor correlated with the degree of HP for electrodes within ST. Future studies should assess surgical techniques and electrode designs that achieve optimal perimodiolar and basal electrode positions for the purposes of HP.
Abstract Body:

Introduction: During the 2020-21 pandemic, many surgeries were adjourned around the world. Cochlear implant is a time-sensitive procedure, especially for prelingually deaf patients. Considering that and the low prevalence of severe COVID-19 infection in pediatric patients, cochlear implants were not postponed during the pandemic in our hospital in southern Brazil.

Methods: A prospective cohort study with 17 children with bilateral sensorineural profound hearing loss who performed cochlear implant (CI) surgery during the COVID-19 pandemic in 2020. We evaluated hearing and speech outcomes through the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS) for children less than 5 years old, the Meaningful Auditory Integration Scale (MAIS) for the ones >5 years old, and the Meaningful Use of Speech Scale (MUSS). All tests were performed between 12 to 18 months after surgery. The incidence of SARS-CoV-2 infection in patients and their relatives was also evaluated before and after the surgery.

Results: The mean age at CI surgery was 37.3 months (SD 20.7) and 58.8% performed simultaneous bilateral CI. Only three patients had comorbidities (two had asthma and one had epilepsy). All patients performed speech therapy after surgery, with 29.4% of them having 2 sessions a week. In regard to hearing results, the postoperative quadritonal mean in free field audiometry was 33.7dBA. The mean scores on MAIS, IT-MAIS, and MUSS were 70.6%, 46.4%, and 51.4%, respectively. No patients or relatives were diagnosed with SARS-CoV-2 infection on the days before or after CI surgery.

Conclusion: Scores at MAIS and MUSS scales were adequate for the follow-up time. The MAIS scale showed higher scores than the MUSS scale, highlighting the importance of the development of the integration of auditory information, followed by an increase in the development of speech. The IT-MAIS scale, applied in children less than 5 years old, pointed to a hearing score lower than expected, possibly related to less time at speech therapy and hearing training. Considering the advanced age at which diagnosis and CI surgery is performed in our population, the smaller susceptibility of children to SARS-CoV-2 infection and the extra sanitation measures, our study suggests the benefits of maintaining cochlear implant surgeries for prelingually deaf children during the pandemic seem to outweigh the risk of infection and allow children.
**Introduction:** It has been more than half a century since the first cochlear implant (CI) was performed and it is thus expected that increasing numbers of implant failures will be encountered and require revision. The current study describes a single center’s experience with revision cochlear implantation in cases where a different electrode was used for reimplantation. More specifically, we reviewed the surgical implications and clinical outcomes in scenarios where the implanted electrode was no longer available (categorized here as legacy devices), or in cases of revision with a different manufacturer.

**Methods:** A retrospective chart review was performed to identify all patients undergoing revision CI surgery with a different electrode than the originally implanted one, between January 2010 and September 2021. In total, 24 patients were included and divided into the following groups: 1) legacy device revisions, 2) manufacturer switches, 3) revisions with a different electrode but same manufacturer. The primary outcome was change in speech perception scores. The secondary outcome was surgical challenges encountered.

**Results:** Among 24 patients included, nine had revision of legacy devices (from all three manufacturers). The median patient age at revision was 27.8 years (range 18.6 to 75.3). Median time between implantation and revision in this group was 20.6 years (range 12.8 to 25.1). All patients with legacy devices were revised due to hard failures, and all but one received an electrode from the same manufacturer. 67% of patients revised had a Nucleus 22 device, and half were revised with a slim straight electrode and the other half with a pre-curved styleted electrode. Two of nine patients did not return to previous best performance (both had abnormal original electrode positions, and ossification of the cochlea allowing for only partial reinsertion of new arrays). Seven patients (8 ears) underwent a manufacturer switch. All but one was revised due to hard failure. Among these patients, two older adults (74 and 75 years old respectively, with time between implantation and revision of 13 and 3 years), had poor speech perception scores compared to preoperatively (1-year postoperative CNC word scores 10% and 8% respectively). Finally, eight patients received a different electrode from the same manufacturer. Four patients required revision of a slim modiolar electrode due to infections and were revised with pre-curved (n=3) or slim straight (n=1) electrodes with
full insertions in all cases. Four patients were revised due to decreased performance with their hybrid (L24) electrodes. All patients were intended to receive a straight electrode, although one patient intraoperatively required a styleted electrode due to ossification around the previous electrode. Complete insertion was ultimately achieved in all four patients.

**Conclusion:** The current study shows favorable outcomes during revision of legacy devices, using both pre-curved and straight electrodes. Preoperative abnormal placement may predict poorer outcomes. Patients can be successfully surgically re-implanted with a different manufacturer electrode, but speech perception outcomes show great variability and older adults may be at risk for worse outcomes.

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**Control Number:** 2022-A-414-ACI

**Complete Status:** Complete

**Presentation Number:** 009

**Publishing Title:** Outcome of Pediatric Cochlear Implantation of Children with Bilateral Cochlear Nerve Deficiency

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**Introduction:** Cochlear nerve deficiency (CND), although a poor prognostic finding, when present bilaterally is no longer universally viewed as a contraindication to cochlear implantation. It is most accurately identified preimplantation by high resolution magnetic resonance imaging (MRI). Knowledge of CND permits specialized implant programming necessary to optimize outcome and appropriate parental counseling of expectations. Preoperative identification of CND is also helpful in counseling of parents and professionals regarding the importance of continued device use and activities to build auditory skills despite slow emergence of auditory skills. The goal of this study is to describe the auditory and communication mode outcome of a large series of implanted children with bilateral CND.

**Methods:** Implanted children with bilateral CND with a minimum one year of device use were retrospectively reviewed. CND was diagnosed prior to cochlear implantation by non-contrast high resolution MRI of the brain and internal auditory canals. Main
outcome measures were auditory thresholds, speech perception measures and communication mode.

**Results:** Thirty-four children with mean age of 2.2 years (0.74 - 6.8) at first implantation met inclusion criteria. Twenty-four were implanted unilaterally and 12 received bilateral implants sequentially. Mean length of follow up by child after first implant was 7 years and by ear was 6 years (1-18.8). At most recent follow up, 14 of 34 (41%) children, and 22 of 48 (45%) ears, had some degree of measurable speech perception. At most recent follow up, six children (18%) had closed-set speech perception and 8 (24%) had open-set speech perception in at least one ear. Mean length of device use till open-set was 3.8 years (1 - 10). Sixteen of 26 (62%) ears without speech perception had a speech awareness threshold of 35dB or less, a marked improvement from baseline. Communication mode at most recent follow up is being collected and will be presented.

**Conclusion:** In our series of children with bilateral CND implanted, most experienced improved auditory awareness after implantation. Almost half of the implanted ears in this series developed a degree of speech perception; almost a quarter developed open-set skills. Speech perception was slow to emerge in this population.

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**Control Number:** 2022-A-415-ACI

**Complete Status:** Complete

**Presentation Number:** CS8-1.4

**Publishing Title:** Greater working memory and speech perception scores in cochlear implant users are associated with better subjective quality of life and hearing according to results from an online test paradigm

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Greater working memory and speech perception scores in cochlear implant users are associated with better subjective quality of life and hearing according to results from an online test paradigm.

**Abstract Body:** A common concern in individuals with cochlear implants (CIs) is difficulty following conversations in noisy environments and social settings. The difficulty may result from listening in a noisy environment, long-term effects of hearing impairment, listening with a CI or a combination of all three. Listening in complex acoustic environments engages cognitive processes, such as working memory and attention to interpret the auditory,
visual and contextual cues in order to make sense of the degraded stimuli. The ability to accomplish these listening tasks relies on the individual’s working memory abilities and draws upon limited cognitive resources to accomplish successful listening. For some individuals this can result in long term detriments of quality of life. For this study, 43 CI users completed a series of online behavioural tests and quality of life surveys, in order to investigate the relationship between visual and auditory working memory, clinical and behavioural measures of speech perception and quality of life and hearing. Behavioural tests included reading and listening (quiet and with noise masking) working memory and a speech perception (quiet and with noise masking) task based on Hagerman’s matrix sentence test. The surveys include the CI Quality of Life (CIQOL) and Speech, Spatial and Quality of Hearing (SSQ). Results showed that recall performance on the three working memory span tests decline from visual reading span to auditory listening in quiet and then listening in noise. Speech perception was predictably worse when presented with noise maskers. Correlation analysis revealed that memory recall and speech perception ability were significantly correlated with sections of CIQOL and SSQ surveys along with clinical speech perception scores. These results confirm that speech perception is related to working memory ability and that working memory ability is correlated to quality of life. Importantly, we demonstrate that online testing can be used as a tool to assess hearing, cognition, and quality of life in CI users.

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Presentation Number: CS8-3.2

Publishing Title: Assessing the Impact of COVID-19 on Cochlear Implantation Candidacy and Surgical Volume

Author Block: Allyson Huttinger, BS, Vivian Kaul, MD, Vika Munjal, BS, Edward Dodson, MD, Aaron Moberly, MD, Oliver Adunka, MD FACS, Yin Ren, MD PhD; The Ohio State Univ. Coll. of Med., Columbus, OH.

Abstract Body: Assessing the Impact of COVID-19 on Cochlear Implantation Candidacy and Surgical Volume

Introduction
Between March and April 2020, most hospital systems in the nation suspended elective surgeries such as cochlear implantation due to surges related to the COVID-19 pandemic. The consequences of the shut down on cochlear implant (CI) surgical volume and patient
access to hearing health care is still being defined. This study sought to examine the CI surgical volume before and after COVID-related shut down. We aim to elucidate if there was a change in demographics and audiometric data of patients who received an implant. **Methods** Retrospective review of consecutive adult CI recipients at an academic tertiary center between June 10, 2019, and January 29, 2021. The pre-pandemic group was defined as patients who received a CI between June 10, 2019, and December 30, 2019. The post-pandemic group was defined as CI recipients between June 4, 2020, and December 28, 2020. Main outcome measures were total and monthly CI volume, patient demographics and socioeconomic factors including income level and travel distance to the CI center, and audiometric data from CI candidacy evaluation including pre-operative pure tone average (PTA), duration of hearing aid use, consonant nucleus consonant (CNC), and AzBio sentence scores in quiet. **Results** A total of 105 patients received CI. There were 46 patients in the pre-pandemic group and 59 patients in the post-pandemic cohort, corresponding to a 28% increase. The monthly CI volume increased from $6.6 \pm 1.6$ cases (range, 1-11) per month pre-COVID, to $8.4 \pm 1.1$ cases (range, 5-13) ($p = 0.028$). The mean distance traveled to the CI center decreased significantly after the pandemic ($54 \pm 30$ vs. $42 \pm 31$ miles, $p = 0.029$). Audiometric data showed that the duration of hearing aid use prior to implantation was significantly shorter in the post-COVID cohort ($12 \pm 12.4$ vs. $18.7 \pm 12.6$ years, $p = 0.03$). Furthermore, post-pandemic CI recipients had better CNC scores on pre-operative evaluation than pre-pandemic patients ($41.0 \pm 30.5\%$ vs. $27.9 \pm 25.4\%$, $p= 0.04$). By contrast, pre-operative PTA and AzBio scores in quiet did not differ ($p = 0.47$ and $p= 0.09$, respectively). Finally, there were no statistically significant differences in age, gender, race, marital or employment status, preferred spoken language, type of insurance, or median family income between the pre-and post-covid groups. **Conclusion** The impact of COVID-19 pandemic-related restrictions on social distancing and masking has profound long-lasting implications in the hearing-impaired population. Interestingly, we found that CI surgical volume increased by almost 30% after the pandemic. Patients who received CI post-pandemic tended to travel less distance to the CI center, have shorter duration of hearing aid use, and had better CNC scores on preoperative evaluation. An unexpected consequence of prolonged isolation from COVID quarantine may include a rise in demand for cochlear implantation.

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**Presentation Number:** CS6-2.3
Surgical Outcomes of Hearing Rehabilitation After Transcutaneous Bone-Conduction Implantation in a Large Pediatric Case Series

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Introduction: The first active transcutaneous bone conduction implant was approved by the Federal Drug Administration (FDA) in July 2018. While it is approved for children 12 years old and older for Conductive or Mixed Hearing Loss and Single Sided Deafness, we sought to review the surgical outcomes of the device in children of all ages. The objective is elucidating the safety and efficacy of the active transcutaneous bone conduction implant, Bonebridge® in pediatric patients.

Methods: A retrospective review of all Bonebridge® implant recipients was conducted at a pediatric tertiary referral center from December 2018 to April 2021. The main outcome measures we queried were age, sex, surgical indication, prior hearing aid use, operative time, post-operative complications, follow-up time and further treatments.

Results: There were 20 children (mean age 13.2 years, range 5-20 yo; 60% female; follow-up time was 41 ± 20 mo) who received a Bonebridge® implant. Indications for implantation included conductive hearing loss (80%), mixed hearing loss (5%) and single-sided deafness (20%). Most common etiologies of hearing loss included cholesteatoma (25%), aural atresia (25%), and chronic otitis media (20%). Average operative time was 99.8 ± 43.7 min. Bilateral implantation was performed in two children. Two children experienced overlying skin infection and one developed wound dehiscence, with none requiring explantation.

Conclusion: In the largest pediatric Bonebridge® series to date, Bonebridge® implantation can be a safe aural rehabilitation option for a variety of etiologies. While the FDA has approved it for ≥12 years old, our case series has shown its safety and efficacy in those implanted younger than that.
Emily Kay-Rivest, MD, MSc, Arianna Winchester, MD, Sean O. McMenomey, MD, David R. Friedmann, MD, MSc, Daniel Jethanamest, MD, MSc, J. Thomas Roland Jr, MD; NYU, NY, NY.

Introduction: The aim of this study was to determine rates of hearing preservation as well as the speech perception scores at one year after implantation of a slim modiolar electrode (SME) in a large cohort of patients. Rates of tip foldover were also assessed.

Methods: A retrospective chart review was performed at a tertiary care centre. Children and adults implanted with a slim modiolar electrode (Cochlear Nucleus Profile: CI532 and CI632) between April 2016 and September 2020 were included. Tip foldover rates were determined for all patients, however pre-lingually deafened children under the age of 5 were excluded from the speech perception and hearing preservation data. Preoperative low frequency pure tone average (LF-PTA) was calculated by averaging thresholds at 250 and 500 Hz in the unaided condition. Patients with a LF-PTA better than 80 dB were considered candidates for hearing preservation though similar surgical techniques were used in all cases. This included soft surgical techniques as previously described. Postoperative speech perception scores were evaluated at 1 year postoperatively (CNC words). Postoperative low frequency unaided thresholds were measured at 3 months and 1 year postoperatively.

Results: A total of 553 slim modiolar electrodes in 442 patients were implanted during this period. The cohort included 145 children and 297 adults. 227 ears were considered candidates for hearing preservation (preoperative LT-PTA ≤80 dB HL). Mean (standard deviation, SD) preoperative, 3-month and 1-year LF-PTA was 59.6 [17.9], 87.8 [24.0] and 88.7 [25.9] dB HL respectively. Mean LF-PTA shift at 1-year was 29.2 dB HL. Furthermore, at 1-year after surgery, 40% of patients maintained a LF-PTA of less than 80 dB. An additional subgroup was analyzed: patients with initial LF-PTA of less than 65 dB HL (n=105). 53% of these patients had a LF-PTA less than 80 dB on 1-year follow up. When comparing patients with preserved LF hearing to those without, mean speech perception scores at 1-year were 69.2% and 64.6% respectively (p=0.32). Finally, the rate of tip foldover in the cohort was 3.1%, with a majority of foldovers occurring in the first year of surgeons’ experience with this electrode array. All foldovers were corrected intraoperatively before leaving the operating room.

Conclusion: Preservation of low-frequency acoustic hearing is possible when using a slim modiolar electrode array and rates of hearing preservation are comparable to other standard-length electrodes.
Introduction: During the 2020-21 pandemic, many surgeries were adjourned around the world. Cochlear implant is a time-sensitive procedure, especially for prelingually deaf patients. We evaluated the impact of COVID-19 on pediatric patients undergoing cochlear implants during the pandemic.

Methods: A prospective cohort study with 24 children with bilateral sensorineural profound hearing loss who performed cochlear implant (CI) surgery during the COVID-19 pandemic in 2020 and 2021. We evaluated the incidence of SARS-CoV-2 symptoms and the diagnosis of patients and their relatives before and after the surgery.

Results: Mean age at CI surgery was 39.7 months. Only three patients had comorbidities (two had asthma and one had epilepsy). Bilateral surgery was performed in 44.4% of patients. No patients or relatives were diagnosed with SARS-CoV-2 infection on the days before or after CI surgery. The medical staff was also tested after the period of surgeries, and no one presented positive serology.

Conclusion: Given the smaller susceptibility of children to SARS-CoV-2 infection, the drawbacks of our health system, and the extra sanitation measures, our study suggests the benefits of maintaining cochlear implant surgeries for prelingually deaf children during the pandemic seem to outweigh the risk of infection.
Abstract Body:

**Introduction:** Pre-curved cochlear implant electrodes have improved hearing outcomes compared to straight electrodes due to their closer proximity to the modiolus, resulting in lower charge requirements for stimulation and decreased spread of excitation. Various electrode insertion techniques have been proposed to position the electrode even closer to the modiolus, further improving postoperative hearing outcomes. One such technique is the pull-back technique, in which the electrode is gently over-inserted and then pulled back to the desired insertion depth. However, the effectiveness of the pull-back technique and the associated insertion force profile have not been adequately demonstrated. This study investigated the utility of the pull-back technique in improving perimodiolar positioning of a pre-curved cochlear implant electrode with simultaneous insertion force profile measurement and direct observation of dynamic electrode behavior in a cadaveric cochlea through an intact, semi-transparent basilar membrane.

**Methods:** The bone overlying the scala vestibuli was removed in 15 fresh cadaveric temporal bones, leaving the scala tympani unviolated. Each specimen was then mounted to a force sensor and robotic insertions of pre-curved electrodes were performed. Force profiles were obtained during standard insertion, over-insertion, and pull-back with simultaneous video recording of the electrode through the semi-transparent basilar membrane.

**Results:** Standard insertion resulted in a mean peak force of 0.14 N (95% CI 0.10-0.18) and occurred at either sheath insertion (n=11, 73.3%) or complete electrode insertion (n=4, 26.7%). Over-insertion was associated with a peak force of 0.18 N (95% CI 0.14-0.21) which was not significantly higher than standard insertion (P = 0.18). Pull-back had a mean peak force of 0.10 N (95% CI 0.06-0.14), which was significantly lower than standard insertion (P = 0.02). Six temporal bones (40%) demonstrated visibly improved perimodiolar positioning.

**Conclusion:** The pull-back technique attempts to achieve optimal close contact of the electrode with the modiolus. This is achieved with a gentle over-insertion followed by electrode pull-back to the standard insertion depth. This technique was not associated with significantly higher insertional forces compared to standard insertion and 40% of temporal bones demonstrated improved perimodiolar positioning compared to standard insertion. Cochlear implant surgeons should consider using the pull-back technique when inserting pre-curved electrodes.
Abstract Body:

Introduction: The cochlear implant is the most effective treatment for cases of profound sensorineural hearing loss. Its main objective is to enable the development of oral language in children who manifest deafness in the prelingual period. Few studies evaluate oral language development of pediatric patients with prelingual deafness implanted in reference hospitals for the treatment of hearing loss in Brazil.

Methods: A retrospective cohort study with a review of medical records of patients undergoing cochlear implant surgery between January 2009 and December 2018. Language development was assessed by reviewing consultations with speech therapy professionals from the cochlear implant group. Patients were divided into six groups considering the type of language most used in their daily lives.

Results: A total of 152 children were included in our study. The mean age at cochlear implant surgery was 3.11 years (SD ± 1.26). We found that 41.2% of children use oral language as their primary form of communication. In a sub-analysis, we evaluated those patients with developed or developing oral language underwent cochlear implant surgery earlier than patients using Brazilian sign language (LIBRAS) or without developed language.

Conclusion: The cochlear implant is a state-of-the-art technology that allows the re-establishment of the sense of hearing and, in many cases, the development of oral language. However, language development is a complex process known to have a critical period to occur properly. Unfortunately, we still see many patients receiving late diagnosis and treatment, which implies a delay and, often, the impossibility of developing oral communication.
Introduction: Numerous studies have shown that cochlear implant technology is an appropriate treatment option for individuals with severe, profound, or moderate sloping to profound bilateral sensorineural hearing loss who receive little or no benefit from hearing aids. Unfortunately, potential cochlear implant candidates are often not referred to cochlear implant centers for an evaluation. It is estimated that less than 10 percent of individuals who might benefit from an implantable hearing technology are referred for additional testing. There are a variety of reasons for the lack of treatment with cochlear implant technology, including a general lack of knowledge about referral criteria and the technological capabilities of cochlear implants. Additionally, many recipients have poor access to cochlear implant centers based on the distance they would have to travel to be seen, and the follow-up required post-implantation. One potential method of improving accessibility of this technology is to disperse cochlear implant evaluation and follow-up protocols to local dispensing audiologists. To improve access to cochlear implant technology, a hub and spoke model of care was initiated between a private otology practice and local dispensing audiologists. From March 2015 to October 2021, several local dispensing audiologists expressed an interest in conducting cochlear implant evaluations for potential candidates and providing follow-up care for their patients after surgery. The main objective of the study was to determine if access to cochlear implantation was improved with this model.

Methods: Between January 2015 to October 2021, 722 pediatric and adult cochlear implant candidates have been implanted at a private practice. Of this number, 96 recipients were evaluated for a cochlear implant by their local dispensing audiologist and were referred to the private otology practice if candidacy criteria were met. Following surgery, these recipients returned to their local center for activation and follow-up post-surgery.

Results: Since the advent of this hub and spoke model of intervention, there has been a general increase in awareness about cochlear implant technology. Since the advent of this model, the number of surgeries rose from 60 (prior the model) to approximately 110 each year since that time. The percentage of patients who were seen by local dispensing audiologists (spokes) have increased over time relative to the percentage of patients who were evaluated and seen for follow-up at the implant center (hub). The absolute number of surgeries conducted per year has not increased significantly from 2016 to 2021.

Conclusion: The grassroot efforts to increase access cochlear implant technology by creating a hub and spoke model has had an insignificant effect on total number of
implants performed over a five-year period. The percentage of patients evaluated and followed by local dispensing audiologists has increased over time relative to the patients followed by the implant center. Other benefits such as convenience, time savings and continuity of care of a hub and spoke model are noted.

Control Number: 2022-A-425-ACI
Complete Status: Complete
Presentation Number: 138
Publishing Title: Understanding the validity of the Montreal Cognitive Assessment as an assessment of cognitive ability in older cochlear-implant users


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Introduction: In the past decade, an emerging literature has developed examining the relationship(s) between hearing loss and cognitive decline. There are many different potential pathways including maladaptive plasticity in response to sensory deprivation and high listening effort, which may strain cognitive processes such as working memory and attention. The relationship may also be driven by concomitant diseases and accompanying psychosocial factors. Cognitive assessments rely on the accurate perception of sensory information in order to produce a valid score. As the population continues aging, diseases that predominantly affect older adults - in particular hearing loss - become increasingly prevalent. Because cochlear-implant (CI) use impacts an individual’s sensory perception, cognitive tests administered via the auditory modality may be inaccurate. There are currently no guidelines on how to assess cognitive abilities in older individuals with one or more cochlear implants.

Methods: Participants in the study have postlingual severe to profound hearing loss and utilize one or two CIs. Participants will be divided into two groups based on their performance on the Montreal Cognitive Assessment (MoCA): those whose scores indicate mild cognitive impairment, and those whose scores indicate normal cognition.
We have built an interdisciplinary team consisting of hearing researchers, an audiologist, two neuropsychologists, and a geriatrician who have created a neuropsychological battery that represents the gold standard to diagnose age-related cognitive decline. This battery consists of clinically validated cognitive tests as well as measures of functional status, quality of life, and medical health. In order to accommodate for differences in auditory perception related to CI use, this battery includes written instructions and stimuli. Functional hearing ability will be measured through sentence testing in quiet and in noise. The results from the cognitive battery will be interpreted by the neuropsychologists to determine a clinical diagnosis for each participant.

**Results:** We will compare the results from the neuropsychological battery to scores on the cognitive screening test. This comparison will inform the efficacy of the MoCA in CI users.

**Conclusion:** The results from this study will inform future research to determine best practices in assessing the cognitive abilities of individuals with CIs.
CI evaluation. The median HA evaluation patient was 67.5 years old (IQR, 61.0 - 77.0 years), compared to a mean age of 62.5 years (IQR, 53.8 - 76.5 years) in the CI population (p=0.046). In reviewing those patients who presented for a HA evaluation, 78.7% (306/389) self-classified as “White,” while 48.1% (182/378) of all patients had some form of insurance HA coverage. Overall, 50.9% (198/389) had Medicare benefits. In the end, 67.5% (261/389) of patients elected to purchase HA. On subgroup analysis, 45.0% (139/306) of White patients had some form of insurance benefits, compared with 51.8% (43/83) of non-White patients (p=0.301), while 53.3% (165/306) of White patients had Medicare benefits, only 39.8% (33/83) of non-White patients did (p=0.022). In terms of sales, 70.2% (218/306) of White patients purchased hearing aids, compared with 55.4% (46/83) of non-White patients (p=0.006). Analyzing those patients who presented with a CI evaluation, 67.8% (135/199) self-classified as “White,” a significant difference as compared to those who presented for a HA evaluation (p=0.004). Overall, 61.0% (122/199) had Medicare benefits, a significant difference as compared to those who presented for a HA evaluation (p=0.017). In the end, 72.9% (145/199) qualified for CI, while 49.7% (72/145) of those who qualified pursued surgery. On subgroup analysis, 61.5% (83/135) of White patients had Medicare, compared with 60.9% (39/64) of non-White patients (p=0.941). Comparing patients who qualified for CI, 67.4% (91/135) were White, while 84.4% (54/64) were non-White (p=0.012). Of those patients with Medicare, 55.4% (46/83) of White patients qualified for CI, as compared to 76.9% (30/39) non-White patients (p=0.022). Of those patients pursuing surgery, 48.4% (44/91) of qualified White patients pursued surgery, compared with 51.9% (28/54) of non-White patients (p=0.684). But when exploring those with Medicare, 45.7% (21/46) of White patients pursued surgery, as compared to 70.0% (21/30) of non-White patients (p=0.037).

**Conclusion:** White patients who present for a HA evaluation are significantly more likely to have Medicare HA benefits as compared to non-White patients. However, while Medicare coverage is not significantly different in those patients who pursue CI surgery, in those patients with Medicare, non-White patients pursued surgery significantly more than White patients.
Abstract Body:

Introduction: Inclusion and reporting of diverse participants in cochlear implantation clinical trials is essential maintaining external validity and scientific rigor. Incorporating race, ethnicity, and sociodemographic variables into the analysis of clinical trials provides enables researchers to evaluate variations in clinical outcomes among different subgroups. Public funding agencies and clinical trials reporting registries have mandated the reporting of race, ethnicity, and sociodemographic data to account for disparities in health. There is a lack of evidence regarding the frequency of reporting of this key patient sociodemographic data among trials involving cochlear implantation and/or cochlear implant recipients. The objective of this study was to systematically evaluate the literature on the frequency of reporting of race, ethnicity, and sociodemographics (education status, geographic location of residence, and socioeconomic status) among cochlear implant interventional clinical trial.

Methods: A systematic review of cochlear Implant interventional prospective clinical trials was conducted. The studies identified for the paper were completed through a manual search of Cochrane, Web of Science, SCOPUS, and Pub Med databases. The inclusion criteria included: published in English, published after 1980, prospective in design, clinical trial involving cochlear implantation or and interventional trial involving cochlear implant patients, reporting of clinical outcome, involvement of either children, adults, or both. Exclusion criteria included: retrospective observational studies, non-original research, and animal studies. Outcomes recorded for each articles included: funding type, level of evidence, race reporting, ethnicity reporting, socioeconomic status reporting, education level reporting, type of insurance, geographic location, and gender of patients. Furthermore, each study was evaluated as to whether any of these variables were used in multivariate data analysis.

Results: The search returned 15,664 papers and a team of 5 screened the articles for inclusion criteria status. A total of 1,350 articles were included for review. Less than 1% of articles included geographic location, education status, type of insurance, socioeconomic status, ethnicity, and race of the patients included in their study. Gender of the patients was the most frequently reported sociodemographic variable in included studies.

Conclusion: Very few prospective clinical trials involving cochlear implants and/or cochlear implant participant outcomes report data on race, ethnicity, and sociodemographic. A lack of reporting of this key data may perpetuate health disparities. These results suggest that failure of studies to take into account these subgroup outcomes will result in decreased generalizability of cochlear implant conclusions across broad clinical populations.
Abstract Body: Cochlear implantation has become a well-established means of addressing severe to profound sensorineural hearing loss, and an expanding range of criteria in patients who cannot benefit from conventional amplification. Understood to be both clinically effective and cost-effective it is estimated that over 500,000 patients have received cochlear implants. When adults and children are grouped together, the rate of cochlear implant utilization/provision remains low at around 6%. The reasons for this are multifactorial, including lack of access to care in underserved America. Objective: We sought to establish a comprehensive cochlear implant program in an area that is traditionally considered underserved. The response from the community has been enormous, and we have outlined the steps and financial support needed to create the program and maintain financial feasibility. Results: Our total population size including our county and surrounding counties was 1.25 million. We negotiated contracts with the most popular manufacturers to optimize the financial margins upfront, but still enabled us to remain a patient choice program. We dedicated 3 audiologists to the program, 2 speech pathologists, and a shared social worker. All the team members were provided mentors who had many decades of cochlear implant experience and auditory verbal training, in addition to courses and training sessions. Telemedicine services were offered to patients to minimize time lost from work or school. Conclusions: Patients who desperately need access to hearing care but do not have resources to travel to regional programs, and dedicate the time needed to appropriately rehabilitate, have been enormously appreciative of the care they are able to receive locally.
Introduction/objectives  Primary objective: • To demonstrate the safety of the Osia 2 System in a pediatric population aged 5-11 years by quantifying the type, frequency, and severity of adverse events. Secondary objectives: • To compare preoperative performance to postoperative performance in parental questionnaires using the Osia 2 System. • To compare preoperative unaided bone conduction thresholds to postoperative unaided bone conduction thresholds. • To compare unaided preoperative speech perception performance in quiet to aided speech perception performance postoperatively using the Osia 2 System. • To compare unaided preoperative adaptive speech in noise performance to aided adaptive speech in noise performance using the Osia 2 System.

Methods/Trial design A pivotal, prospective, multi-center, open-label study. The study duration is 14-18 months, and the intervention period starts at treatment with the device. Participants: Children aged 5-11 years who present with either a mixed or conductive hearing loss (up to 55dB HL) and still can benefit from sound amplification, or a profound sensorineural hearing loss in one ear and normal hearing in the opposite ear (i.e., single-sided deafness or SSD), will be considered for eligibility for the study. Children who present with insufficient bone quality or quantity, chronic or non-reversible vestibular or balance disorders, abnormally progressive hearing loss, or a hearing loss that is bilateral retro cochlear or bilateral central origin will be excluded from the study. The trial will be completed at 10 US-based pediatric centers. Intervention: Eligible subjects will be surgically implanted with the BI300 and OSI200 implants. Four weeks post-surgery, subjects will be fitted with the Osia 2 Sound Processor. Results/Main Outcomes Primary Outcome: • Number of adverse events quantified by type, frequency, and severity. Secondary Outcomes: • Change in parental questionnaires. • Change in unaided bone conduction thresholds. • Change in word recognition using CNC words presented in quiet. • Change in sentence recognition in noise using the BKB-SIN. The primary outcome will be assessed from the time of surgery to 12-months post-surgery. The secondary outcome for unaided bone conduction thresholds will be assessed at baseline and 4-weeks post-surgery. All other secondary outcomes will be assessed at baseline, 3-months post-surgery, and 6-months post-surgery. There will be
no randomization. All subjects will receive the same treatment. Blinding and masking are not appropriate design considerations due to the product design and clinical use of the device.

Sample size for the study is not driven by power requirements for a formal statistical hypothesis test. The planned sample size of 50 subjects will provide data to characterize safety and effectiveness with a reasonable degree of statistical precision. Additionally, the planned sample size will allow for a high probability of observing events of interest. Stratification of the 50 subjects will include a minimum of 10 subjects with single-sided deafness. In addition, a least one-third (15) of the subjects represented will be at the youngest ages (5-6 years), with the remaining 35 subjects represented by the other age groups as evenly as possible. Conclusion/Trial Status Participant’s recruitment is estimated to start in December 2021. Anticipated end of recruitment is June 2022.

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Control Number: 2022-A-432-ACI
Complete Status: Complete
Presentation Number: 147
Publishing Title: Language, speech recognition, and quality of life in long-term pediatric cochlear implant users
Author Block: Andrea Warner-Czyz, Ph.D.¹, Ann Geers, Ph.D.¹, Karen Johnson, Ph.D.², Christine Mitchell, MPH³, Clare Hennessy, B.S.¹, Nae-Yuh Wang, Ph.D.³, Laurie Eisenberg, Ph.D.²; ¹Communication Sciences and Disorders, The Univ. of Texas at Dallas, Richardson, TX, ²Univ. of Southern California, Los Angeles, CA, ³Johns Hopkins Univ., Baltimore, MD.

Introduction: Quality of life (QoL) encompasses a multidimensional subjective evaluation of life satisfaction centered on three pillars: physical, social, and emotional well-being. Hearing loss may lead to social isolation, depression, and negative feelings, thereby negatively influencing QoL. Auditory technology such as a cochlear implant (CI) may mitigate the negative consequences of hearing loss with resultant improvements in various domains of QoL. Research in adult CI users shows a large, significant positive impact of CI on QoL, but these well-being benefits do not correlate significantly with speech recognition measures in quiet or in noise. No studies to date systematically evaluate the link between communication skills (e.g., speech recognition, language performance) and QoL in pediatric CI users. The present study examines the association and predictive value of early-emerging demographic characteristics, speech recognition
skills, and language abilities on parent proxy or child-reported QoL in pre-adolescent long-term CI recipients.

**Methods:** Participants include 68 experienced pediatric CI users from the Childhood Development after Cochlear Implantation database. Participants had a mean implantation age of 3.4 years, mean chronologic age at testing of 11.4 years, and mean duration of CI user of 7.8 years. All children completed the Comprehensive Assessment of Spoken Language test, a standardized language measure including several age-appropriate subtests (e.g., Antonyms, Syntax Construction, Pragmatic Judgment) between 10 and 13 years chronologic age. Speech recognition measures included the Hearing in Noise Test presented in quiet or in the presence of a competing signal. For QoL, the CI user and their parent completed the Child Health and Illness Profile (CHIP) questionnaire. Statistical analyses included correlation and stepwise linear regression.

**Results:** For parent-rated QoL, higher resilience coincided with lower chronologic age at testing (p=.03). Global QoL, whether parent proxy or child self-report, at 8 years post-implant did not significantly correlate with early demographic characteristics, speech recognition performance post-implant, or language subtests or composite standard scores at 8 years post-implant. Stepwise linear regression confirmed the lack of significant predictors in the variables measured.

**Conclusion:** As with previous reports of life satisfaction in adult CI users, speech recognition performance did not significantly influence QoL in long-time pediatric CI users. Additionally, traditional variables used to predict outcomes such as age at implantation, duration of device use, and spoken language ability did not correlate with or predict either parent proxy or child self-reported overall QoL. These results seem counterintuitive in that professionals working with children who are deaf or hard of hearing expect better communication skills to correspond to improved life satisfaction and well-being. An alternate interpretation could focus on the multidimensional nature of QoL such that this construct may evolve from a plethora of variables that do not center on communication-based factors. Rather, other variables (e.g., family dynamics, individual temperament) may contribute more heavily to parent- and child-rated well-being in long-term pediatric CI recipients.

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**Control Number:** 2022-A-433-ACI

**Complete Status:** Complete

**Presentation Number:** CS9-1.2
Spoken Language Development Over More Than a Decade of Longitudinal Follow-Up After Pediatric Cochlear Implantation: The Childhood Development after Cochlear Implantation Study

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Introduction: Long-term follow-up of a large, representative sample of children with severe-to-profound sensorineural hearing loss who underwent cochlear implantation at a young age is necessary to document the attainment of normal, age-appropriate spoken language levels over time in this population.

Methods: The Childhood Development after Cochlear Implantation (CDaCI) Study is a multicenter study designed to characterize longitudinal development of spoken language in young children following cochlear implant (CI) surgery and factors influencing that development. Standardized verbal language tests were administered longitudinally to track spoken language skills using normed standard scores. Age-appropriate core subtests from the Comprehensive Assessment of Spoken Language (CASL) battery were administered to participants to assess spoken language development starting at 4 years post-CI. The Syntax Construction subtest was evaluated at 4-10 years of age, the Paragraph Comprehension subtest was tested at 5-10 years of age, the Antonyms subtest was administered at 5-12 years of age, the Nonliteral Language subtest was administered starting at age 7 years, and Pragmatic Judgement was evaluated beginning at age 4 years. Time-to-event analysis and mixed-effects longitudinal regression models were used to prospectively estimate the cumulative incidence of attaining normal, age-appropriate spoken language levels among 188 young CI candidates and to identify factors associated with normal spoken language achievement over time. A standard score of 85 (one standard deviation below the mean) was used as the threshold for normal, age-appropriate language competence.

Results: Among the youngest CI recipients, about 75% attained age-appropriate levels of Syntax Construction and approximately 90% of these children achieved age-appropriate levels of Paragraph Comprehension by 10 years of age. By age 12, close to 70% of the youngest CI recipients attained age-appropriate levels on the Antonyms subtest. At the end of follow-up, close to 70% of the youngest CI recipients, with greater than 12 years of CI experience, attained age-appropriate levels on the Nonliteral Language and Pragmatic Judgment subtests. The CASL Core Composite score, based on age-appropriate core subtests, indicated that approximately 50% of the youngest CI recipients (with more than 12 years of CI experience) attained age-appropriate levels of spoken language.

Conclusion: Longitudinal assessment is essential in evaluating developmental outcomes after early cochlear implantation. Although spoken language development following cochlear implantation is highly variable, long-term longitudinal follow-up data from the CDaCI Study showed an average upward trajectory of spoken language development over
time in the core domains and composite score, outpacing the expected language development trajectory (i.e., “catching up”), with the majority of children achieving age-appropriate spoken language by the end of study follow-up.

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**Control Number:** 2022-A-434-ACI  
**Complete Status:** Complete  
**Presentation Number:** CS3-1.3  
**Publishing Title:** Social Determinants of Health in Cochlear Implantation using the TriNetX system a population-based study  
**Author Block:** Claudia I. Cabrera, MD, MS, Stephen Politano, MD, Benjamin Johnson, MD, Alejandro Rivas, MD, Sarah Mowry, MD; Otolaryngology, UH Cleveland Med. Ctr., Cleveland, OH.

**Abstract Body:**

**Introduction:** In 2005, the center of Medicare and Medicaid (CMS) approved cochlear implantation for patients with bilateral pre- or post-linguistic, sensorineural, and moderate-to-profound hearing loss. Afterwards the national coverage of cochlear implants increased to include new technologies and expanded coverage regarding age or specific audiometric results. Despite all this, patients with specific social determinants of health (SDOH) are still under served. The aim of this study was to evaluate the rates and characteristic of cochlear implantation in patients with disparities and hearing loss.

**Methods:** Queries were made to include Hearing loss of any cause H90 and H91, with their subcategories, with and without a code of Cochlear Implantation (CI). The Z-codes of disparities were identified individually. Z-codes evaluated were: Z73.6 (disability), Z55.0 (illiteracy and low-level literacy), Z59.5 (extreme poverty), Z59.6 (low income), Z59.4 (lack of adequate food and safe drinking water), Z59.0 (homelessness), and Z59.1 (inadequate housing). The queries included patients from January 1, 2016, to July 31, 2021, from 30 Healthcare Organizations.

**Results:** We identified 13,188 patients with hearing loss and a CI and 2,035,642 with hearing loss without a CI. Both cohorts had a bimodal distribution with one peak at 5-years-old and the other at 73-years-old. There was a fairly even distribution in gender in both cohorts 51% and 50% were male in the CI and the non-CI cohort, respectively. 74% of the CI cohort were white compared to the 71% of the non-CI cohort. Conversely, in the CI cohort 8% were African American compared to the 12% in the non-CI cohort (p<0.001). Overall, in the CI cohort there were <10 patients with any of the codes
assessing patients with social determinants of health.

**Conclusion:** Cochlear Implants (CI) are among one of modern medicines greatest achievements. By restoring hearing and having another chance to perceive the world, many people have benefitted tremendously from this technology. Despite great power, marginalized groups, most importantly those illiterate and without housing, suffered the greatest by having significantly reduced likelihood to receive a CI. In addition, white persons received CI at higher proportions than all other demographics. Continued efforts to assess and implant minority groups will lead to a more equitable world.

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**Control Number:** 2022-A-435-ACI

**Complete Status:** Complete

**Presentation Number:** Publishing

**Publishing Title:** Impact of the spread of excitation width and the refractory period on the neural response telemetry thresholds

**Author Block:** Valeria Goffi, PhD, Rubens Brito Neto, MD PhD, Ricardo Bento, MD PhD, Robinson Tsuji, MD PhD, Ana Cristina Hoshino, PhD, Paola Samuel, PhD; ENT, Hosp. das Clinicas da Faculdade de Medicina da USP, São Paulo, Brazil.

**Impact of spread of excitation width, refractory properties of the auditory nerve and etiology of hearing loss on the intraoperative neural response thresholds in cochlear implants. Introduction** In cochlear implants (CI), the neural response telemetry threshold (tNRT) is very useful in speech processor programming, especially in children. The aim of this study was to identify whether there are differences in spread of excitation and refractory properties of the auditory nerve between adults and children, and between perimodiolar and straight arrays; to identify whether there is an association of these parameters and etiology with the neural response threshold in adults and children implanted with perimodiolar and straight arrays. **Methods** Retrospective, cross-sectional study approved by Ethics Committee. From intraoperative recordings of the neural response of patients implanted with the Nucleus™ (Cochlear™) device, the tNRT, the spread of excitation width (SOE), the amplitude of this response and the absolute and relative refractory periods (REC) were collected of three electrodes corresponding to the apical, medial and basal regions of the cochlea. Data on the etiology of deafness, age and electrode array were collected from the patients' files. Statistical analysis included Mann Whitney and Kruskal-Wallis tests and multivariate linear regression using the R software. **Results** A total of 400 SOE and REC recordings from children and 258 from
adults on electrodes 16, e11 and e6 were selected. In the comparison between adults and children, we identified that the SOE width and the absolute refractory period are different between them in the perimodiolar arrays. The comparison between the perimodiolar and straight arrays showed that in children, there was a significant difference in tNRT, REC and in the SOE width at e11. At e16 there was a significant difference in the SOE width, confirming the modiolar proximity in the perimodiolar array. In adults, the differences between the perimodiolar and straight array were similar to those in children, except that a longer absolute refractory period in e16 in adults implanted with a perimodiolar array. Regression using the R program showed that the tested electrode, the SOE width, the t0 and the tau are variables that significantly influence the tNRT, when considering adults and children implanted with all electrode arrays. The stratified analysis showed that SOE and the tested electrode influence tNRT in children, while in adults all the studied variables influence tNRT. **Conclusion** We concluded that the differences found between electrode arrays and between adults and children, show that they should be studied separately. Differences in eCAP parameters among etiologies suggest an impact of neural density and bone impedance on these measurements. The tested electrode (representing the cochlear regions), the SOE width (representing the electric field), t0 and tau (representing the auditory nerve recruitment) are associated with the tNRT in adults, although in children it is only associated with the SOE width and the tested electrode. The fact that there is a significant influence of the SOE width on tNRT, and of the refractory properties of the auditory nerve in adults, confirmed our hypothesis that the correlation between the tNRT and the psychophysical stimulation levels must be the result of a specific equation for each cochlear region that must include the SOE width and the refractory properties.

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**Control Number:** 2022-A-436-ACI

**Complete Status:** Complete

**Presentation Number:** CS5-2.2

**Publishing Title:** Initial Hearing Preservation Outcomes of a Novel Short, Slim Lateral Wall Cochlear Implant Array

**Author Block:**

*Jason G. Mendries, B.S*, Thomas Haberkamp, MD, Anh N. Huynh, MD PhD, Sarah Sydlowski, AuD, PhD, MBA, Erica Woodson, MD;

Head & Neck Institute, Cleveland Clinic Fndn., Cleveland, OH.
**Introduction:** For individuals presenting with unilateral or bilateral profound sensorineural hearing loss (SNHL), cochlear implantation (CI) is the standard of care in treatment today. For patients with significant residual acoustic hearing, acoustic hearing preservation (HP) has been shown to positively affect performance and has become an important secondary goal of CI surgery. A novel lateral wall electrode array was recently introduced with design modifications including a shorter insertion depth and more flexible tip than its predecessor. The goal of this study is to evaluate the initial post-operative HP outcomes of this novel electrode array compared to our institution’s experience with other electrode array designs.

**Methods:** A retrospective chart review was performed of patients with a low-frequency (125, 250, and 500 Hz) pure tone average (LFPTA) threshold <80 dB undergoing CI at a tertiary academic medical center between January 2020-August 2021. All subjects had baseline audiograms within six months of surgery, and postoperative audiograms typically 4 weeks after surgery. Successful HP was defined as LFPTA threshold <80 dB and/or change in LFPTA <20 dB from pre- to post-operative. Other variables evaluated included date of operation, performing surgeon, laterality, perioperative steroid regimen, and demographics (e.g age and sex).

**Results:** The new novel electrode array is not equivocal to pre-existing electrode array choices and performs worse at initial HP than both lateral wall and slim perimodiolar options. Patients undergoing CI with the novel electrode array had better preoperative thresholds and poorer postoperative thresholds than preexisting array options.

**Conclusion:** Novel electrode arrays are introduced frequently with the intention of being less traumatic to the cochlea, with the surgeon’s expectation that design modifications will also improve outcomes for their patients. Despite theoretical design advantages, the novel slim short electrode array fails to preserve hearing as well as slim perimodiolar and lateral wall designs.
Abstract Body: Introduction: Patients with autosomal recessive non-syndromic hearing loss (ARNSHL) account for 80% of hereditary deafness cases. Mutations in the gene GJB2 encoding connexin-26 are most frequently implicated. However, mutations in the myosin protein XVA (MYO15A) account for 2-10% of ARNSHL cases, predominantly in Asia and the Middle East. This mutation disrupts stereocilia elongation in hair cells, resulting in severe-profound hearing loss preferentially involving the high frequencies. Auditory rehabilitation outcomes with the cochlear implant (CI) for these patients have not been previously reported in the United States. We present a case series of patients with mutations in MYO15A and their auditory outcomes after CI.

Methods: We examined a database of patients at a tertiary medical center with congenital hearing loss attributed to genetic mutations identified by next generation sequencing (NGS) of 110 probable genes. Patients with the MYO15A mutation and a history of cochlear implantation were selected for review of auditory outcomes.

Results: Patient I is a 4-year-old male with bilateral profound sensorineural hearing loss (SNHL) attributed to two homozygous variants of MYO15A. At 12-months he underwent implantation with CIs bilaterally. During the procedure a congenital cerebrospinal fluid (CSF) leak via a patent Hyrtl’s fissure was identified and repaired using a fascia graft. Failure of the right CI required explantation with re-implantation at 18-months following the initial surgery. Pre-operative audiometric testing prior to implantation revealed a right PTA threshold of 88 dB and a left PTA threshold of 78 dB. Post-operative audiometry 3 years later showed improvements in sound field PTA thresholds to 35 dB in the bilateral condition. Receptive and expressive oral language skills developed appropriately after an initial delay. Patient II is a 9-year-old male with bilateral moderate to profound downsloping SNHL due to a heterozygous pathogenic mutation in MYO15A at exon 35 (p.Asp2375fs). At 5-years of age he underwent surgery for a left CI and 2 years later he received a right CI. Pre-operative audiometry demonstrated a right PTA threshold of 81 dB and a left PTA threshold of 79 dB. Post-operative audiometry 3 years later demonstrated sound field PTA thresholds of 31 dB in the bilateral condition. He also presented a Consonant Nucleus Consonant (CNC) score of 84%, and Azbio sentence score of 95% in quiet and 70% in noise.

Conclusion: Individuals with hearing loss due to MYO15A mutations may receive similar benefit from auditory rehabilitation with CI as the general ARNSHL population. Further studies should include a larger sample size from different populations with the MYO15A mutation and correlate their initial presentation with long-term CI auditory outcomes.