**Concurrent Session:** Concurrent Session 1-1 "Imaging Innovations"

**Abstract Number:** 27

**Abstract Title:** Anatomical Variations of the Round Window Prechamber: Their Implications on Cochlear Implantation: An Anatomical, Imaging,and Surgical Study

**Abstract Content:**

Introduction: Over the last decades, there has been a tremendous increase in the number of cochlear implant recipients and, consequently, there is a recent increase of interest in the proper understanding of the anatomy of the round window (RW), which is the most important anatomical landmark during cochlear implant surgery. Objectives: The present study was undertaken to assess the detailed surgical and radiological anatomy of the RW prechamber; its shape, directions, measurements, common anatomic variations, and its relationships with different surrounding structures as related to cochlear implantation. Methods: Total of 20 cadaveric specimens of human temporal bone were microscopically dissected for the anatomical assessment of the measurements of the RW and its relation to surrounding structures in the tympanum. A total of 20 patients were subjected to cochlear implantation, and a radiological and surgical assessment of the anatomy of their RW prechambers was performed. Results: The distances between the RW and the facial canal (FC), the jugular fossa (JF), the carotid canal (CC), and the oval window (OW) were measured. Among the cases subjected to cochlear implantation, the infracochlear tunnel was studied radiologically; the lengths of the anterior and posterior pillars were assessed, and the relation with the direction at which the RW faces was statistically analyzed. Conclusion: Proper understanding of the topographic anatomy of the RW, including its direction of opening and the distances from different adjacent structures in the tympanum, is essential for a successful cochlear implantation surgery, since it can help decision-making before the surgery and is useful to avoid many complications, such as misplaced electrode and iatrogenic injury to the surrounding structures.

**Primary Author/Presenter:** Ahmed Mehanna, PhD

**Author Block:** Ahmed A. Mehanna, Doctorate degree Otolaryngology, Alexandria school of medicine Egypt, Alexandria, Egypt.

**Learner Objectives:**

Proper understanding of the topographic anatomy of the RW is essential for successful cochlear implantation surgery; it can help decision-making before surgery and is very useful to avoid many complications, such as misplaced electrode and iatrogenic injury to the surrounding structures.

The parameters of relation of the round window to the surrounding structures in the tympanum; the infracochlear tunnel and the incudostapedial complex were properly assessed.
Conducting for cochlear implantation (CI) has expanded to include individuals with steeply sloping hearing loss in the high-frequency region. One of the risks of CI surgery is loss of residual hearing. Determining the correct electrode to provide high frequency stimulation to the severely impaired region of the cochlea while preserving the low frequency hearing is critical. Using pre-operative imaging through OTOPLAN software has proven useful for patients with single-sided deafness to determine the most appropriate electrode length to provide full cochlear coverage in this population. In contrast, OTOPLAN can also be used for patients with residual hearing to determine the most appropriate electrode for preservation of residual hearing while providing a full complement of electric and acoustic hearing.

Methods: Study aim: use OTOPLAN to choose the electrode length for each patient based upon the subjects preoperative residual hearing and imaging to determine cochlear duct length. Subjects will be prescribed the most appropriate electrode choice based upon these two variables. Inclusion criteria included: subjects with implant ear sensorineural hearing loss, up to normal hearing in the low frequencies, sloping to severe to profound hearing loss in the high frequencies (PTA at 2000, 3000, 4000 Hz ≥ 70 dB HL) and scoring 60% correct or poorer in the ear to be implanted.

Results: Hearing preservation and speech understanding was assessed for subjects to determine success of utilizing this methodology of choosing electrode. Hearing preservation was maintained in the majority of patients at cochlear implant activation.

Conclusion: Electrode choice should be determined based upon the length of the cochlea and the preoperative residual hearing to promote better residual hearing outcomes.

Primary Author/Presenter: Camille Dunn, PhD

Author Block: Camille Dunn, PhD Otolaryngology, Univ. of Iowa, Iowa City, IA.

Learner Objectives:

Identify length of cochlear duct to determine best electrode for hearing preservation
**Abstract Content:**

Introduction: Prior investigations in scala tympani dimensions have utilized micro-CT or casting modalities, which cannot be correlated directly with microanatomy visible on histologic specimens. The objective of this study was to perform detailed height and cross-sectional area measurements of the scala tympani in histologic sections of non-diseased human temporal bones and correlate them with cochlear implant electrode dimensions. Methods: 3-D reconstructions of 10 archival human temporal bone specimens with no history of middle or inner ear disease were generated using H&E histopathologic slides. Manual segmentation of the scala tympani was performed to generate 3-D reconstructions of the scala tympani. At 90° intervals, the heights of the scala tympani at lateral wall, mid-scala, and perimodiolar locations were measured, along with cross-sectional area. Results: The height of the scala tympani had its most significant decrease over the first 180°. The vertical height of the scala tympani at its lateral wall significantly decreased from 1.28 mm to 0.88 mm from 0° to 180°, and the perimodiolar height decreased from 1.20 to 0.85 mm. The cross-sectional area decreased from 2.29 (sd 0.60) mm<sup>2</sup> to 1.38 (sd 0.13) mm<sup>2</sup> from 0° to 180° (<i>p</i>=0.001). After 360°, the scala tympani shape transitioned from an ovoid to triangular shape, corresponding with a significantly decreased lateral height relative to the perimodiolar height (<i>p</i>&lt;0.001). Wide variability was observed among the cochlear implant electrode sizes relative to scala tympani measurements. Conclusion: The present study is the first to conduct detailed measurements of heights and cross-sectional area of the scala tympani and the first to statistically characterize the change in its shape after the basal turn. The largest decrease in scala tympani height occurred at 180°, and the shape of the scala tympani notably changed at 360° to 450°. Both these angular distances correspond with locations susceptible to translocation injuries in the current literature. These measurements have important implications in understanding locations of intracochlear trauma during insertion and electrode design.

**Learner Objectives:**

describe observed changes in the height of the scala tympani and their correlation with translocation injuries
describe variations among the different cochlear implant electrodes
Concurrent Session: Concurrent Session 1-1 "Imaging Innovations"

Abstract Number: 205

Abstract Title: Radio-Clinical Assessment of Posterior Tympanotomy Difficulties During Cochlear Implantation; A Prospective Case-Series Study.

Abstract Content:
Introduction: Our study proposed a preoperative radiological scoring system for predicting posterior tympanotomy (PT) and mastoidectomy-associated difficulties during cochlear implantation (CI). At the same time, we tried to supply the radiologists and the CI surgeon with proper radiological methods for simply analyzing the preoperative HRCT. We aimed by this scoring system to efficiently prepare the CI operation by an accurate difficulty prediction.

Methods: It was a multicenter prospective case-series study from October 2021 to April 2022. We included 73 CI candidates through the PT approach. The radiological score, composed of thirteen items, was fulfilled and evaluated before each CI surgery. Then, we correlated this score with the intraoperative difficulty and surgical duration.

Results: The operation was straightforward in 42 patients with a score of 3.87 ± 1.72 and challenging in 31 patients with a score of 10.66 ± 1.73. The radiological score was strongly correlated with the surgical difficulty and duration (P-value <0.0001).

Conclusion: Our proposed radiological score was a valid, reliable, and precise tool to predict intraoperative difficulty during cochlear implantation. Chorda-facial angle was the strongest predictor, significantly affecting the difficulty, surgical duration, and preoperative radiological score. A score equal to or more than 7.5 was expected to be associated with surgical difficulty with high accuracy.

Primary Author/Presenter: Haitham Elfarargy, PhD

Author Block: Haitham Elfarargy, PHD Otorhinolaryngology, Kafrelsheikh Univ., Kafrelsheikh, Egypt.

Learner Objectives:
To provide a radiological score that can predict posterior tympanotomy difficulty during cochlear implantation
**Concurrent Session**: Concurrent Session 1-1 "Imaging Innovations"

**Abstract Number**: 224

**Abstract Title**: MRI surveillance after translabyrinthine vestibular schwannoma resection and cochlear implantation - is it feasible?

**Abstract Content**:

Introduction: Cochlear implantation in patients with vestibular schwannomas is of increasing importance and interest. Two remaining challenges are the assessment of conduction of the cochlear nerve and the possibility of postoperative surveillance with magnetic resonance imaging. The aim of the current study was to assess follow-up imaging and determine the visibility of the internal auditory canal after vestibular schwannoma resection and cochlear implantation as well as in patients with persistent vestibular schwannomas and cochlear implants in place. Visibility of the internal auditory canal, cerebellopontine angle and labyrinth were evaluated and graded.

**Methods**: For this retrospective study, 15 MR examinations of 13 patients after translabyrinthine vestibular schwannoma resection and ipsilateral cochlear implantation were included. All patients had been implanted with a MED-EL cochlear implant. Magnetic resonance imaging was carried out on a 1.5 tesla device. All patients were prepped according to the manufacturer’s recommendations.

**Results**: All 15 examinations were carried out without any adverse event during imaging, such as pain, magnet dislocation or malfunction. The internal auditory canal and the cerebellopontine angle were sufficiently visible in all cases to allow for vestibular schwannoma follow-up.

**Conclusion**: Magnetic resonance imaging surveillance of the internal auditory canal following vestibular schwannoma resection and cochlear implantation is feasible and safe with modern implants with a 1.5 tesla magnetic resonance imaging device using metal artifact reduction sequences. Necessary follow-up imaging should not be a contraindication for cochlear implantation in patients with vestibular schwannomas.

**Primary Author/Presenter**: Valerie Dahm, MD

**Author Block**: Valerie Dahm, MD, Ursula Schwarz-Nemec, Prof, Alice Auinger, MD, Christian Matula, Prof, Christoph Arnoldner, Prof, Med. Univ. of Vienna, Vienna, Austria, Radiology, Med. Univ. of Vienna, Vienna, Austria, Otorhinolaryngology, Head and Neck Surgery, Med. Univ. of Vienna, Vienna, Austria, Neurosurgery, Med. Univ. of Vienna, Vienna, Austria.

**Learner Objectives**:

Describe complications that can arise during MRI in patients with cochlear implants

Discuss options to overcome artefacts in magnetic resonance imaging in patients with cochlear implants
Cochlear Implantation: Better frequency-to-place matching, better hearing

Abstract Content:
Introduction: The traditional audiological fitting includes a default frequency allocation to represent a tonotopic mapping that resembles the normal cochlea. This default allocation disregards the personal variation in cochlear duct length, length of the electrode, and the degree of insertion, which results in a frequency-to-place mismatch. The studies regarding the effect of this frequency-to-place mismatch on the audiological and speech outcomes of the patients still remain scarcely studied. This article aims to evaluate the effect of the frequency-to-place mismatch on audiological and speech outcomes.

Methods: A retrospective analysis was performed on patients who received cochlear implants at a tertiary referral center. Patients were excluded if they had any congenital or acquired cochlear anatomical anomalies. The CT-based frequency allocation of each electrode was estimated using a surgical planning software and then compared to the default frequency mapping to determine the frequency-to-place mismatch. The effect of this mismatch was evaluated to find any relation to the audiological and speech outcomes of the patients.

Results: A total of 116 implanted ears had been included, with 39% females and 61% males. The CI hearing age ranged from 8 to 72 months at the time of evaluation. The patients were implanted with Form-24 (65%) and Flex-28 (35%) had been evaluated clinically. Generally, no statistically significant correlations were found between the frequency-to-place mismatch and the PTA, SRT, SDS, CAP and SIR (Pearson correlation, all P >0.06). However, there is a strong negative linear correlation between the cochlear coverage and the frequency-to-place mismatch more in the most apical electrode.

Conclusion: The findings of this study show that the audiological and speech outcomes of the patients are better with a lower frequency-to-place mismatch. However, these findings are not reaching a statistical significance except in the lower frequencies in the apical electrodes which affect the PTA level significantly.

Primary Author/Presenter: Isra Aljazeeri, MD

Author Block: Isra A. Aljazeeri, Fellowship trained consultant otology neurotology Otology, Ministry of health, Houfuf, Saudi Arabia.

Learner Objectives:
In this article, we discuss the details of how the frequency-to-place mismatch affects the audiological and speech outcomes of patients.
Abstract Number: 90

Abstract Title: Frequency-to-Place Mismatch: A Role for Electrocochleography-Based Programming to Optimize Speech Perception Outcomes in Cochlear Implant Recipients

Abstract Content:

Introduction: Current mapping for cochlear implant (CI) devices have utilized the tonotopic organization of the cochlea, as described by Greenwood, to inform frequency allocation across the electrode array. Variations in length and location of the electrode array, cochlear diameter and our current understanding of the natural tonotopic map, may all result in discrepancy in allocation of the electrical stimulus by frequency, known as the frequency-to-place mismatch. Optimizing frequency allocation has the potential to improve performance, especially among post-linguistic adults who have longstanding familiarity with their natural, tonotopic map. Acoustically-evoked electrocochleography (ECochG) measurements can be performed using the individual CI electrodes to generate personalized frequency allocation functions in CI recipients. The primary aims of this study were: (1) describe how ECochG-based frequency allocation can be measured in CI recipients and (2) examine the relationship between early speech perception and frequency-to-place mismatch.

Methods: Fifty patients underwent implantation with the slim perimodiolar array. Stimuli from 250 Hz to 4 kHz were presented acoustically and measurements were made across all 22 electrode contacts immediately after implantation. A fast Fourier transformation was then used to determine the amplitude of the 1st harmonic, which is composed primarily of the cochlear microphonic or outer hair cell response. Tuning curves were then generated for the various frequencies to determine the best frequency (BF), or the location with the maximum cochlear amplitude for a particular frequency. The cumulative absolute semitone difference was then calculated between the patient’s default frequency allocation table and their ECochG-based BF map (frequency-to-place mismatch) across 250 Hz to 2 kHz. ECochG total response (ECochG-TR), a single measure of cochlear health, was also calculated as prior studies have shown that 47% of the variance in CI performance can be accounted for by this variable. Both the ECochG-TR and frequency-to-place mismatch were used in a multivariate model to determine the individual impact of each variable on speech-perception performance.

Results: There was a moderate linear correlation between frequency-to-place mismatch (as measured by cumulative absolute semitone difference) and 3-month performance on CNC words ($r = -0.42$, $p = 0.003$). There was a strong linear correlation between ECochG-TR and 3-month performance on CNC ($r = 0.68$, $p < 0.0001$). A forward selection stepwise multivariate regression model showed that the addition of frequency-to-place mismatch to ECochG-TR was able to explain 62.1% of the variability in CNC scores at 3 months.

Conclusion: All patients had some frequency-to-place mismatch with their default frequency filters compared to the ECochG-based best frequency map. However, smaller degrees of frequency-to-place mismatch resulted in better early speech perception, where 15.9% of the variability in CI performance in quiet was accounted for by this mismatch after controlling for cochlear health. The results of this study suggest that an electrophysiological-based frequency reallocation may result in better speech discrimination compared to standard mapping or anatomic-based mapping in the same patients. Future studies should look at prospective, frequency allocation using ECochG-based mapping techniques.

Primary Author/Presenter: Amit Walia, MD, MSCI

Author Block: Amit Walia, MD, MSCI, Amanda Ortmann, PhD, Jordan Varghese, MD, Shannon Leffler, AuD, Brynn Gentile, BA, Matthew Shew, MD, Jacques Herzog, MD, Craig Buchman, MD; Otolaryngology - Head and Neck Surgery, Washington Univ. in St. Louis, St. Louis, MO.
Learner Objectives:

Describe how electrocochleography can be used to identify best frequency to inform frequency allocation in cochlear implant recipients.

Describe the frequency-to-place mismatch (electrocochleography-based map vs default frequency allocation table) and its relationship with speech-perception performance in cochlear implant users.
Concurrent Session: Concurrent Session 1-2 "Programming: Improving Frequency-to-Place Match and Mapping"

Abstract Number: 221

Abstract Title: A Deep Learning Approach for Automatic Cochlear Segmentation and Measurement: Application in Patient-Specific Frequency-to-Place Mapping

Abstract Content:

Introduction: There is large variation in the size and tonotopic distribution of individual cochleae, however cochlear implant frequency-to-place mapping has traditionally been performed in a generalized approach where individual anatomy and post-operative electrode contact locations are not taken into consideration during programming. Recently, techniques have been proposed for patient-specific implant frequency-to-place mapping which require estimates of the complete angular length of individual cochleae. Although the angular length of cochleae can be estimated in clinical CT data manually, the measurements are time consuming and require extensive experience with image processing software. The objective of this work was to develop a deep learning-based pipeline for the automatic segmentation (i.e., labelling) and measurement of the inner ear and cochlea in clinical CT data to automate patient-specific frequency-to-place mapping.

Methods: A large cadaveric image dataset, containing 81 paired μCT and clinical-resolution CT scans of the same specimens, was used to train a deep convolutional neural network for the automatic segmentation of the inner ear and round window in clinical CT scans. Additionally, automatic geometric analysis algorithms were developed for the extraction, alignment, and angular measurement of cochleae using an inner ear and round window segmentation. Independent test samples with clinical-resolution CT and μCT acquisitions were used to assess the accuracy of the automatic segmentations and angular measurements produced by the proposed algorithms.

Results: The trained deep convolutional neural network was capable of producing consistent and accurate inner ear and round window segmentations in independent clinical-resolution test set scans. Further, the developed geometric analysis algorithms were shown to accurately estimate the angular length of cochleae in clinical CT scans.

Conclusion: Patient-specific cochlear implant frequency-to-place mapping techniques have been developed, however the angular measurements required for their application can be difficult to obtain clinically. A deep learning-based pipeline for the automatic segmentation and angular measurement of the inner ear and cochlea was developed to automate the clinical application of frequency-to-place mapping techniques.

Primary Author/Presenter: Luke Helpard, BESc


Learner Objectives:

Describe how a deep learning-based pipeline can be used for automated frequency-to-place mapping
Concurrent Session: Concurrent Session 1-2 "Programming: Improving Frequency-to-Place Match and Mapping"

Abstract Number: 243

Abstract Title: The effect of the Anatomy Based Fitting in postlingually deaf cochlear implant users

Abstract Content:

Introduction: Personalization of treatment is a growing trend in various fields of medicine including cochlear implantation. Scientific evidence supports the importance of complete stimulation of the cochlea and the tonotopic alignment of the electrodes within it. The cochlear implant allows us to take into consideration key factors such as these for the individualization of each case, not only regarding to the choice of the electrode arrays, but also the fitting settings. The objectives of this study are (1) to determine the frequency-to-place mismatch in cochlear implant users implanted with equal electrode array length, (2) to compare anatomy based fitting (ABF) vs standard fitting in terms of speech tests and subjective outcomes.

Methods: The Synchrony ST Flex28 was used in the eight adults who were enrolled in this prospective observational study. A postoperative Computed Tomography (CT) was performed following surgery. The length of the cochlear duct and the insertion depth for each patient was measured, 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 ABF distribution and that performed by default in the standard fitting software. The ABF was changed to the standard fitting nine months later. Speech tests (disyllables in silence and MATRIX - Oldenburg test with fixed noise at 55dB) and the sound quality questionnaire HISQUI<sub>19</sub>, as well as the patient preference were used to evaluate the hearing outcomes after nine months with ABF and one month later of the standard fitting.

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. The mean score of disyllables in silence was 73% ±11 vs 72% ±16 with ABF and standard fitting, respectively. The Signal to Noise Ratio to achieve the Speech Recognition Threshold was 4±3 vs 4±5 dB with ABF and standard fitting, respectively. Patients considered as moderate their quality of sound with both ways of fitting (77±25 vs 76±24). However, all patients except one preferred ABF when they were asked about their preference between both fitting methods.

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). In spite of similar hearing outcomes most patients prefer ABF vs standard fitting. More data are necessary to corroborate the benefit of the ABF over standard fitting in speech and subjective tests.

Primary Author/Presenter: Luis Lassaleta, MD

Author Block: Luis Lassaleta, MD, Miryam Gavilán, MD, Isabel Sánchez-Cuadrado, MD, Javier Gavilán, MD; Otolaryngology, La Paz Univ. Hosp., Madrid, Madrid, Spain.

Learner Objectives:

Define the concept of Anatomy Based Fitting in Cochlear implant users
Concurrent Session: Concurrent Session 1-2 "Programming: Improving Frequency-to-Place Match and Mapping"

Abstract Number: 249

Abstract Title: The Effect of T Levels, Mapping Functions, and Compression Setting on Low-Level Speech Recognition and Speech Recognition in Noise

Abstract Content:

Introduction: Cochlear implant (CI) recipients should have good access to low-level sounds while achieving loudness normalization for moderate to high-level sounds. Additionally, cochlear implant recipients need to understand soft speech while also understanding speech in noisy situations. Modern CI audio processors contain input processing designed to code a wide range of input intensities into the narrow electrical dynamic range (EDR) of hearing. For instance, a sound processor may be equipped with logarithmic mapping function and automatic gain control (AGC) processing to code a wide range of input intensities into the EDR. Electrical hearing thresholds (i.e., THR levels) may be set to a percentage of a recipient’s upper stimulation level (e.g., 8% of MCL), but THR levels may also be measured to increase stimulation for low-level inputs. There are no published studies examining the effect of different logarithmic mapping functions and measured vs. estimated THR levels for CI recipients who use modern CI audio processors. The objective of this study was to compare the effect THR settings and logarithmic mapping functions on behavioral outcomes.

Methods: A single-group, repeated measures design was used to evaluate performance differences obtained in a variety of technology including measured vs. estimated THR levels (8% of MCL, measured, measured with 9% decrease), multiple logarithmic mapping functions (500 and 1000), AGC settings (3:1 and 3.5:1), and microphone sensitivity settings (75% and 100%). CNC word recognition in quiet was evaluated at 50 dB SPL and 60 dB SPL presentation levels in each of the technology conditions listed above. Speech recognition in noise was evaluated with AzBio sentences. In the default program, the signal-to-noise ratio for 30%-50% performance on the AzBio sentence test was determined with the speech signal presented at 60 dB SPL and 80 dB SPL. The noise level will be adaptively adjusted to determine the target SNR (30%-50% correct). AzBio sentence recognition noise will be evaluated in each of the technology conditions listed above in each of two listening conditions: <ol> <li>AzBio presentation level at 60 dB SPL</li> <li>AzBio presentation level at 80 dB SPL</li> </ol> Aided thresholds were determined in each technology condition, and participants rank ordered their overall preference for these technology conditions in each of three listening conditions: 1. Running speech at 50 dB SPL 2. Running speech in quiet at 80 dB SPL 3. Running speech in noise with the speech signal at 80 dB SPL at the SNR described above.

Results: THR, logarithmic mapping functions, and AGC settings influence speech recognition and subjective preference. Specific results will be described in this presentation.

Conclusion: Speech recognition and subjective preference are affected by THR levels, logarithmic mapping functions and AGC settings. Audiologists should understand the impact the mapping parameters have on the outcomes of CI recipients.

Primary Author/Presenter: Sara Neumann, AuD

Author Block: Sara Neumann, Au.D., Jace Wolfe, Ph.D., Jacy Manning, Ph.D., Au.D.; Hearts for Hearing, Hearts for Hearing, Oklahoma City, OK.

Learner Objectives:

describe the effect of THR levels, mapping functions, and compression settings on low-level speech recognition.
describe the effect of THR levels, mapping functions, and compression settings on speech recognition in noise.
**Abstract Content:**
Introduction: Spanish is the second most common language spoken in the United States and is predicted to be the largest Spanish-speaking country in the world by 2050. Despite the growing population of Spanish speakers, access to validated, culturally appropriate Spanish-language materials for testing subjects with hearing loss is limited. Recently, a Spanish version of the widely accepted AzBio speech perception in noise test was introduced, however, little is known about the effect of test-language on performance. This study examined performance on a spectral discrimination task in normal-hearing adult bilingual speakers and compared outcomes to speech perception in noise measured using the English and Spanish versions of the AzBio, and Adaptive HINT test to determine if different language measures resulted in the same classifications of hearing performance.

Methods: Twenty normal-hearing, bilingual adults (10 Spanish dominant and 10 English dominant) were enrolled. Adaptive Hearing in Noise Test (HINT) and AzBio sentences were presented in both English and Spanish. Each AzBio sentence list was presented at fixed SNRs from -8 to +8 dB SNR in 2 dB increments. A psychometric function was fitted for both AzBio languages. Thresholds (50% correct point) from the psychometric function were compared to the adaptive HINT results for each corresponding language. Last, the SMRT +8 dB SNR performance prediction was correlated to the results.

Results: Bilingual performance differed for Spanish and English AzBio. The psychometric function yielded higher SRT 50% for English (0 dB) compared to Spanish one (-2.5 dB). HINT scores were not significantly different than AzBio for both languages. Results suggest HINT in Spanish to be an easier test (-2.8 dB) when compared to English (-1dB). The SMRT task predicted perfect performance for AzBio at +8 dB SNR. Language dominance was not a predictive factor in performance for either measure.

Conclusion: The signal-to-noise ratio required to achieve 50%-word understanding is lower for the Spanish Adaptive HINT and AzBio when compared to English ‘paired’ tests. Results suggest that test materials and language have the potential to influence the difference in performance. There are inherent differences between the Spanish and English languages that may contribute to speech discrimination scores. English speakers typically use twice as many sounds as Spanish speakers. In addition, the Spanish language uses more multisyllabic words, fewer meaningful monosyllabic words, and fewer high frequency consonant clusters. Further research is required to clarify the differences between the two measures and ensure the test measures are accurately reflecting functional performance.

**Primary Author/Presenter:** Sandra Velandia, AuD

**Author Block:** Sandra L. Velandia, AuD, Sandra Prentiss, PhD, Sebastian Ausili, Scientist, SOM, Hillary Snapp, AuD, PhD; Otolaryngology, Univ. of Miami, Miami, FL.

**Learner Objectives:**
Discuss the differences in speech discrimination performance in noise between English and Spanish Adaptive HINT and AzBio tests.

Explain the psychometric function for the Spanish and English AzBio tests and compare thresholds (50% correct point) from the psychometric function to the adaptive HINT results for each corresponding language.
Abstract Number: 260

Abstract Title: Consideration of ethno-racial and socio-economic variables in clinical trials pertaining to children with hearing loss who use listening and spoken language: A systematic review

Abstract Content:

Introduction: Ethno-racial and socio-economic variables are associated with intervention outcomes. Disaggregating such variables can identify possible disparities in outcomes with respect to minority children with hearing loss. Purposes of this systematic review are: (1) to determine the extent to which ethno-racial and socio-economic variables are included in research studies designed to benefit children with hearing loss, and (2) to ascertain whether data were disaggregated for analyses.

Methods: A total of 8 databases were searched using the following terms: children, and hearing (or Deaf or Hard of Hearing), and intervention (or treatment or training or instruction). Databases included: PsycArticles, Psycinfo, ERIC, PubMed, ComDisDome, Health Source: Nursing/Academic, Psychology and Behavioral Science, and Academic Search Complete. The search resulted in 597 peer-reviewed studies published from 2002 to 2022. A total of 38 papers met the inclusion criteria with the rest being eliminated for the following reasons: non-intervention studies, medical/surgical intervention, clinical trials conducted outside of the US and those with children who did not rely on listening and spoken language for communication. Demographic data, type of intervention, and publication year were extracted from each of these studies.

Results: The qualified studies represented interventions in the areas of auditory training, speech production, language, reading, cognition, and socio-emotional behaviors for children between ages of 1.3 - 17 years. While a majority of studies provided information on participant gender and home languages, less than half of the studies reported information on race and/or ethnicity, existence of additional disabilities; parent education level, and family income. With the exception of single case designs, very few studies presented disaggregated data.

Conclusion: This systematic review revealed that ethno-racial and socio-demographic variables are under-represented in clinical trials pertaining to children with hearing loss. Discussion will center on whether participation of diverse children with hearing loss are representative of the population demographics, the generalizability of findings, and disparities in intervention outcomes.

Primary Author/Presenter: Haley Perry, BS

Author Block: Sneha Bharadwaj, Ph.D., Ellen Rhoades, Ed.S LSLS Cert. AVT, Haley Perry, BS; Communication Sciences and Disorders, Texas Woman's Univ., Denton, TX, AVT / Consultation Services, Plantation, FL.

Learner Objectives:

1. At the end of this session, participants will be able to list at least five ethno-racial and socio-demographic variables that are associated with intervention outcomes in children with hearing loss.

2. At the end of this session, participants will recognize the need for disaggregating intervention outcomes data based on ethno-racial and socio-demographic variables.
**Abstract Content:**

Introduction: According to the American Speech Language Hearing Association’s (ASHA) 2020 member survey data, only 3% of audiologists self-identify as Hispanic or Latino (ASHA 2020). This reflects the disproportionate number of Spanish speaking providers practicing audiology in the United States (US) compared to the number of Spanish-speaking individuals who require hearing healthcare. Despite the increasing number of Spanish-speakers in the US, research and clinical resources to evaluate their hearing loss are scarce. To date, no best practice guidelines or recommendations exist for audiological management of Spanish-speaking CI candidates. Speech perception testing is a crucial component of a comprehensive evaluation to assess functional benefit from CIs, hearing aids, or bone conduction devices. Few audiology questionnaires and speech recognition tests exist in Spanish, and there is limited information regarding their validity and clinical utility. Previous literature revealed Hispanic patients are at a disadvantage to receiving access to healthcare as compared to non-Hispanic patients. This is highlighted by the lack of protocols for assessing Spanish speakers in audiology clinics. This presentation will discuss a proposed Spanish test protocol utilized by a large CI center that serves a high volume of Spanish speakers. Clinical cases will be showcased to emphasize the utilization of the proposed protocol.

Methods: Spanish speaking audiologists at one institution developed a Spanish test protocol by discussing clinical experiences and completing a literature review of existing test measures. Multiple word and sentence tests were considered, and consensus was reached by the team for final determination of the protocol. The proposed protocol will describe the available measures that exist for Spanish speaking patients and will highlight the set-up, test level, test condition (degrees azimuth), and related SNR values necessary for each. The protocol will follow a stepwise process to assist clinicians with identifying the appropriate test based on the patient’s language and hearing loss configuration.

Results: Unaided test protocol includes use of bisyllable Spanish word lists as monosyllabic words are rarely found in Spanish language. Adult aided test protocol consists of a combination of bisyllable Spanish words and Spanish AzBio sentences in various signal to noise ratios. A BKB-SIN test does not exist in Spanish; therefore, our protocol recommends Spanish AzBio at +5 dBBN, which can be presented at various azimuths depending on the hearing loss configuration and/or hearing device utilized.

Conclusion: Inconsistencies exist with how audiologists assess and manage Spanish speaking patients with hearing loss. This is likely due to the provider’s limited access to appropriate training, test materials, and resources. Subsequently, the lack of a recommended test protocol may lead to mismanagement of the Spanish-speaking population. The clinical implementation of the proposed protocol can improve equitable access to hearing healthcare for patients who speak Spanish and decrease health disparities for this population.

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**Primary Author/Presenter:** Chrisanda Sanchez, AuD

**Author Block:** Chrisanda M. Sanchez, AuD, Sandra Velandia, AuD, Meredith Holcomb, AuD, Ivette Cejas, PhD; Otolaryngology, Univ. of Miami, Miami, FL.

**Learner Objectives:**

Define the proposed speech testing protocol for patients who speak Spanish
Abstract Number: 285

Abstract Title: Cultural Consideration During Early Implantation: Exploring Language as a Barrier to Hearing Healthcare

Abstract Content:

Introduction: It has been reported that approximately one-fifth of people in the United States speak a language other than English at home. Patients and families who are non-native English speakers can experience miscommunication in healthcare due to language barriers. Language barriers may impact a patient’s understanding, follow-up, quality of care, and overall patient satisfaction. As hearing healthcare professionals, it is important to be culturally sensitive and aware in order to provide the best healthcare to our increasingly diverse patient populations. This presentation will explore barriers related to language that can ultimately impact patient health-related behaviors and outcomes.

Methods: Cultural differences, such as language, can influence patient health-related behaviors and outcomes. Research has shown that language barriers in healthcare can lead to decreased quality of care, reduced patient and provider satisfaction, and miscommunication. It is important to understand the implications of language barriers in order to better serve our diverse patient populations. Throughout this presentation we will investigate the impact of language barriers and provide solutions to overcome these barriers in hearing healthcare.

Results: Multiple ways to overcome language barriers should be incorporated into audiological care. Because we serve a more diverse population, it is important that we actively work on becoming more culturally competent in order to provide culturally sensitive interventions in hearing healthcare. Different modes of interpreting services should be offered and patient language satisfaction should be assessed regularly. Printed and media based educational resources should be available in most common languages in the regional area to be inclusive of non-English speaking patients. Case studies and professional examples will also be discussed to support the use of culturally sensitive interventions in clinical practice.

Conclusion: Cultural competence and cultural sensitivity are concepts that we as healthcare professionals should continue to work on and expand on, to facilitate their incorporation into the service delivery model and support that we provide all of our patients and families. By understanding the implications of language barriers and incorporating ways to overcome these challenges, we can improve the quality of our hearing healthcare and patient and family satisfaction.

Primary Author/Presenter: Britney Sprouse, AuD


Learner Objectives:

At the end of the session, participants will be able to examine ways to address language barriers in hearing healthcare with patients and families.

At the end of the session, participants will be able to demonstrate the importance cultural competency and cultural humility as hearing healthcare providers.
Abstract Number: 322

Abstract Title: Clinician Perspectives in the Management of Non-English Speaking Adults with Hearing Loss

Abstract Content:

Introduction: As the foreign-born population in the United States increases, medical providers are likely to serve increasing numbers of patients whose primary language is not English. Patients who do not speak English may have miscommunication issues with medical professionals, therefore negatively impacting the quality of healthcare and patient safety. In order to improve equity and access to healthcare in this patient population, we seek to quantify and assess common practices among providers caring for adult hearing loss patients.

Methods: A cross-sectional survey targeting audiologists, otologists, and otolaryngologists was disseminated nationally via email. The survey assesses numerical values such as years of experience, narrative values such as practice setting, and quantitative analysis of experience using likert scale measures. Results were analyzed using chi-square, paired t-test, regression analysis in STATA.

Results: 66 providers (27 Audiology, 29 Otology/Neurotology, 11 General Otolaryngology) completed the survey. Most providers spoke no other language than English (71.3%). 74.6% occasionally see non-English speaking patients, while 17.9% of the providers see non-English speaking patients more than half of the time. 42.4% have been in practice <5 years and most practice in urban academic centers (60.6%). The most common practice of testing pure tone audiometry for non-English speaking patients is relying on an interpreter in person (43.9%) or via remote video call (32.9%). The most common practice of testing speech discrimination in non-English speakers was recorded CNC word list in English (44.4% for Spanish and 48.1% for non-English/non-Spanish). Inability to test discrimination was higher for non-English/non-Spanish vs Spanish speakers (5.5% vs 29.6%). Among audiologists, provider confidence in speech discrimination testing results was lower for non-English/non-Spanish vs Spanish speakers (1.4 vs 2.64; p<0.01). A similar pattern was observed among provider confidence in surgical counseling among Otologist/Neurotologist and General Otolaryngologist (2.13 vs 2.68; p<0.01). Providers reported increased effort required in explaining results to non-English/non-Spanish speakers than for primary Spanish speakers (3.55 vs 3.18; p<0.01).

Conclusion: Our results provide data regarding providers’ perspectives and practice patterns on caring non-English speaking patients. Survey data suggest that most providers feel less confident counseling patients whose primary language is neither English or Spanish, and a great majority reported that counseling this patient population is time-consuming and inefficient. This work highlights the need for continued efforts to improve hearing healthcare in this patient population.

Primary Author/Presenter: Tianyi Jia, Candidate for BA in Biology and BS in Economics


Learner Objectives:

- Identify and discuss common practices among providers caring for non-English speaking adult hearing loss patients
Concurrent Session: Concurrent Session 2-2 "Assessing and Optimizing Programming"

Abstract Number: 13

Abstract Title: Cochlear Implantation and Programming Considerations in Children with Abnormal Cochleoves­icular Nerves

Abstract Content:

Introduction: Cochleoves­icular nerve (CVN) abnormalities have been associated with poor post-cochlear implant (CI) expressive language skill acquisition and may be considered by some a relative contraindication to cochlear implantation. However, recent evidence suggests children with CVN abnormalities still benefit from CI. We review our experience with CI in pediatric patients with CVN abnormalities and describe non-traditional programming strategies that may improve outcomes in this population.

Methods: Retrospective case series review of seven pediatric CI patients with CVN abnormalities from a single outpatient clinic. Nuanced programming strategies specific for this population are described.

Results: Seven patients, including 13 implanted ears, with absent or hypoplastic CVN were examined. Mean implantation age was 34 months (range 12-101 months). Eight ears from 6 patients initially presented with prior outside programming, the remaining 5 ears were initially programmed at our institution. All (8/8) CIs with initial outside programming presented with all electrodes activated; following reprogramming, 6/8 (75%) CIs had stimulation intensity levels broadly reduced and 4/8 (50%) had a pulse-width reduction. The final programming for all CIs (n=13) included 9/13 (69%) with at least one electrode deactivated: 5/13 (38%) with low-frequency electrodes deactivated to improve perception, 3/13 (23%) with high-frequency electrodes deactivated because they were extra-cochlear and 1/13 (7%) with an intra-cochlear high-frequency electrode deactivated. Following the last programming, all seven patients obtained speech awareness, with 6/7 children (88%) demonstrating objective speech perception, and an average binaural speech recognition threshold of 30 dB (range 25-35 dB). Binaural open set word recognition and word recognition scores over 50% were seen in 4/7 (57%) patients. All patients developed verbal language as their primary communication form. The two patients who underwent sequential CI experienced rapid verbal language development following the second CI surgery.

Conclusion: All participants benefited from cochlear implantation, despite a hypoplastic or absent CVN. Practitioners should be aware of the potential need for nontraditional CI programming strategies that avoid overstimulation in this population. Additionally, consideration may be given to upfront bilateral implantation in this population with CVN abnormalities.

Primary Author/Presenter: Alexander Claussen, MD

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Learner Objectives:

Describe the nuances regarding cochlear implant (CI) programming in children with cochleoves­icular nerve (CVN) abnormalities.

Describe audiologic and developmental outcomes following cochlear implantation in children with cochleoves­icular nerve (CVN) abnormalities.
Concurrent Session: Concurrent Session 2-2 "Assessing and Optimizing Programming"

Abstract Number: 242

Abstract Title: Music evaluation in different age groups following cochlear implantation

Abstract Content:

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, at least 12 months of hearing experience with CI. Subjects were divided in three age groups: adults ≥17 years; children 6-10 years; and adolescents 11-16 years. Our study also included a control group with normal hearing (NH) subjects, and in the same age range than CI users. 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: Sixty-nine CI users participated in the study. Of these participants, 39 were adults, 14 were children, and 16 were adolescents. The same number of age matched NH controls were collected. The percentage of implanted adolescents who completed all 5 levels in each category was higher than the rest of the CI users, being: Spatialization (100%), Rhythm (81%), Melody (44%), Density (50%), and Stable/Unstable (31%). However, NH participants completed more levels than implantees. Considering the mean score for each task, adolescents performed better than children in Rhythm (2.3 vs 1.3) and Melody (1.7 vs 0.8); and also better than adults in Spatialization (2.7 vs 2.0), Melody (1.6 vs 1.0), and Density (1.6 vs 1.2). However, adults outperformed children in Rhythm (2.2 vs 1.3). When comparing with their NH-matched, NH adults outperformed in all categories, NH children performed better only in Melody (1.6 vs 0.8), and NH adolescents outperformed in Stable/Unstable (2.1 vs 1.2) and Density (2.3 vs 1.6). 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. Pediatric CI users achieve similar results to their NH peers in terms of musical perception.

Primary Author/Presenter: Luis Lassaletta, MD

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Learner Objectives:

Evaluate music perception in different age groups undergoing cochlear implantation.
**Abstract Number:** 263  
**Abstract Title:** Effects of peripheral neural health on perception of temporal speech cues in cochlear implant recipients

**Abstract Content:**

Introduction: Electrically-evoked compound action potentials (ECAPs) correlate with the density of surviving spiral ganglion neurons (SGNs) in cochlear implanted guinea pigs, and correlate with speech recognition performance in cochlear implanted (CI) humans. However, it is not clear how higher SGN density promotes specific speech cues. We hypothesize that greater SGN density is important for auditory temporal encoding and that increasing carrier pulse rate improves temporal encoding of silent gaps, but only in channels with SGN densities sufficient to accurately encode faster rates. We tested this hypothesis using ECAPs and cortical evoked potentials, evoked by silent gaps in the pulse train.

Methods: Participants included adult post-lingually deafened (>18 years old) CI recipients who had at least 3 months’ CI experience. ECAP amplitude-growth functions (AGFs) were measured using two interphase gaps (IPGs) of 7 and 30 µs. The difference in AGF slope between the two IPGs for each electrode was calculated (“IPG effect”). For each participant, we identified the electrodes estimated to stimulate the highest and lowest SGN survival rates, indicated by the highest and lowest IPG effects, respectively. Auditory evoked potentials were recorded using direct stimulation and a 64-channel Neuroscan Quickcap connected to a SynAmps RT. The cortical acoustic change complex (ACC) was recorded to fixed duration silent gaps, using two carrier pulse rates (500 and 3500 pps) on two electrodes (higher and lower ECAP IPG effect) within each participant.

Results: Cortical encoding of temporal gaps is more precise when using a higher carrier pulse rate, but this effect is modulated by the condition of the auditory nerve. Specifically, results thus far suggest that using higher pulse rates on an electrode estimated to excite a higher density of SGNs in the cochlea results in more precise encoding of temporal cues in the auditory cortex. However, a similar improvement in the encoding of temporal cues is not noted when higher pulse rates are delivered to electrodes estimated to excite a lower density of neurons.

Conclusion: Preliminary studies demonstrate the extent to which auditory nerve health drives cortical representation of temporal cues within individuals. These results may provide novel approaches to improving speech recognition in CI users and help to elucidate underlying factors attributing to differential speech recognition performance across CI recipients when higher or lower pulse rates are used.

**Primary Author/Presenter:** Kara Leyzac, AuD, PhD

**Author Block:** Kara Leyzac, AuD, PhD , Kelly C. Harris, PhD;Med. Univ. of South Carolina, Charleston, SC.

**Learner Objectives:**

Learn on auditory nerve health relates to cortical encoding of speech cues

Learn how encoding of pulse rate at the level of the auditory cortex is modulated by auditory nerve health.
**Concurrent Session**: Concurrent Session 2-2 "Assessing and Optimizing Programming"

**Abstract Number**: 287

**Abstract Title**: Longitudinal Crossover Study of Music and Speech Perception of CI Cohort Utilizing Flat Panel CT-Based Mapping at Initial Activation

**Abstract Content**:

Introduction: Music perception remains challenging for many cochlear implant (CI) recipients, due perhaps in part to the frequency mismatch that occurs between the electrode-neural interface and the frequencies allocated by the CI programming. Individual differences in ear anatomy, electrode array length, and surgical insertion can lead to great variability in the positions of electrodes within the cochlea, but these differences are not typically accounted for by current CI programming techniques. Flat panel computed tomography (FPCT) can be used to visualize the location of the electrodes and calculate the corresponding organ of Corti characteristic frequencies. Such FPCT-based CI frequency mapping may improve pitch perception accuracy, and thus music appreciation, as well as speech perception. The hypothesis of this study is that long-term (1 year) use of CT scan-based frequency maps, beginning on the first day of CI activation, will improve CI user performance in the areas of speech and music perception, as compared to the use of default frequency maps. Methods: Subjects underwent a FPCT scan after CI surgery and a FPCT-based map was provided to their clinical audiologist for use during CI activation. Subjects utilized the CT-based map for 1 year and then completed a crossover phase for 1 month while using the manufacturer-specified clinical default frequency map. A speech and music test battery as administered at 1, 3, 6, 12 and 13 months, consisting of CNC words, AzBio sentences in noise, closed set phoneme identification tests, a novel harmonic consonance-dissonance task, a novel pitch interval comparison task, and the Distorted Tunes Test. Results: At the time of the ACIA meeting, we will report on the 9 subjects who are expected to have completed the 13 month study and 4 additional subjects who will have finished the 6 month test session. Preliminary results utilizing 6 month test data from 12 subjects show CNC word scores within the expected range (avg 64% std dev 17%), although the primary comparison will be between the chronic use of the CT-based map at 12 months and chronic use of the clinical default map at 13 months. Conclusion: We will report on music and speech performance of a CI cohort (n=9) who have completed a 13-month crossover study comparing CT-based mapping, beginning at initial activation, with clinical default frequency mapping.

**Primary Author/Presenter**: Melanie L. Gilbert, AuD

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**Learner Objectives**:

Describe the sources of variability in cochlear implant

Explain why music may be used, in additional to speech metrics, to assess CI outcomes
**Concurrent Session:** Concurrent Session 2-2 "Assessing and Optimizing Programming"

**Abstract Number:** 316

**Abstract Title:** Alternative Approaches to Cochlear Implantation and Programming for Children with X-Linked Stapes Fixation with Gusher

**Abstract Content:**

**Introduction:** X-linked stapes fixation with gusher (XSFG) is a rare non-syndromic genetic disorder, though the exact prevalence is not currently known. This disorder typically causes congenital mixed progressive hearing loss. Children with XSFG have atypical cochlear anatomy, often with a bulbous internal auditory canal, dysplastic cochlea, and deficient or absent modiolus. Location of spiral ganglion cells is often unclear. This anatomical profile, along with perilymph gusher, makes cochlear implantation (CI) surgery complex. Also, children with XSFG may initially benefit from a CI, however may lose benefit over time and become non-users, therefore obtaining and maintaining benefit is a programming challenge.

**Methods:** We present the case of a young boy (XZ) with hearing loss due to XSFG. XZ was identified with moderate to severe mixed hearing loss at age 12 months. He was an excellent hearing aid user until hearing declined at age 3. The move toward CI was approached with great caution given the poor outcomes reported in literature for this population. XZ’s family was counseled that outcomes may not be optimal nor sustained. They used spoken and sign language and were encouraged to continue both. The family elected to obtain a CI for one ear. Given his challenging anatomy, a Cochlear CI24RE(ST) full-banded straight array was chosen to simulate the most spiral ganglion cells possible. A successful plan was derived to address the perilymph gusher intraoperatively. Once activated, programming presented additional challenges due to high, variable current requirements. Variable pulse widths were used on individual electrodes to balance current level, maxima, and rate. XZ obtained good benefit, and his second ear was implanted at age 5.

Consistent performance measures and frequent reprogramming were required as benefit would often wane over time. Performance and power requirements stabilized after the first few years, however continue to be closely monitored. XZ is currently 9 years old and he continues to obtain excellent benefit.

**Results:** XZ, a young boy with hearing loss due to XSFG (an etiology usually associated with poor outcomes), received bilateral CIs at our center, and continues to receive excellent benefit.

**Conclusion:** This outcome is atypical of that often reported in literature. One possible cause of his excellent outcome may be the significant amount of natural and amplified hearing he used in the first few years of life, which is uncommon for children with this etiology of hearing loss. While his implant team made thoughtful choices in regards to implantation and programming to attempt to maximize and maintain benefit, we are unable to conclude that the uncommon electrode choice, frequent performance monitoring, or somewhat radical programming strategy were the cause of his success. We cannot assert that the choices made would have the same outcome for another child with this etiology, however we are encouraged that this young boy may enjoy his ability to hear for many years to come.

**Primary Author/Presenter:** Jennifer Harris, AuD

**Author Block:** Jennifer Harris, AuD, Dennis Poe, MD; ORL/CCE, Boston Children's Hosp., Waltham, MA.

**Learner Objectives:**

Identify the unique anatomy of a patient with x-linked stapes fixation with gusher and the surgical implications it may have.

Give examples of ways a map can be modified to accommodate variable current requirements.
**Concurrent Session:** Concurrent Session 2-3 "Literacy and Developmental Outcomes"

**Abstract Number:** 68

**Abstract Title:** A Model for Integrating Psychology into Otolaryngology/Audiology Clinics

**Abstract Content:**

Introduction: Research has shown that hearing differences and its intersection with social, systemic, and community factors, affects numerous areas of child development (e.g., executive functioning, behavioral challenges, anxiety, depression, social functioning, academic performance, and parental interactions). However, assessment and treatment of pediatric hearing differences historically has not targeted the “whole child” beyond audition and speech. This presentation will highlight current research and clinical gaps, and present a model of care for integrating psychology into pediatric otolaryngology/audiology clinics that serve Deaf/hard of hearing (DHH) patients and their families, including pediatric cochlear implant patients.

Methods: A literature review and clinical reflection/peer collaboration was completed to develop a model of integrated psychological services for pediatric psychologists in otolaryngology/audiology clinics and as part of multidisciplinary cochlear implant evaluation teams.

Results: Fully integrating psychology services into otolaryngology/audiology clinics can include, but is not limited to, psychotherapeutic supports following initial diagnosis of hearing loss, neuropsychological evaluations for cochlear implant candidates, mental health screening of patients with permanent hearing differences, and consultation-liaison services for those with microtia/atroisia. Integrated psychologists can also engage in multidisciplinary research and contribute to programmatic development centered on diversity, health equity, and intersectionality.

Conclusion: The reviewed data clearly show that current multidisciplinary models for treating those with hearing differences leave numerous unmet needs that psychologists can help address. Incorporating psychologists into pediatric hospital settings that serve DHH patients is an essential ingredient in high quality care that meets the needs of the “whole child,” including, but not limited to, pediatric cochlear implant candidates.

**Primary Author/Presenter:** Michael Hoffman, PhD

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**Learner Objectives:**

Review current research and clinical gaps in psychological research in DHH kids

Present a model for integrated psychological services and review the role psychologist can play in multidisciplinary clinics
Introduction: Children who receive cochlear implants (CIs) are at an increased risk for the development of sensory processing disorders which could lead to developmental delay. Additionally, 31-75% of children with profound hearing loss demonstrate vestibular dysfunction leading to difficulty meeting early gross motor milestones in the first year of life such as the development of head control, and later demonstrate challenges with fine motor skills, ADLs, and difficulty with participation in childhood activities. Despite this high risk, there is no standardization for a coordinated developmental screening and referral process in CI clinics. Lack of screening results in referral delays for children with hearing loss who would benefit from intervention and treatment for non-hearing related developmental delays. The aim of the project was to implement a new screening process at a CI clinic in order to detect potential developmental delay in children receiving CIs or currently with CIs.

Methods: This quality improvement project included the use of two questionnaires, the Ages and Stages Questionnaire (ASQ) and the Sensory Profile Two (SP2) which were given to caregivers for all children under the age of five who were seen in the CI clinic from June of 2021 to April of 2022. The ASQ consists of 5 domains: Language, Gross Motor, Fine Motor, Problem-Solving, and Personal Social. The SP2 is used to determine the child’s sensory preferences compared to like age peers. Caregivers completed these assessments at audiology visits or speech language pathology clinic visits, and based on results, referrals were placed for occupational therapy, physical therapy, and/or developmental pediatrics. Established normative cut off values were used to direct patient referrals.

Results: Thirty-one children were screened and 64.5% (n=20) were found to be at-risk in one or more domains of the ASQ and were referred for further evaluation. In this cohort, 55% (n=17) of children were delayed in the language domain, 39% (n=12) of children were delayed in gross motor, 25% (n=8) in fine motor, 45% (n=14) in problem-solving, and 32% (n=10) in the personal social domain. While the SP2 data was not used to make direct referrals to services, it provided rich information about each child to the evaluating provider.

Conclusion: The current study demonstrates that developmental delays in pediatric cochlear implant users extends well beyond difficulty with language acquisition. Specifically, children are experiencing difficulties in fine motor skills hindering school performance, gross motor skills inhibiting children from participating in sport and playground activities, and lastly, social and emotional dysfunction linked directly to how children process emotions and interact with peers. Use of the ASQ allowed for incorporation of occupational therapists into clinic workflow and provided an efficient and holistic approach to screening patients. Utilization of the SP2 provided additional information on atypical sensory processing preferences in children referred for further evaluation. The results of this study highlight the importance of early referral to in-depth evaluations and therapy services, which help reduce the long-term impact of delays. Further analysis with a larger cohort is underway to identify the impact of early screening and referral of children with hearing loss on reducing severity of developmental delays.
Learner Objectives:

Discuss the need for a screening process for developmental delay in children receiving cochlear implants as a treatment for sensorineural hearing loss.

Explain the results of implementing a screening process for developmental delay in children receiving cochlear implants.
**Concurrent Session:** Concurrent Session 2-3 "Literacy and Developmental Outcomes"

**Abstract Number:** 209

**Abstract Title:** Outcomes After Cochlear Implantation: Long-term Results in Children Implanted in Pre-school Age Reaching Minimum 15 Years of Age

**Abstract Content:**

Introduction: There are over 550 patients with hearing loss who underwent cochlear implantation (CI) surgery in our ENT department. The aim of our study was to analyze audiological outcomes in certain time periods as the prelingually deaf children grew up reaching 15 years of age and more, their achievement in education and work. Methods: One hundred implanted prelingually deaf children affected by severe to profound sensorineural hearing loss were retrospectively evaluated. These patients were operated between 1997 and 2008, with mean age 42.07 +/- 12.94 months. 10 patients were with incomplete data (did not come for fitting due to different reasons, moved to another country). We analyzed audiological outcomes 1<sup>st</sup>, 3<sup>rd</sup>, 5<sup>th</sup> and 10<sup>th</sup> year after CI surgery and their professional progress. Results: Free field tone audiometry (500-4000 Hz) 1<sup>st</sup> year after CI was 40 dB (SD = 7.86 dB), 3<sup>rd</sup> year after CI was 35.5 dB (SD = 8.28 dB), 5<sup>th</sup> year after CI was 34.5 dB (SD = 7.80 dB), 10<sup>th</sup> year after CI was 33.75 dB (SD = 7.35 dB) average. The average score 10<sup>th</sup> year after CI in Slovak monosyllabic speech test in quiet was 50.32 +/- 25.34%. The average score 10<sup>th</sup> year after CI in Slovak speech audiometry in noise under SNR 60/50 dB condition was 68.97 +/- 26.36%. CAP 10<sup>th</sup> year after CI surgery was 6.16 +/- 0.98 (understand conversation without lip-reading). Out of this group 98% patients integrated by attending ordinary primary school, high school and university. Of 13 patients who already achieved adulthood and completed their education, 77% (10 patients) were employed and 23% (3 patients) were unemployed. Conclusion: Long-term follow-up outcomes after CI surgery help us to give a global view to a development of children with severe and profound hearing loss.

**Primary Author/Presenter:** Branislava Fides Bercikova, MD

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**Learner Objectives:**

At the end of the session, participants will be able to define outcomes in children implanted in pre-school age reaching minimum 15 years of age.

At the end of the session, participants will be able to assess the impact of CI on education and employment.
Abstract Number: 245

Abstract Title: Getting Ready to be Readers: Preliteracy Development During COVID and Beyond

Abstract Content:

Introduction: Literacy achievement has long been a concern of parents and professionals working with children with cochlear implants (CI). Recent research has found that age-appropriate reading skills are possible for many of today's deaf and hard of hearing elementary schoolers, including those with CI, to achieve (e.g., Mayer et al., 2021; Smolen et al., 2020). The road to successful reading begins long before formal schooling. In fact, the early intervention (EI) and preschool periods provide many opportunities for parents and professionals to facilitate preliteracy skills. However, interruptions to in-person intervention and schooling due to the COVID-19 pandemic have presented challenges to formal instruction, causing many to worry about “learning loss” (Donnelly & Patrinos, 2021).

Methods: This presentation will explore preliteracy development for DHH infants and toddlers as they are getting ready to become successful readers. Diverse samples of DHH students with CI and hearing aids in prekindergarten through grade 5 enrolled in a listening and spoken program in the Southeast United States participated in the study in 2019 (n = 75) and 2022 (n = 99). Eight reading subtests of the Woodcock Johnson IV Tests of Achievement were administered to assess the participants’ word reading, word- and sentence-reading fluency, and passage comprehension.

Results: Results showed that while basic reading skills, including phonological awareness, are generally strong for this population, challenges with reading fluency may impact reading comprehension for some. A comparison of the prereading skills of a subset of study participants—one cohort of DHH children enrolled in prekindergarten in 2018-19 (n = 16) and another cohort enrolled in prekindergarten in 2021-22 (n = 22) showed no significant differences in mean performance on any of the eight subtests or five cluster skills assessed. However, individual performance was significantly more variable in 2021-22, particularly in the areas of reading fluency and reading rate.

Conclusion: While the mean performance suggests that, overall, prekindergarteners with CI and hearing aids in 2022 did not experience “learning loss” in preliteracy in comparison to their peers enrolled in pre-k prior to the pandemic, there was a large amount of variability in the 2022 scores, especially in reading fluency. While many children developed age-appropriate fluency skills despite interruptions in in-person intervention, others struggled. Though often overlooked, fluency is essential for reading comprehension and should be a key component of early intervention and CI habilitation for young children. Strategies for targeting preliteracy through shared book reading, routines-based language learning, mental state talk, and auditory memory will be discussed, along with tools to track the development of these skills in very young children.

Primary Author/Presenter: Elaine Smolen, PhD

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Learner Objectives:

Describe skills involved in early reading fluency for infants and toddlers

Discuss the impact of COVID-19 pandemic on the development of early reading skills for DHH pre-kindergarteners
Abstract Content:

Introduction: Becoming a skilled reader requires building a functional neurocircuitry for printed-language processing that integrates with spoken-language-processing networks. Work from our lab and others has shown that cross-modal (print-speech) neural convergence contributes to reading ability in normal hearing children. Specifically, there is a robust relationship between print-speech coactivation in left-hemisphere language regions and reading-related skills in both children and adults. Moreover, skilled readers show robust activation and functional connectivity across the left-hemisphere reading circuit in print-processing tasks. In CI children, while some develop age-appropriate reading skill compared to their NH peers, some do not. The extent to which difficulty with language and reading in CI children is related to the lack of print-speech convergence and/or the development of the left hemisphere reading circuit is unknown. Using a supervised learning model, we have recently shown that reading and language skill can be predicted by the coherence and connectivity patterns in multiple brain areas. In the present study, we focus specifically on differences in the reading circuit and examine the extent to which print-speech convergence is associated with good and poor reading skill in CI school age children.

Methods: Cortical activity was obtained from 50 CI recipients, ages 7 to 17 years old, and 25 age-matched children with normal hearing (NH) using functional Near Infrared Spectroscopy (fNIRS) while performing tasks for processing printed and heard speech and multisensory (audio-visual-AV) speech processing. All children were evaluated for basic reading and language skill using the Reading Inventory and Scholastic Evaluation (RISE, ETS) and the Clinical Evaluation of Language Fundamentals 5 (CELF-5). Evoked potentials, coherence and their connectivity for each task and hemodynamic activity in anterior and posterior regions associated with language related areas were extracted. Statistical analysis was performed to establish group level differences and a machine learning model was used to associate the neural findings with reading and language scores.

Results: Significant differences were observed between the groups in the evoked activity for both tasks with the more highly skilled readers exhibiting stronger potentials. Similarly, effective connectivity indicating the strength and direction of information flow was different between the high and low skilled readers in the language related brain areas. Print-speech convergence for children with CI was also associated with reading skill similar to AV processing.

Conclusion: The current study is one of the first to demonstrate the neural characteristics of reading in CI children. In addition, these findings provide evidence of the neurofunctional differences in CI children with good and poor reading skill and their association to print-speech convergence.

Primary Author/Presenter: Vincent Gracco, PhD

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Learner Objectives:

describe the differences in neural coherence and connectivity that occur in children with cochlear implants with good and poor outcomes.

describe the relationship between print-speech convergence and literacy outcomes of children with cochlear implants.
**Abstract Content:**

Introduction: With expanded patient criteria to include patients at extremes of age including babies ≥ 9 months and elderly patients often with co-morbidities, it is increasingly important to shorten anesthetic time to decrease risk to patients undergoing cochlear implant surgery. Placement check is recommended for slim modiolar electrodes which have a potential for tip fold-over. However, intraoperative X-rays can often be time consuming and difficult to interpret. The primary objective of this study is to assess the difference in anesthetic time for completion of SmartNav for placement check compared to conventional intraoperative X-rays. The secondary objective is to compare reliability of SmartNav to X-ray in identifying tip foldover.

*Methods:* Prospective study evaluating all patients undergoing cochlear implantation with a Cochlear Americas CI632, CI622 or CI612 device were included. Placement check using SmartNav was completed immediately after insertion and conventional X-ray was performed. Time to complete placement check using SmartNav versus time to call for, complete and read X-ray was recorded. Comparison of recorded tip foldover using both modalities was made.

*Results:* Time for completion of SmartNav was significantly shorter (average 12 minutes) than intra-operative X-ray and with much less variability (range 2.6 min SmartNav and 26 min Xray). In 3 cases of identified tip foldover on x-ray, all were accurately identified on SmartNav, and in at least one case was more reliably identified on SmartNav than X-ray.

*Conclusion:* Utilization of SmartNav for placement check of electrode array significantly decreases anesthetic time for patients undergoing cochlear implantation. SmartNav is as reliable as X-ray and in some cases may be easier to interpret than plain film Xrays.

**Primary Author/Presenter:** Katrina R. Stidham, MD

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**Learner Objectives:**

- describe how SmartNav is used intraoperatively to assess for tip foldover, and compare differences in reliability between SmartNav and Xray.

- discuss the difference in anesthetic time between use of SmartNav and conventional Xray in determining proper electrode positioning, and define how that difference could potentially impact patient care.
**Abstract Content:**

Introduction: Currently available cochlear implants in the U.S. and much of the world are semi-implantable. A fully implanted device offers patients lifestyle advantages including a unique opportunity for patients to experience hearing 24/7 with enhanced comfort and no visible external components. The study device and its unique sensor leverages the normal anatomy of the middle ear and the natural sound conducting mechanism of the tympanic membrane.<br />

Methods: We present a small case series of patients implanted with a novel fully implanted cochlear implant system. We will report surgical and audiometric results on up to three patients enrolled in an FDA approved early feasibility study at a single center. Subjective benefits of comfort and aesthetics will be assessed and experience with the battery recharging process reported.<br />

Results: The surgical implantation of this device involves new steps for the cochlear implant surgeon. We will report on the nuances of surgery, unique risks, and complications experienced. The programming process and evolution of hearing performance over time are discussed. The audiometric outcomes reported will include pure tone thresholds, impedance testing, speech perception measures, and sensor calibration following implantation. Subjective measures of comfort, aesthetics and device usability will be reported.<br />

Conclusion: Compared to a standard semi-implantable cochlear implant a fully implanted device offers comfort and aesthetic advantages and access to sound 24 hours per day. Surgical implantation is more complex, but otologists and ENT surgeons possess the necessary skill set to execute the surgery with limited additional training.

**Primary Author/Presenter:** Colin L. Driscoll, MD

**Author Block:** Colin L. Driscoll, MD, Aniket Saoji, PhD, Melissa DeJong, AuD; Mayo Clinic, ROCHESTER, MN

**Learner Objectives:**

Compare this novel device to existing cochlear implants

Discuss surgical and audiometric outcomes for this device
Abstract Number: 163  

Abstract Title: Towards optimizing the intraoperative protocol: Weighing the utility of spread of excitation, transimpedance matrix, and computerized tomography to describe electrode placement  

Abstract Content:

Introduction: Electrode placement significantly impacts cochlear implant (CI) outcomes. Verifying electrode placement using intraoperative imaging has become common across CI centers, with computerized tomography (CT) as the gold standard (Cosetti et al., 2012; Zuniga et al., 2017). However, not all centers have access to perioperative imaging, which affords real-time surgical guidance to determine whether electrode placement revision is warranted. Even without perioperative imaging, every CI center can obtain electrophysiological information using CI software. Spread of excitation (SOE) and transimpedance matrix (TIM) have shown promise in providing information about electrode placement (Hans et al., 2021; Klabbers et al., 2021; Muller et al., 2021). Therefore, the current study aimed to 1) describe the relationships, if any, between SOE, TIM, and CT for electrode placement factors, and 2) compare the sensitivity and specificity of SOE and TIM in detecting electrode tip fold-over confirmed by CT. <br />

Methods: At the time of abstract preparation, data were available for 17 ears (anticipated N equal to or greater than 100) with a Cochlear device implanted between March 2019 and the present. Participants with transimpedance matrix (TIM), spread of excitation (SOE; electrodes 5, 11, & 17), and CT imaging data (electrode-to-modiolus distance, angular insertion depth, scalar location) collected prospectively were included. SOE widths measured in millimeters and the variance of TIM values in kilohms averaged across three electrodes (5, 11, 17) were calculated, and Spearman rank correlations and independent samples (two-tailed) t-tests with equal variances not assumed were used for preliminary data analyses.<br />

Results: Preliminary results comparing SOE and CT data showed a moderate positive correlation between average SOE widths and average electrode-to-modiolus distance (r = 0.56, p = 0.035) but no significant relationship between average SOE widths and angular insertion depth (r = 0.18, p = 0.543). Also, scalar location did not have a significant impact on SOE widths (t = -1.365, p = 0.237). Preliminary results comparing TIM and CT data showed no significant relationships between TIM and average electrode-to-modiolus distance (r = -0.23, p = 0.398) or angular insertion depth (r = -0.11, p = 0.680). Further, scalar location did not have a significant impact on TIM (t = 0.127, p = 0.901). None of the participants in this preliminary sample experienced an electrode tip fold-over; therefore, SOE and TIM will be evaluated for sensitivity and specificity of detecting tip fold-over once data collection is complete.<br />

Conclusion: Preliminary results suggest SOE but not TIM may provide electrode placement information in the absence of intraoperative CT. However, additional data is needed before the utility of each measure can be fairly evaluated, particularly for detecting electrode tip fold-over.

Primary Author/Presenter: Katelyn A. Berg, AuD


Learner Objectives:

To compare the sensitivity and specificity of using spread of excitation and transimpedance matrix to identify electrode array tip foldover in a large sample.
To describe the relationships between spread of excitation, transimpedance matrix, and electrode placement factors measured intraoperatively
Abstract Content:

Introduction: Auditory Brainstem implant is an emerging option for children who do not qualify for cochlear implants due to anomalies of inner ear and or auditory nerve. However, the evidences for clear indications and predictions on outcomes are not clear due to limitations in availability of data, technology and procedures including surgical, audiological and rehabilitation. The purpose of the study is to describe the trend in development of communication skills in children with Auditory Brainstem Implant (ABI) and to correlate the long-term outcome with Electrically Evoked Auditory Brainstem Response (EABR) and Electrically evoked compound action potential of cochlear nucleus (CN eCAP) to predict outcomes.

Methods: Fifty children with ABI were studied retrospectively with mean implant age of 44 months. The subjective outcomes were measured during pre-activation and post activation at 12 months, 24 months, 36 months and 48 months using CAP, SIR, MAIS, MUSS and LEAQ performance scales and measures. EABR and CN eCAP were measured post-operatively using a novel method. Perception measures of auditory and non-auditory sensations were performed behaviorally in trained children.

Results: Scores improved gradually till 24 months post switch-on, after 24 months a plateau in scores were observed. By 48 months, a maximum of 6 participants showed a median score of 5 in CAP and a total of 10 participants revealed a median score of 4 in SIR. LEAQ scores showed 4 children with ABI were comparable to children with cochlear implants. Outcomes were better in children, where more than 75% of electrodes elicited good eABR, positive correlation was found between the subjective scores and number of electrodes with good eABR. Morphology of eABR were variable, peaks vary from 1 to 4, with first three peaks within 4.5ms. Peaks with late latency beyond 5.5ms were higher in amplitude compared to early peaks across electrodes. Behavioural responses for non-auditory sensation correlated with eABR, differentiating auditory and non-auditory sensation for each electrode stimulated. CN eCAP could be measured in few electrodes across subjects, since it is very preliminary data the morphology and its relationship will be discussed during presentation.

Conclusion: Outcomes with ABI in children are variable, however speech production is very poor compared to auditory comprehension. In few children auditory performance are comparable to CI users over a period of time. eABR is a reliable tool, and a good predictor of outcomes. Morphology, latency and amplitude of peaks aid to predict electrode nature which is very useful during programming the boundaries of stimulation in children. Children with ABI require a longer period of rehabilitation and some children need to be dependent on visual cues for communication. However, all children with ABI use the device consistently and dependent on the same with some non-auditory that are yet to be explored.

Primary Author/Presenter: Ranjith Rajeswaran, MASLP

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Learner Objectives:

- Describe the long term communication performance and outcomes in children with Auditory Brainstem Implant
- Describe the relationship with objective measures and long term outcomes in children with Auditory Brainstem Implant
Abstract Number: 233

Abstract Title: Measurement tool for the placement of hearing implants

Abstract Content:

Introduction: The placement of hearing implants is usually performed by surgeons according to cursory guidelines based on anatomical constraints and comfort factors. Often, a more precise placement is desired, e.g., when transferring optimal positions found in preoperative plans in cases with restricted anatomy, or when aiming for symmetrical placement in bilateral conduction implants. For this purpose, we designed a measurement tool and evaluated it in clinical cases with bone conduction implants.

Methods: The developed titanium tool enables to specify an anatomy-based coordinates system with respect to a reference axis (zygomatic line or Frankfurt line) and Henle's spine [1]. In the reference frame, the implant position can be indicated on two orthogonal axes. The tool was evaluated in five cases (2 females, 3 males) of bone conduction implant surgery (BONEBRIDGE BCI602TM, MED-EL, Austria, and OSIA 2TM, Cochlear, Australia). The temporal bone thickness and cortical bone density were systematically assessed at retroauricular positions using an algorithm referenced by an anatomy-based coordinate system [2]. Then, two indices, the screw implantation safety index (SISI) and the column density index (CODI), were computed as described in Talon et al. [2] to define the optimal implant position. The coordinates for the implant position were transferred with different iterations of the measurement tool and marked with a surgical marker.

Results: In all cases, the indices were successfully computed, and optimal implant positions were defined. In 4 cases, the preoperatively planned implant position could be identified, and the implant was placed at the planned position. In one case of restricted anatomy (Atresia), the optimal position could not be reached, as it would have required too extensive a skin incision. In this case, the implant was placed following the guidelines of the manufacturer.

Conclusion: The developed measurement tool is a convenient way to transfer preoperative geometric information to the patient. Possible applications lie in the optimized positioning of implants in case of restricted anatomy, or in the symmetric placement of implant bodies for bilateral cochlear implantation.

References:


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Learner Objectives:

Develop a measuring tool for surgeons to facilitate implant positioning
Concurrent Session: Concurrent Session 3-2 "Hearing Preservation and Electroacoustic Stimulation"

Abstract Number: 26

Abstract Title: Long-Term Results of Hybrid Cochlear Implantation

Abstract Content:
Introduction: Electroacoustic stimulation (“hybrid” cochlear implantation) has been used since the early 2000s for patients with poor speech recognition performance and high frequency hearing loss beyond the limits of traditional hearing aid amplification, but with only mild or moderate low-frequency hearing loss (especially <500 Hz). Soft surgical technique is used to implant cochlear implant electrode arrays that will replace high frequency hearing (via electrical stimulation of cochlear nerve fibers) while preserving hair fibers at the apex of the cochlea involved in transmission of low-frequency sounds (for use with traditional acoustic amplification). The combination of electrical and acoustic hearing provided in this manner has been shown to result in improvements in speech understanding, noise localization, and music perception compared to electrical stimulation alone. Research is limited on the long-term hearing preservation outcomes after implantation with hybrid devices; only a small number of studies have sought to examine hearing outcomes of patients implanted with hybrid CI > 5 years post-implantation. The present study sought to add to this limited body of literature measuring long-term low-frequency hearing preservation following implantation with the Hybrid L24 cochlear implant.

Methods: A retrospective cross-sectional study was conducted on patients implanted with the Hybrid L24 cochlear implant at a university medical center from 2014-2021. The study was approved by the Institutional Review Board. All patients implanted with the hybrid device were identified, and those without recent audiograms in the past year were contacted for updated audiometric testing. Patient demographic, surgical, and audiometric data was extracted from the medical record. Changes in low-frequency pure tone averages (LFPTA, 125, 250, 500 Hz) were calculated at each of several time-points relative to the date of implantation. The proportion of patients with preserved LFPTA (LFPTA <80 decibels hearing level, dB HL) at last follow-up and the incidence of loss of residual hearing (LFPTA > 80 dB HL) were calculated.

Results: 30 ears in 29 patients underwent hybrid CI (mean age 59 years, 65% female, 50% right ears). The median follow-up time was 24.1 months (interquartile range, IQR 12 - 53.5 months). Mean pre-operative LFPTA was 31.7 dB. The median time to first audiometric follow-up post-implantation was 32.5 days (IQR, 24-50 days); the mean LFPTA across all implanted ears at first follow-up was 45.1 dB and no patient had experienced loss of residual hearing at first follow-up. At 1 month (n=25), the mean LFPTA was 46 dB; at 12 months (n=17), 51.6 dB; at 24 months (n=17), 50.7 dB; at 36 months (n=13), 54.9 dB; and at >48 months (n=10), 57.2 dB. One-way repeated measures ANOVA demonstrated a significant effect of test interval for each frequency (F( 29,7)= 5.77, p<0.0001). Six patients had loss of residual hearing during the follow-up period, with an incidence rate of 0.0065 (time at risk=917.8 months). Kalan Meier curve demonstrates the hearing loss distribution during the follow-up period.

Conclusion: This study demonstrates long-term (> 5 years) hearing preservation outcomes following hybrid cochlear implantation. Based on these results, this device offers good preservation of low-frequency hearing, with only modest decline in the long-term post-implantation, and a low incidence of loss of residual low-frequency hearing.

Primary Author/Presenter: Michael Bartellas, MD, MSc

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Learner Objectives:

Describe the outcome measures for post-implantation residual hearing preservation findings in this study.

Discuss the post-implementation hearing loss distribution curve demonstrated in the Kalan Meier curve.
Concurrent Session: Concurrent Session 3-2 "Hearing Preservation and Electroacoustic Stimulation"

Abstract Number: 113

Abstract Title: A Phase IIa Trial Evaluating Presence of SENS-401 in Perilymph and its Potential in Preserving Residual Hearing Function following a Cochlear Implantation

Abstract Content:

Introduction: Cochlear implantation is considered the "gold standard" treatment for severe to profound sensorineural hearing loss. However, one of the complications following a cochlear implant surgery may be the partial to complete loss of residual hearing function. Apart from pure surgical technical considerations that can reduce this risk, there are non-surgical factors that can help to improve rates of hearing preservation after cochlear implant surgery like the selection of the electrode design. The use of pre-operative corticosteroids for anti-inflammatory action was also shown to be of clinical interest for the protection of the residual hearing. SENS-401 ((R)-azasetron besylate), is a selective 5-HT3 Receptor antagonists, currently in clinical development as a potential candidate to protect against hearing loss caused by cochlear insults, specifically sudden sensorineural hearing loss and cisplatin-induced ototoxicity. We hypothesize that SENS-401 can cross the labyrinthic barrier after oral administration to reach the perilymph compartment and be concentrated at a level of pharmacological interest that might prevent residual hearing loss due to cochlear implantation. Here, we report the successful protocol acceptance by Australian and French authorities and initiation of the trial recruitment and randomization.

Methods: This is a Phase IIa multicenter, randomized, controlled, open-label trial evaluating the presence of (R)-azasetron besylate (i.e., SENS-401) in the perilymph and its potential ability to prevent residual hearing loss due to cochlear implantation. Subjects are adults 18-75 years with preoperative threshold levels in the impaired ear demonstrating unaided audiometric threshold of 80dB or better (i.e., ≤80 dB) at 500Hz, who meet the locally approved indication for, and have already consented to receiving, a cochlear implant. Arm A includes participants scheduled for cochlear implantation and randomized to be treated with oral 43.5 mg SENS-401 twice daily for 49 days (from 7 days prior to 42 days after a cochlear implant surgery) while Arm B includes participants scheduled for cochlear implants and randomized to not be treated with SENS-401. A total of 27 subjects (18 in arm A and 9 in Arm B) are planned to be randomized. During cochlear implant surgery one microliter of perilymph fluid will be collected from Arm A subjects to detect the presence of SENS-401; the following tests will be conducted on both arms: audiometric pure tone average, otoscopic examination and immittance audiometry at screening, randomization (Day 1), Day 49 and Day 105, and electrocochleography during the surgery at Day 8.

Results: Three consented subjects have been screened and are planned to be soon randomized. On the day of the surgery, 1 μL of perilymph fluid will be collected through the round window from subjects allocated by random to arm A. The sample will be sent to a centralized laboratory for evaluation, and the subject will enter the follow up phase of the study including regular audiometry testing.

Conclusion: In a first collaboration between our clinical sites, we aim to successfully collect patients’ perilymph from the implanted ear; the outcomes of this study will assess the presence of SENS-401 in the perilymph compartment, and will contribute to assess the efficacy profile of SENS-401 in preserving residual hearing after a cochlear implant procedure. We expect to benefit from interim results by mid-2023.

Primary Author/Presenter: Stephen O'Leary, MD, PhD

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Learner Objectives:

Describe the goal and the first results of the Phase Ila trial presented
**Concurrent Session:** Concurrent Session 3-2 "Hearing Preservation and Electroacoustic Stimulation"

**Abstract Number:** 191

**Abstract Title:** Interaural Correlation of Acoustic Hearing Preservation Following Sequential Cochlear Implantation

**Abstract Content:**

Introduction: Hearing preservation is an important area of research in patients with residual low-frequency hearing undergoing cochlear implantation. While there is increasing evidence of the benefits of electroacoustic stimulation including speech understanding in quiet and noise and melody recognition, factors that predict acoustic hearing preservation are not well understood. There is little data on whether sequentially implanted ears will have similar degree of acoustic hearing preservation. In this study, we present a cohort of patients with bilateral residual low-frequency hearing who underwent sequential implantation using varying electrode lengths and analyze the interaural correlation of acoustic hearing preservation.

Methods: This is a retrospective analysis of prospectively collected data in a tertiary referral center. Twenty-three adults (9 males and 14 females) with bilateral preoperative residual low-frequency hearing underwent sequential cochlear implantation: 12 patients received a longer electrode in the second ear compared to the first implanted ear, eight patients received the same length, and only three patients were implanted with a shorter array in the second ear. Demographic data, age at first and second implantation, implant type, and pre- and post-operative pure tone audiometric data were collected. The mean age at the time of the first and second implants was 48.4 (SD=16.6) and 54.6 (SD=18.0) years, respectively. Statistical tests were performed using paired t-test and Wilcoxon signed rank test.

Results: Despite similarities in the pattern of low-frequency hearing preservation between the first and second implanted ears, a paired t-test ($t = -2.7$, df = 20, p-value = 0.014) showed that the degree of low-frequency hearing loss was higher in the second implanted ear compared to first implanted ear. The correlation of hearing loss was found to be weak and statistically insignificant (0.3, p=0.18).

Conclusion: While there is a correlation between low-frequency hearing preservation tendency, the degree of hearing loss seems to be higher in the second implanted ear compared to the first. Larger controlled trials are needed to investigate the predictive factors that could play a role in acoustic hearing preservation in the contralateral ear, including inflammatory and immune responses to the first implantation.

**Primary Author/Presenter:** Armine Kocharyan, MD

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**Learner Objectives:**

Implications of electroacoustic stimulation following cochlear implantation

Interaural correlation of low-frequency hearing preservation
Results of a 5-year study with the Hybrid-L24 system: acoustic hearing preservation and functional outcomes

Introduction: Cochlear implant (CI) recipients with acoustic hearing preservation are rapidly growing in number due, at least in part, to advances in electrode design, minimally traumatic surgery, and expanded CI indications. Combined electric and acoustic stimulation (EAS) or “hybrid hearing” affords listeners binaural low-frequency acoustic hearing and broad-spectrum electric hearing producing significant benefit for speech recognition in complex listening scenarios, spatial hearing abilities, and subjective reports of communication ease and localization. The Nucleus Hybrid-L24 system has been FDA approved for nearly a decade and the post-approval study and resultant data analyses are now complete.

Methods: The post-approval study enrolled 52 adult participants (mean age = 59.9 years) meeting Hybrid-L24 indications who were implanted across 17 centers in the U.S. The study included 9 study visits spanning a 5-year period including candidacy evaluation, activation, 3 months, 6 months, 1 year, 2 years, 3 years, 4 years, and 5 years. Assessments included unaided and CI-aided pure-tone audiometry, monosyllabic word recognition, and sentence recognition in noise for the best unilateral and bilateral listening conditions as well as subjective reports via the validated speech, spatial, and qualities (SSQ) questionnaire.

Results: Functional acoustic hearing preservation—defined as postoperative low-frequency pure tone average < 90 dB HL—was achieved for 96.2% of enrolled participants at activation, 72.9% at 1 year, and 66.7% at 5 years. Speech understanding data were consistent with previous reports such that Hybrid-L24 recipients achieved highly significant benefit for speech recognition in quiet and noise with mean CI-ear performance essentially doubling from preoperative candidacy to the 3-month point for both monosyllabic words and sentence recognition at +5 dB signal-to-noise ratio (SNR) (29 to 61% for CNC; 22 to 40% for AzBio +5 dB) with additional increases in performance over time. In the bilateral, best-aided condition, mean performance improved by approximately 30-percentage points from the preoperative evaluation to the 3-month visit for both words and sentences in noise (46 to 72% for CNC; 35 to 66% for AzBio +5 dB). SSQ questionnaire data revealed highly significant perceived benefit by the 6-month point that remained stable over the 5-year study. Note that the speech recognition and qualitative data revealed significant benefit even for individuals who ultimately lost residual acoustic hearing thereby validating the benefits of cochlear implantation in this population of adults with aidable low-frequency hearing and precipitously sloping high-frequency hearing loss.

Conclusion: In summary, cochlear implantation with acoustic hearing preservation is possible, can persist over at least 5 years, and yields highly significant communicative benefit.

Primary Author/Presenter: René Gifford, PhD


Learner Objectives:

describe long-term acoustic hearing preservation data for large sample of adult cochlear implant (CI) recipients
describe speech recognition and subjective communicative outcomes following cochlear implantation with the Hybrid-L24 system
**Abstract Content:**

Introduction: Adult and pediatric cochlear implant (CI) recipients with hearing preservation experience significant improvements in monaural and binaural hearing abilities with electric-acoustic stimulation (EAS) as compared to preoperative hearing abilities. While the majority of EAS users experience significant benefits, outcomes across individuals vary widely. The variability in outcomes may be due to individual differences in electrode array placement, which is not accounted for with default mapping procedure. By not considering electrode array placement, the majority of EAS users have electric frequency-to-place mismatches and/or electric-on-acoustic masking with default maps, which could negatively influence monaural performance. Electric mismatches and electric-on-acoustic masking may also negatively impact binaural hearing abilities, particularly for EAS users with normal to near-normal hearing in the contralateral ear, also known as unilateral hearing loss (UHL). EAS users with UHL may experience better performance with a place-based mapping procedure, which individualizes the map setting to eliminate electric mismatches and limit electric-on-acoustic masking. The present study reviewed the monaural and binaural hearing abilities of pediatric and adult EAS users with default maps as compared to those listening with place-based maps.

Methods: Adult and pediatric CI recipients with hearing preservation were randomized at activation to listen with either a default or place-based map. Participants listened exclusively to their assigned map during the first 12 months of device use. Monaural speech recognition with EAS was evaluated with CNC words in quiet. Binaural hearing was assessed with recorded sentences presented in spatially-separated noise and with a sound source localization task. Intraoperative x-ray or postoperative computed tomography imaging was used to calculate the angular insertion depth of individual electrode contacts in order to estimate the cochlear place frequencies and identify electrode contacts within the region of functional acoustic hearing.

Results: Preliminary data suggest that EAS users with default maps had electric mismatches that ranged by approximately one octave, with the majority with at least one electrode contact within the functional acoustic hearing region that may result in electric-on-acoustic masking. Electric-on-acoustic masking or large magnitudes of electric mismatch may negatively influence the monaural and binaural hearing of EAS users.

Conclusion: Adult and pediatric EAS users with UHL may experience better performance when electric mismatches are minimal and electric-on-acoustic masking is limited, such as with place-based maps. Investigation is ongoing to determine whether these early patterns of performance differences are maintained over time.

**Primary Author/Presenter:** Margaret Dillon, AuD, PhD

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**Learner Objectives:**

compare performance outcomes for EAS users with default versus place-based maps.
Abstract Number: 12

Abstract Title: Evaluation of computed tomography parameters in patients with facial nerve stimulation post-cochlear implantation

Abstract Content:

Introduction: Facial nerve stimulation (FNS) after CI surgery is a problematic complication with an incidence of 0.9-15% has been reported. A leakage of electrical current from the electrode at the upper basal turn of the cochlea to the labyrinthine segment of the facial nerve may underlie this complication, as the distance between the electrode and the facial nerve is the shortest at this point. The aim of this work is to compare the preoperative computed tomography (CT) parameters, including the thickness and density of the bone separating the upper basal turn of the cochlea (UBTC) and the labyrinthine segment of the facial nerve (LSFN), in patients with and without facial nerve stimulation (FNS) in post-cochlear implants (CI).

Methods: A retrospective case review of 1700 CI recipients in a tertiary referral center between January 2010 and January 2020 was performed; out of the 35 recipients who were found to have FNS, 29 were included in the study. The control group comprised the same number of randomly selected patients. CT parameters of the patients were measured independently by three fellowship-trained neuro-otologists blinded to the postoperative status of the patients. Thickness in axial and coronal views and density of the bone separating the UBTC and the LSFN were measured.

Results: There was satisfactory agreement between the readings of the three reviewers. The distances (in mm) between the UBTC and LSFN obtained from the coronal (0.43 ± 0.24 vs. 0.63 ± 0.2) and axial (0.42 ± 0.25 vs. 0.6 ± 0.18) views were statistically lower in the FNS group (p = 0.001 and 0.005, respectively). The density (in HU) of the bony partition was also statistically lower in the FNS group (1038 ± 821 vs. 1409 ± 519; p = 0.029).

Conclusion: Patients who experienced FNS postoperatively had significantly lower distance and bone density between the UBTC and the LSFN. This finding can help surgeons in preoperative planning in an attempt to decrease the occurrence of FNS.

Primary Author/Presenter: Isra Aljazeeri, MD

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Learner Objectives:

At the end of this session, participants will be able to recognize the risk of facial nerve stimulation after CI using preoperative CT.
Approach to Cochlear Implantation in Patients with Ventriculoperitoneal Shunts

Robert J. Macielak, MD; A. Morgan Selleck, MD; Armine Kocharyan, MD; Jacob B. Hunter, MD; Ankita Patro, MD; Elizabeth L. Perkins, MD; Christopher A. Hamilton, MD; Neil S. Patel, MD; Richard K. Gurgel, MD; Alexander D. Sweeney, MD; Kevin D. Brown, MD, PhD; Michael J. Link, MD; Matthew L. Carlson, MD

Introduction: Cochlear implants (CIs) and ventriculoperitoneal (VP) shunts share limited space within the head and neck, potentially leading to injury to either device during placement. Furthermore, there is potential for magnetic interaction and subsequent shunt malfunction if a programmable shunt is present, which has prompted a warning from the United States Food and Drug Administration about concurrent use of these devices. Despite this, few studies have evaluated this scenario and its nuances. The goal of the present study was to evaluate the safety and outcomes of CI in a large group of patients with VP shunts to inform clinical practice.

Methods: A multi-institutional historical cohort of patients with VP shunts and CIs was identified at multiple tertiary referral centers and analyzed using descriptive statistics.

Results: A total of 46 patients (median age 8 years [IQR 2-46]) with VP shunts and CI were identified. Of these, 41 (89%) patients had a VP shunt prior to CI. Based on institutional preference and individual patient factors, CI was performed contralateral to a pre-existing VP shunt in 24 of these 41 cases (59%) and ipsilateral in 17 (41%). Furthermore, pre-CI relocation of the VP shunt was performed in 3 cases (7%), and 2 patients (5%) underwent planned revision of their VP shunt concurrent with CI. In total, 2 of 27 pediatric patients (7%) required unanticipated revision shunt surgery, both contralateral to CI device placement, given VP shunt malfunction. One of 19 adult patients (5%) required shunt revision during CI due to shunt damage noted intraoperatively. Among 43 patients with available follow-up, 38 (88%) are regular CI users, with a median CNC word score of 58% (IQR 28-72).

Conclusion: Cochlear implantation can be performed at low risk, either contralateral or ipsilateral to a VP shunt, and does not mandate shunt revision in most cases. Additional considerations regarding CI receiver-stimulator placement are necessary with programmable shunts to mitigate device interaction. Preoperative planning, including coordination of care with neurosurgery, is important to achieving optimal outcomes.

Primary Author/Presenter: Karl Khandalavala, MD

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Learner Objectives:

Identify the important considerations in concurrent cochlear implants and ventriculoperitoneal shunts

Describe techniques to safely perform cochlear implantation with a programmable ventriculoperitoneal shunt
Concurrent Session: Concurrent Session 4-1 "Electrode Design and Surgical Considerations"

Abstract Number: 138

Abstract Title: Combined Transcanal Transmastoid Cochlear Implant Technique for Congenital Malformation of the Mastoid

Abstract Content:
Introduction: Cochlear implants in the setting of congenital malformations of the inner ear continues to be a surgical challenge. CHARGE has multiple temporal bone abnormalities that alter the expected mastoid anatomy, both limiting exposure and increasing the risk of facial nerve injury through the traditional mastoidectomy approach. Multiple other approaches that are transcanal, avoiding the difficult mastoid anatomy, have been described. These approaches have required ear closure or other methods to prevent electrode extrusion. We describe a novel transcanal/transmastoid approach with optimized exposure and traditional placement of the excess electrode array in the mastoid.

Methods: Case report of bilateral simultaneous combined transcanal transmastoid cochlear implantation in patient with CHARGE and anomalous dilated mastoid emissary veins that prevented access to the facial recess with review of literature of transcanal approaches.

Results: We successfully performed simultaneous bilateral cochlear implants via a transcanal/transmastoid approach on a 4-year-old female with CHARGE. She had a progressive hearing loss since birth in left ear and an acute decrease in hearing of the right ear after a head injury resulting in right moderate to profound and left profound sensorineural hearing loss. She had bilateral inner ear malformations, progressive hearing loss in the better ear and cochlear nerve hypoplasia in the poorer ear; thus, we pursued bilateral cochlear implants. Preoperative temporal bone imaging was significant for dilated prominent mastoid emissary veins, dysplasia or absence of the semicircular canals, and a dehiscent facial nerve course across the promontory. The mastoid emissary veins coursed across the mastoid causing significant narrowing of the mastoid and blocking access to the mastoid antrum and facial recess. Intraoperatively we successfully implanted both ears using a very small transmastoid approach without a posterior tympanotomy. The mastoidectomy was constricted by the anomalous mastoid emissary veins and disallowed access to the facial recess. A small antrum was created that allowed exposure of the ossicles and posterior epitympanum. The round window was exposed by elevating the canal skin and tympanic membrane without incisions. The implants were directed through the mastoid under the incus or after removing the incus through the posterior epitympanum. The electrode was directed transcanal into the cochlea through the round window. The electrode array was then stored in the mastoid in the usual manner. This approach limited the risk of electrode exposure that may occur with an open cavity or by drilling a groove for the implant in the posterior canal wall. Preoperative aided audiometric testing showed 44% and 0% right and left word scores, AZ Bio Pediatric Sentences in quiet in the bilateral aided condition were 50%. One month post op audiological follow up showed consistent use and good progression through MAPS. Speech outcomes and possible hearing preservation on the right will be assessed in future follow ups.

Conclusion: The transcanal/transmastoid approach can optimize surgical exposure and allow for storage of the electrical array in the mastoid in the typical fashion. This avoids the poor cosmesis of external ear closure as well as the risk of exposure of the electrical array when left transcanal.

Primary Author/Presenter: Mikayla Huestis, MD

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Learner Objectives:
**CI2023 Dallas: Cochlear Implants in Children and Adults**

Describe the transcanal approach to cochlear implantation and its potential application to congenital malformation cochlear implants.
Abstract Number: 153

Abstract Title: Reducing Fibrosis on Human Cochlear Implant Electrode Materials with Thin Coatings of Zwitterionic Hydrogels in a Long-term Subcutaneous Model

Abstract Content:

Introduction: The foreign body response can seriously hamper the performance of cochlear implants. Fibrosis on the stimulating electrode array causes signal spread and increases battery consumption. Neo-ossification can permanently remodel the cochlea. Local inflammation can cause residual hearing loss on hybrid implants. Approaches to limit the complications of the foreign body are critically needed. To meet this need, we have engineered a thin film made of a zwitterionic hydrogel that can graft onto the surface of cochlear implant electrode arrays via photopolymerization. The thin film has been shown in vitro to reduce adhesion of agents of the foreign body response like fibrinogen, macrophages, and fibroblasts. The purpose of this work is to determine whether the foreign body response, specifically fibrosis, is reduced in vivo on cochlear implant electrode arrays when modified with zwitterionic hydrogel thin films. Methods: Human cochlear implant mid-scalar electrode arrays were prepared with thin film coatings by soaking the surface with a photografting-agent in acetone, dispersing a monomer solution with cross-linker over the surface, and photopolymerizing. After washing and sterilizing, the substrates were implanted subcutaneously in mice for 1 year. Upon removal, implanted electrode arrays were embedded in epoxy, sectioned with a diamond knife, and stained with Toluidine Blue to visualize fibrotic tissue. Results: Zwitterionic thin films on cochlear implants were intact and present after 1 year in vivo. The films demonstrated a potent anti-fibrotic effect on both electrode surfaces and housing surfaces, reducing capsule thickness by 40-65%. Cellular morphology at the interface of uncoated electrodes demonstrated giant cells and thick fibrosis that was largely absent or reduced in coated electrodes. Conclusion: These results demonstrate that zwitterionic thin films can reduce the foreign body response and the associated fibrotic capsule on human cochlear implant electrode arrays and related materials in vivo. Such a reduction in capsule thickness has the potential to improve cochlear implant performance by reducing power consumption and signal spread, while also preventing complications like residual hearing loss and neo-ossification.

Primary Author/Presenter: Ryan R. Horne, MS

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Learner Objectives:

Determine the effect of thin film zwitterionic hydrogels on reducing fibrosis in vivo on human cochlear implant electrode arrays.
**Abstract Number:** 187

**Abstract Title:** Is Characteristic Frequency Limiting Real-Time Electrocochleography During Cochlear Implantation?

**Abstract Content:**

Introduction: Electrocochleography (ECochG) recordings during cochlear implantation have shown promise in estimating impact on residual hearing. Prior studies have exclusively focused on using a single frequency during the insertion with 500-Hz being the most common. When using a single stimulus frequency, a drop in response may be related to (1) electrode-basilar membrane contact resulting in reversible or irreversible intracochlear trauma or (2) advancement of the most-apical electrode beyond the CF place in the cochlea. However, there is no way of determining which of the above causes resulted in a drop in response, making it challenging to provide clinically useful feedback intraoperatively.

Multifrequency ECochG is a technology that has been available recently that allows for simultaneous or alternating stimulus presentation of multiple frequencies for response measurement throughout electrode insertion and has the potential to address some of the limitations regarding a single stimulus frequency. To our knowledge, no prior studies have evaluated multifrequency ECochG as a hearing preservation tool, and only one case report to date has assessed the feasibility of intraoperative multifrequency ECochG. The purpose of the study was (1) to determine whether a 250-Hz stimulus is superior to 500-Hz in detecting residual hearing decrement and if so; (2) to evaluate whether crossing the 500-Hz tonotopic, characteristic frequency (CF) place partly explains the problems experienced using 500-Hz.

Methods: Multifrequency ECochG comprising an alternating, interleaved acoustic complex of 250- and 500-Hz stimuli was used to elicit cochlear microphonics (CMs) during insertion. The largest ECochG drops (≥30% reduction in CM) were identified. After insertion, ECochG responses were measured using the individual electrodes along the array for both 250- and 500-Hz stimuli. Univariate regression was used to predict whether 250- or 500-Hz CM drops explained low-frequency pure tone average (LFPTA; 125-, 250-, 500-Hz) shift at 1-month post-activation. Postoperative CT scans were performed to evaluate cochlear size and angular insertion depth.

Results: For perimodiolar insertions (N=34), there was a stronger linear correlation between largest ECochG drop using 250-Hz stimulus and LFPTA shift (r=0.58), compared to 500-Hz (r=0.31). The 250- and 500-Hz CM insertion tracings showed an amplitude peak at two different locations, with the 500-Hz peak occurring earlier in most cases than the 250-Hz peak, consistent with tonotopicty. When using the entire array for recordings after insertion, maximum 500-Hz response was observed 2-6 electrodes basal to the most-apical electrode in 20 cases (58.9%). For insertions where the apical insertion angle is >350 degrees and the cochlear diameter is <9.5 mm, the maximum 500-Hz ECochG response may occur at the non-apical most electrode. For lateral wall insertions (N=14), the maximum 250- and 500-Hz CM response occurred at the most-apical electrode in all but one case.

Conclusion: Using 250-Hz stimulus for ECochG feedback during implantation is more predictive of hearing preservation than 500-Hz. This is due to the electrode passing the 500-Hz CF during insertion which may be misidentified as intracochlear trauma; this is particularly important in subjects with smaller cochlear diameters and deeper insertions. Multifrequency ECochG can be used to differentiate between trauma and advancement of the apical electrode beyond the CF.

**Primary Author/Presenter:** Amit Walia, MD, MSCI

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**Learner Objectives:**
**CI2023 Dallas: Cochlear Implants in Children and Adults**

Describe the importance of considering characteristic frequency place when using real-time multifrequency electrocochleography for hearing preservation during cochlear implant surgery.

Differentiate whether a 250-Hz stimulus is superior to a 500-Hz stimulus in detecting residual hearing decrement when using real-time electrocochleography for hearing preservation during cochlear implantation.
**Concurrent Session:** Concurrent Session 4-1 "Electrode Design and Surgical Considerations"

**Abstract Number:** 244

**Abstract Title:** Electrode array type or brand does not influence short-term hearing preservation outcomes after cochlear implantation

**Abstract Content:**

Introduction: Preserving residual low-frequency hearing following a cochlear implant (CI) can result in improvements in hearing outcomes, particularly if an acoustic component is combined with the CI, compared to outcomes achieved with a CI alone. However, there is uncertainty as to whether certain types or brands of electrode arrays will provide better hearing preservation outcomes. By comparing hearing preservation outcomes among different electrode types and brands we can help clinicians and surgeons better determine what CI to provide to candidates. Therefore, the following study aimed to assess the hearing preservation outcomes of adult CI recipients that received a perimodiolar or straight electrode array from two leading brands (Cochlear, Med-El). Methods: Participants included 283 adults consecutively implanted, between January 2017 and April 2022, with either a perimodiolar (CI532 or CI632) or straight (CI522, CI622, Synchrony, or Synchrony 2) electrode array from one of two leading CI brands (Cochlear & Med-El) at a large Western Australian implant clinic. Participants’ pure tone audiograms were obtained retrospectively from clinical records at three time points; pre-operatively, and at 3 months (n=195) and 6 months (n=137) post-operatively. Low-frequency average hearing loss (LFAHL) was determined by averaging hearing threshold levels at 250Hz and 500Hz frequencies. Functional low frequency hearing was considered as ≤70 dB LFAHL (3 months: n=113, 6 months: n=83). Results: For individuals with pre-operative functional LFAHL, absolute change in LFAHL from pre-operatively to 3 months post-operative levels was similar between electrode type (Straight: 27.7±18.1 dB, Perimodiolar: 24.3 ±16.9 dB, p>0.05), electrode brand (Cochlear: 24.1±17.1 dB, Med-El: 28.8±17.9 dB, p>0.05) and specific electrode type/brand (Cochlear Perimodiolar: 24.3±16.9 dB, Med-El straight: 28.8±17.9 dB, p>0.05). These results remained similar at 6 months post operation for electrode type (Straight: 27.9±16.8 dB, Perimodiolar: 22.2±14.8, p>0.05), electrode brand (Cochlear: 25.7±18.2, Med-El: 25.9±14.4, p>0.05) and specific electrode type/brand (Cochlear Perimodiolar: 22.2±14.8 dB, Med-El straight: 25.9±14.4 dB, p>0.05). Age at implantation was a weak predictor of LFAHL at 3 months (r=0.25, p<0.05) and 6 months (r=0.39, p<0.05). Pre-operative LFAHL and surgeon were not predictors of LFAHL change (p>0.05). Conclusion: For our cohort, these results indicate that within 6 months post-operation, change in LFAHL is independent of electrode array type or brand. Factors outside of electrode type and brand, such as age at implantation, may provide better indicators of the change in LFAHL following cochlear implantation.

**Primary Author/Presenter:** Cathy Sucher, AuD

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**Learner Objectives:**

Understand factors that influence hearing preservation following cochlear implantation
Concurrent Session: Concurrent Session 4-1 "Electrode Design and Surgical Considerations"

Abstract Number: 253

Abstract Title: Dexamethasone-Eluting Cochlear Implant Electrode: Final Results of the CIDEXEL- Study

Abstract Content:
Introduction: Despite atraumatic electrodes, optimized insertion technique and established systemic and local steroid administration-strategies, the electrode insertion trauma in the course of cochlear implantation leads to growth of scar tissue around the electrode, destruction of neuronal structures and loss of residual hearing. Local prolonged immunosuppressive pharmacotherapy via the electrode carrier itself could be a game-changer in this context and improve the performance of patients, especially those with EAS, in the near future.

Methods: A total of 9 patients were implanted with a dexamethasone - eluting cochlea implant electrode and then followed up over the postoperative course, the first fitting and for 9 months afterwards (n=8). The primary objective of this study was to investigate the safety profile through the analysis of adverse events. Furthermore, electrode impedances, unaided pre- and post-op pure tone audiograms, speech intelligibility in noise and the surgeon's subjective feedback were evaluated.

Results: Handling and insertion properties were considered almost identical compared to non-eluting electrodes of the same manufacturer by experienced surgeons. No device or procedure-related serious adverse events occurred throughout the complete follow-up period. Final results show remarkable low and stable impedance values across all areas of the electrode (basal, medial and apical). Very good preservation of residual hearing (≤15 dB hearing loss) was achieved in the majority of patients.

Conclusion: The use of the new dexamethasone - eluting electrode was safe and led to considerably lower impedances and better hearing preservation compared to patients with a standard electrode. This may have been achieved by successfully mitigating the immunological insertion trauma and by suppressing the intracochlear foreign body reaction.

Primary Author/Presenter: Nils Prenzler, MD

Author Block: Nils K. Prenzler, PD Dr. med., Rolf B. Salcher, Dr. med., Daniel Kley, M. Sc., Thomas Lenarz, Prof. Prof. h.c. Dr. med.; ENT, Hannover Med. Sch., Hannover, Germany.

Learner Objectives:
Explain the intention behind local immunosuppressive pharmacotherapy in the course of cochlear implantation.
Concurrent Session: Concurrent Session 4-1 "Electrode Design and Surgical Considerations"

Abstract Number: 255

Abstract Title: The Concept of Individualized Cochlear Implantation

Abstract Content:
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. Important factors to take into account are hearing preservation - using adequate atraumatic electrode arrays - and optimal cochlear coverage for electric stimulation.

Methods: The concept of individualized cochlear implantation was developed based on the clinical experience and data of the over 1000 patients treated with flexible electrodes of different length in our clinic. For patients with no functional residual hearing the concept aims for an optimal cochlear coverage. Speech perception data sets (n=154) of patients treated with flexible electrode of different length (16 mm -31mm) were analyzed to find the optimal coverage range. For patients with residual hearing aiming for EAS the concept of partial insertion was developed: A long electrode is partially inserted to provide sufficient electrical stimulation for hearing restoration in the high and mid frequencies while optimizing the hearing preservation for the low frequencies. In total, n=85 patients were treated with a partial insertion. Hearing preservation and speech outcomes were examined between first fitting and 2 years post activation. N=24 patients were treated with an individualized partial insertion, where the insertion depth was selected based on the individual amount and slope of residual hearing of the patients.

Results: The best benefit with the CI in ES-only mode was found for patients with a cochlear coverage of 79-82%. For patients treated with partial insertion the median hearing loss at first activation was 16 dB (n=74) and 15 dB (n=22) 2 years post activation. The majority of patients (n=60) use their preserved residual hearing for EAS and achieved in median 80% in HSM sentence in noise at 12 months. n=13 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: Taking cochlear geometry and the amount of residual hearing into account, an optimal cochlear coverage, good hearing preservation results and individual outcomes using ES or EAS can be achieved. If hearing loss 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 such as drug eluting electrodes. Furthermore, this approach could allow for an indication extension towards patients with more residual hearing e.g. older patients suffering from presbyacusis.

Primary Author/Presenter: Thomas Lenarz, MD, PhD

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Learner Objectives:

Explain the concept of individualized cochlear implantation based on the anatomy and amount of residual of a specific patient.
Abstract Content:

Introduction: In 1996, and in the revision of 2011, separate committees identified sets of materials, herein called Minimum Speech Test Battery-1 (MSTB-1) and MSTB-2, to be used clinically and in research studies to assess candidacy and the performance of adults with cochlear implants (CI). A decade later, and following changes in test materials and candidacy criteria, a new committee formed to revise the MSTB-2 to reduce uncertainty and variability in CI candidacy evaluation and outcomes for a diverse group of candidates, herein called MSTB-3. A test battery was developed with a breadth and scope of content for clinics as they evaluate not only traditional unilateral and bilateral candidates, but also candidates with Single Sided Deafness (SSD), Asymmetrical Hearing Loss (AHL) and candidates with the potential to benefit from Bimodal hearing and Electric Acoustic Stimulation (EAS). The battery includes pre- and post-operative speech test batteries in addition to interpretive definitions (e.g., best aided), functional questionnaires, cognitive screening recommendations, documentation templates, and calibration instructions. Methods: The project was overseen by two co-chairs and 12 content experts to develop streamlined test batteries for adult CI patient populations that would be widely and consistently used among CI audiologists for pre-operative determination of candidacy and postoperative assessment of adult CI users. Content experts performed a rigorous of the literature and evidence related to their assigned content area to develop evidence- and experience-based protocols and test recommendations. As part of the two-round consensus process, Likert statements regarding testing protocols were developed by content experts. A rigorous iterative process to protect against bias and undue influence was implemented through an anonymized e-survey of Likert statements. Consensus on round one Likert statements was established for the purpose of further deliberation if: 1) mean score of each statement was 7 or higher; and 2) there were fewer than two outlying ratings (< 2 points below the mean). Following round one, written comments and a web-based conference discussion was utilized to establish agreements, reduce eventual disagreements, and allow content experts to refine their Likert statements at their discretion. Final consensus was determined by a Round 2 anonymized e-survey of Likert statements. Results: Final protocols and test materials will be discussed and described. These included test materials, listening conditions, presentation level, and calibration. Conclusion: The MSTB-3 incorporates current best-practice metrics for a standardized minimum battery of tests used for CI candidacy and recommended follow-up.

Primary Author/Presenter: Camille Dunn, PhD

Author Block: Camille Dunn, PhD, Terry Zwolan, PhD; Otolaryngology, Univ. of Iowa, Iowa City, IA, Cochlear Americas, Lone Tree, CO.

Learner Objectives:

Understand the revisions to the Minimal Speech Test Battery and incorporate them into their clinical mode.
Abstract Content:

Introduction: Traditional sound booth testing has been used for decades to establish and monitor cochlear implant users’ speech perception abilities. Recent studies have explored the use of direct audio input (DAI) or digital audio streaming (DAS) as methods for administering speech perception testing outside of the test booth; however, limited data exist on the feasibility and utility of these methods in the pediatric population. The purpose of this study was to evaluate the feasibility and replicability of completing DAS speech perception testing in the pediatric population using a proprietary application. Understanding whether self-administered DAS testing is feasible in this population will potentially lead to clinical application of these test measures during and between clinical appointments.

Methods: Ten children (ages 8-15 years) with cochlear implants were recruited for this study. Speech perception testing was completed in the sound booth using the Pediatric Az-Bio Sentences in Noise and the BKN-SIN tests per typical clinical protocol, and additional measures were completed using the Digits in Noise and Oldenburg Modified American English Matrix Test via a self-administered application on an iPad. Participants also completed subjective measures of usability of the self-administered application with questions focusing on ease of use and comparisons of experiencing speech perception testing in the sound booth versus via DAS.

Results: All ten participants were able to perform speech perception testing in the sound booth and using the self-administered application. Results from the Digits in Noise and Matrix tests revealed performance via the application was replicable. Participants in the study reported favorable ease of use of the proprietary application with limited help needed from study staff and/or parents.

Conclusion: Speech perception testing via self-administered DAS is feasible in the pediatric population. Although DAS testing may not replace traditional sound booth testing given differences in stimulus effects via DAS versus sound booth acoustics, self-administered, wireless speech perception testing via an application may be used in a number of ways to streamline clinical monitoring. With additional research, DAS testing may provide a viable way to reduce in-clinic time by troubleshooting suspected perceptual changes remotely or by streamlining in-clinic appointments to one programming room for all programming and progress monitoring measures.

Learner Objectives:

Examine outcomes of cochlear implant users assessed via self-administered speech perception tasks.

Describe the clinical implications and use of a home-based, self-administered speech perception task.
Introduc��on: According to CDC 2019 data, in the US nearly 30% of babies who fail the newborn hearing screening are lost to follow-up or documentation. These delays mean babies with hearing loss are not getting the support they need, limiting their overall potential to reach positive outcomes. Research was conducted to understand the level of awareness of NBHS and follow-up with parents. Families with babies who had failed the NBHS were surveyed to understand their experience and identify risk indicators. Awareness of the NBHS prior to delivery is correlated with higher rates of follow-up, but many had never heard of the NBHS until the results were shared in the hospital. As a result, parents underestimate the importance and urgency of follow-up. However, when parents were made aware of the importance of hearing for brain development, their sense of urgency to follow-up increased. Methods: <i>Starts Hear </i> was created as a public health awareness campaign to educate expectant parents in the United States about the NBHS and next steps should their newborn fail. The campaign emphasizes the following key messages: 1) Hearing is critical to your baby’s brain development and builds a foundation for learning, spoken language and literacy, 2) Because of the importance of hearing, your baby will have a hearing screening at birth, and 3) 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, paid 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: The Starts Hear campaign was piloted for 10 weeks in 4 cities in 2020 and the campaign launched in the US on February 17, 2021. Results for year one: Campaign ads were shown 228.1 million times, with 24.7 million campaign video views. Videos averaging 15 and 30 seconds were watched on YouTube for 20,395 hours. 1.3 million emails were sent to expectant and new moms sharing valuable information on newborn hearing screening and newborn hearing health, and 14,450 moms shared the results of their baby’s screening. The Starts Hear campaign has continued through 2022 and is ongoing. Year two results will be reported in this presenta��on. Conclusion: Approximately 3.6 million babies were born in the United States in 2020. The Starts Hear campaign has delivered over 228.1 million impressions to expectant mothers in the first year 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. A key insight uncovered during year one of the campaign is that new moms are more likely to engage with campaign messages closer to giving birth and in the first 4-8 weeks after. For the second year, the campaign was optimized by including targeted messages during week 7 after birth. Campaign performance data will be used to determine the continuation of the campaign in 2024 and beyond.

Primary Author/Presenter: Teresa Caraway, PhD, CCC-SLP, LSLS Cert. AVT

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Learner Objectives:
CI2023 Dallas: Cochlear Implants in Children and Adults

Explain the importance of learning directly from consumers regarding the barriers to hearing healthcare.

Describe the strategy and rationale of raising awareness of hearing health with expectant parents as a driver to timely access to hearing technology.
Abstract Number: 121

Abstract Title: Comparison of virtual and 'real' sound booth speech perception test methodologies.

Abstract Content:
Introduction: Physical booth space is shared between several audiologists in our clinic. Sharing of our test booth often requires a change to the standard, cochlear implant appointment workflow, including when testing is completed during an appointment, and how much testing is completed during an appointment. Testing in a virtual sound booth could alleviate the space problems our clinic faces. This research compares speech perception tests via a simulated virtual sound booth (VSB) environment through digital audio streaming with a physical sound booth (SB) in a clinic. Methods: 14 adult cochlear implant recipients tested. Materials: AzBio Quiet (1 list per condition); AzBio in Noise (1 list per condition); CNC (1 list per condition); Location: a sound booth in a hospital based cochlear implant clinic; Test Comparisons: VSB vs SB; The virtual sound booth acoustic environment was simulated based on a reference sound booth measure. Results: Results suggest that speech scores obtained via the VSB environment correlate with the actual clinic SB results (r square of 0.58, 0.75 and 0.75 respectively), and the group averages match (AzBio Quiet: 74.3 ± 22.2 (Mean, SD) vs 72.5 ± 22.2; AzBio Noise: 38.3 ± 24.0 vs 32.7 ± 24.4; CNC: 56.4 ± 21.8 vs 54.1 ± 19.1); There are no significant differences between VSB and SB test methodology (2-factor repeated ANOVA test, F = 1.76, p = 0.21), and no significant interactions between methodology and speech material (F = 0.42, p = 0.66). There are score differences per individual subject basis (> 15 percentage points difference for 6 out of 14 for AzBio in Quiet, 3 out of 14 for AzBio in Noise, and 4 out of 14 for CNC words). These differences could result from 1) microphone status of the subject’s sound processor; 2) differences between the physical sound booth and the simulated virtual sound booth; and 3) other factors, e.g. tested at different times day, fatigue, different scoring clinician. Conclusion: No significant differences found between VSB and SB test methodologies suggests that VSB and, specifically, testing via digital audio streaming, could be a viable alternative test method to evaluate CI recipient speech performance.

Primary Author/Presenter: Dawn Marsiglia, AuD


Learner Objectives:
compare virtual and real sound booth test results.
identify a benefit of virtual sound booth testing.
Abstract Number: 162

Abstract Title: Implementing multi-rate excitation in cochlear implants using time-varying electrode stimulation with CCI-MOBILE: an open source research platform

Abstract Content:

Introduction: According to certain studies, the spectral resolution can be improved by decreasing the spacing of electrodes in the Cochlear implant (CI) array, but restrictions from the FDA and manufacturers question the feasibility of that approach. To find a roundabout, previous research suggests that using time-varying stimulation rates in the speech processing algorithms could potentially provide additional usable information like fundamental frequency and fine-tuning information, to listeners for quiet conditions as compared to the fixed-rate algorithms.

Methods: In this work we present and demonstrate a safe method of variably stimulating the CI electrode array using the CCI-MOBILE research platform. CCI-MOBILE is an open-source CI research platform that allows researchers to implement and test novel implant strategies while improving and fine-tuning them through feedback from subjective studies. The main approach of work involves implementing 2 stimulation rates simultaneously such that one stimulation rate is 1/10 of the other stimulation rate. This difference in stimulation rates prevents over-stimulation of adjacent electrodes. The aim of this coding strategy is to focus on the varying spectral densities in conversational speech. The algorithm is designed such that, spectral maximas located towards the higher end of the band, activates the higher stimulation rate while the lower stimulation rate is activated when the spectral energy is denser at the lower frequency band.

Results: The objective results prove that increasing the stimulation rate on a single electrode monotonically increases pitch percept up to approximately 300-500 pulses per second. The validation and verification of the strategy implemented on the CCI-MOBILE has been discussed through offline processing of the Advanced Combination Encoder strategy and electrogram generation. Oscilloscope results showing different stimulation rates on the selected channels confirm the output streaming of the RF coils.

Conclusion: Multi-rate capabilities will significantly help researchers explore vast stimulation options for speech understanding - targeting high information spectral bands with more meaningful stimulation content to support better voice modulation perception by CI users.

Primary Author/Presenter: Ria Ghosh, PhD

Author Block: Ria Ghosh, Ph.D , John H. L. Hansen, Ph.D ; Computer Engineering, Univ. of Texas at Dallas, Richardson, TX, Electrical and Computer Engineering, Univ. of Texas at Dallas, Richardson, TX.

Learner Objectives:

Implement and verify a novel sound coding strategy involving multi-rate stimulation of the cochlear implant electrode array to improve pitch perception in users.

Use CCI-MOBILE, a custom-made portable algorithm testing device as an open-source platform to validate and fine tune algorithms or coding strategies real-time in naturalistic environments.
**Concurrent Session**: Concurrent Session 4-2 "Updates in Assessment Tools and Telehealth"

**Abstract Number**: 276

**Abstract Title**: Cochlear-Implant Telehealth: Remote Programming and Simulated Sound-Field Testing for Patients at Home

**Abstract Content**:

Introduction: Many cochlear implant (CI) patients live far from a tertiary-care medical center, which can impede necessary treatment and potential outcomes due to delayed care. Our facility created a telehealth option to fill this need. Our goal was for standard-of-care device programming and sound-field testing to be available to patients in their homes. CI programming and sound-field testing are completed virtually using a laptop with calibrated headphones, which are handed to the patient during a clinic visit or mailed. The purposes of this study were (1) to evaluate whether the telehealth system provided comparable results to in-clinic sound-field testing, and (2) to evaluate patient satisfaction with the system for CI follow-up visits. This project was awarded a Telemedicine and Advanced Technology Research Center (TATRC) grant through the United States Army Medical Research and Development Command (USAMRDC).

Methods: The telehealth laptop includes software for: (1) remote desktop control, (2) commercial CI programming, and (3) aided-threshold and speech testing, and the following hardware: (1) commercial programming cables, (2) an external sound card, and (3) circumaural headphones placed over a behind-the-ear (BTE) sound processor. Stimuli were created from recordings using a BTE microphone attached to a CI sound processor on an acoustic mannequin. Warble tones were recorded from the audiometer loudspeaker. Speech stimuli from a standard compact disc were filtered using virtual-audio techniques based on impulse-response recordings. To verify that the same spectrum and levels are produced for headphones placed over the sound processor as for the sound field, the mannequin sound processor coil was connected to an internal “cochlear implant in a box” with a resistive load to simulate the cochlea, and the resulting electrical stimulation levels measured. Detection thresholds and speech perception scores were compared in 9 CI users tested with the telehealth system in a simulated remote environment (hospital office) and in the sound-field via an audiometer in a clinic booth. Then, the system was deployed for at-home follow-up appointments. Three (of 10 planned) patients completed telehealth visits and completed surveys to evaluate their satisfaction. Although the system is designed for any CI patient, these initial study participants were single-sided deafness CI users, chosen to facilitate easier on-line verbal communication.

Results: For the audiogram, the across-subject mean absolute differences between the telehealth and sound-field systems were 4-6 dB for all frequencies between 250-6000 Hz. For speech tests, mean absolute differences were 4 (CNC words) or 6 percentage points (AzBio sentences). At-home telehealth participants expressed high satisfaction levels and appreciated the ability to have continuity of care despite geographic barriers.

Conclusion: The telehealth headphone system yields equivalent results to standard sound-field tests. Telehealth can replace the main components of an in-person clinic visit and is a viable option for follow-up care for patients who live far from the CI clinic.

**Primary Author/Presenter**: Elicia Pillion, AuD

**Author Block**: Elicia M. Pillion, Au.D, Anthony M. Tolisano, MD, Joshua G. W. Bernstein, Ph.D; Department of Surgery, Walter Reed NMMC, Bethesda, MD.

**Learner Objectives**:

Understand the technical considerations involved in simulating sound-field testing over headphones

Describe the individual components of a cochlear-implant clinical visit that can be replaced with a telehealth alternative
Concurrent Session: Concurrent Session 4-2 "Updates in Assessment Tools and Telehealth"

Abstract Number: 301

Abstract Title: Comparative analysis of children and adults with new assessment tool

Abstract Content:

Introduction: To assess and validate the results of auditory capacity and performance found in cochlear implant users, pure tone audiometry (PTA) and speech recognition tests are conventionally performed in a sound booth (SB). To carry out these tests, it is necessary to have high-quality loudspeakers in a free field, a room with minimal background noise, to reduce external influences on the test results. Cochlear Corporation launched a new CI assessment tool, called CLABOX, used with the DAI connection to assess PTA and speech recognition tests.

Methods: Fifty individuals (33 adults and 17 children) participated in the study, with children aged between 8 and 13 years. All participants underwent PTA assessments and Speech in Noise Recognition (Hearing in Noise test - HINT) in two moments, one with SB and the other with the CLABOX tool.

Results: The results were not statistically significant in the evaluations of the tests with the PTA and of speech perception in noise (HINT) using the CLABOX and SB assessments, between the group of children and adults.

Conclusion: The CLABOX tool presented a new possibility of assessment in the PTA and speech recognition tests, both in adults and in children, compared to the conventional assessment in SB.

Primary Author/Presenter: Fernanda Ferreira Caldas, Au, MSc, PhD

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Learner Objectives:

To analyze pure tone audiometry (PTA) and speech perception tests among children and adults with cochlear implant (CI) in a sound booth (SB) and CLABOX with direct audio input (DAI).
**Abstract Number:** 315

**Abstract Title:** Using aided word-recognition testing post-hearing aid fitting to identify hidden cochlear implant candidates

**Abstract Content:**

Introduction: Hearing aids (HA) are the first line intervention for patients with hearing loss. For HA fittings, the best practice protocol is defined as objective verification and subjective validation. While such measures are important, they fail to ascertain whether HAs have objectively improved speech perception ability; the primary goal for most HA users. Instead, audiologists often use PB max (phonetically balanced maximum) to predict aided word recognition scores (A-WRS) despite these metrics being poorly correlated. The difference between the PB max score and the A-WRS is referred to as SP Gap (speech perception gap). Not only does aided speech perception testing objectively validate speech understanding benefit from hearing aids this technique also identifies hidden cochlear implant candidates that may otherwise be missed as they do not meet typical cochlear implant (CI) referral criteria.

Methods: A retrospective review of clinical data included 501 ears with both PB max and A-WRS completed. PB max was obtained using recorded 50-word CNC lists at a presentation level of uncomfortable level minus 5 dBHL. Aided word recognition scores were obtained using recorded 50-word CNC lists at a presentation level of 60 dBA via sound-field speaker. Patients were fit with hearing aids that were objectively verified and fit to NAL-NL2 targets. The SP gap (PB max minus A-WRS) was calculated for each patient. A significant SP gap was defined as a difference of ≥20%.

Results: Between April 27, 2017 and October 14, 2022, 501 adult patient-ears had both PB-max and A-WRS data available for review. Average PB max was 59% and average A-WRS was 55%. A significant SP gap (≥20%) was present in 18% of ears with an average SP Gap of 32%. Patients with PB max scores between 41-80% were at the highest risk with 33% of ears identified with a significant SP gap. In regards to patients, 38% scored ≤60% PB max in the better hearing ear and thus would be typically referred for a CI candidacy evaluation. Sixty-two percent of patients scored >60% PB max in their better hearing ear, however, once aided speech testing was obtained 20% of this group demonstrated a significant SP gap that resulted in A-WRS of ≤60% indicating possible CI candidacy.

Conclusion: The primary goal of HA wearers is improved speech intelligibility but speech perception with HAs in place is rarely assessed outside of CI candidacy evaluations. Aided word recognition testing should be performed on all patients fitted with hearing aids whose PB max score is 60-80% as this group is at highest risk for speech perception gaps. Additionally, 42% of such patients may actually qualify for cochlear implants and this protocol allows for earlier identification and improved access to such technology.

**Primary Author/Presenter:** Mary Rose Goldstein, AuD

**Author Block:** Mary Rose Goldstein, Doctor of Audiology, Stephanie Bourn, Au.D., Alissa Knickerbocker, Au.D., Abraham Jacob, MD; Ctr. for Neurosciences, Tucson, AZ.

**Learner Objectives:**

1. Identify hidden cochlear implant candidates by performing aided word recognition testing post-hearing aid fitting.
2. Describe the most at-risk group for hidden cochlear implant candidacy.
**Abstract Content:**

Introduction: In many states, the utility of universal screening for congenital cytomegalovirus (cCMV) is being discussed. In 2021, the Minnesota legislature passed a law known as the “Vivian Act” (SF1698). The Vivian Act directs the Minnesota Department of Health (MDH) to raise awareness as well as provide education and outreach regarding cCMV to health care providers, women who may become pregnant, expectant parents, and parents of infants. In addition, the Vivian Act established a pathway (including funding), pending review by the Minnesota Newborn Screening Advisory Committee, to add cCMV to the panel of universal newborn screening tests provided for babies born in Minnesota via dried blood spot testing (DBS). Following the committee’s thorough review process, it was recommended that cCMV be added to the newborn screening panel, and in February 2022, the Minnesota Health Commissioner approved this addition to the panel, paving the way for Minnesota to become the first state in the US to screen every newborn for cCMV. Ohio stakeholders are actively working together to achieve a similar goal of universal screening.

**Methods:** Panel presentation and discussion regarding the pros and cons of universal cCMV screening will be given. A review of testing options including DBS will be covered. Further discussion will include the process, challenges and choices when considering universal cCMV screening.

**Results:** A panel of professionals from 2 different states will review the different possible avenues for instituting universal screening for cCMV, and compare and contrast the experiences of these states (Minnesota and Ohio).

**Conclusion:** Although the Recommended Uniform Screening Panel does not recommend universal cCMV screening, addition of this test to the newborn screening panel is likely on the horizon for many states. Some controversies, and many uncertainties, remain. One state, Minnesota, has successfully instituted universal screening through legislative mandate, but there are other avenues that states may choose to pursue to reach this goal. Consideration of the pros and cons of universal cCMV screening is important for all practicing audiologists and ENT physicians, as well as all stakeholders who are involved in the care of children.

**Primary Author/Presenter:** Abby C. Meyer, MD, MPH

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**Learner Objectives:**

Identify the different testing options for congenital cytomegalovirus.

Discuss the important considerations of universal screening for congenital cytomegalovirus.
Progression Through the Pediatric Minimum Speech Test Battery- A Look at Pediatric Cochlear Implant and Hearing Aid Users with Genetic Hearing Loss and Comorbid Conditions

Introduction: The Pediatric Minimum Speech Test Battery (PMSTB) is a standardized pediatric protocol for monitoring a child’s auditory progress via speech discrimination, word and sentence recognition in quiet, and sentence recognition in noise (Uhler et al., 2017). Each measure in the test battery reports an expected age range that may or may not correspond to the chronologic age or listening age (duration of device experience) of children who are deaf/hard of hearing (DHH). The disconnect from chronologic and listening age is exacerbated in children with comorbid conditions, who comprise 30-40% of pediatric cochlear implant (CI) users. Traditionally, clinicians rely on objective measures and parent report to guide knowledge of audiologic progress because children who are DHH with comorbidities historically show poorer outcomes, greater variability, and less predictability in their auditory, speech, and language outcomes (Cejas et al., 2015; Corrales & Oghalai, 2013). It is unclear how children with comorbidities attain auditory skills after device fitting. This study uses retrospectively collected clinical data as a first attempt to track the progress of children who are DHH with genetic or comorbid conditions through the PMSTB protocol.

Methods: Data collection is ongoing, but the sample currently includes 28 children who are DHH using hearing technology with either genetic etiology (e.g., Connexin 26) or comorbid conditions (e.g., congenital cytomegalovirus, auditory neuropathy, autism, various syndromes). Of the current sample, 8 use at least 1 hearing aid (HA) and 19 use at least 1 CI. Most participants were identified at birth, received the first HA by 8 months (range 5-40 months) and first CI by 15 months (range 11-47 months). The PMSTB includes a hierarchical test battery that includes parent report measures, a speech discrimination task, and closed- and open-set speech recognition measures.

Results: Children with genetic hearing loss outperformed children with comorbid conditions, with 80% achieving open-set and the remaining 20% attempting closed-set speech recognition tasks by 3-6 years of age and 1-4 years device experience. Seven children with comorbidities achieved closed-set speech recognition by 3-6 years of age and 2-3 years of device experience. The remaining 16 participants could not complete behavioral testing so measures of auditory progress relied on parent report measures.

Conclusion: Preliminary results show vast variability in auditory skills and speech recognition outcomes in children who are DHH. Children with genetic hearing loss were the only participants who attained age-appropriate auditory skills. Some children who are DHH with comorbidities could complete behavioral testing but required longer durations of device experience compared to the group with Connexin 26. Results support the need to analyze developmental trajectories differently based on etiology of hearing loss and presence of comorbidities.

Primary Author/Presenter: Sarah Crow, BS

Author Block: Sarah Crow, B.S , Andrea Warner-Cyz, PhD , Kim Fiorentino, AuD , Shari Kwon, AuD , Stephanie Williams, AuD , Amanda Frost, AuD , Amanda Frost, AuD ; The Univ. of Texas at Dallas, Dallas, TX, Callier Ctr. for Communication Disorders, Dallas, TX.

Learner Objectives:
Discuss outcomes of children with genetic hearing loss and comorbid conditions on the Pediatric Minimum Speech Test Battery

Explain reasons why children with comorbid conditions progress slower on speech recognition tasks
Abstract Content:

Introduction: One per every 200 children is born with congenital Cytomegalovirus (cCMV) in the United States, making it the most common congenital viral infection affecting newborns. CMV can be easily transmitted to an unborn child by a pregnant mother experiencing a CMV infection. Hearing loss is just one of the conditions commonly caused by congenital CMV; however, in many states it is a key factor in the early identification of the condition. There is significant variety in how states educate expectant mothers and conduct screenings for this common infection. The range in mandates spans from requiring education about CMV on a public-access website to mandated universal newborn screening. This significant variation makes consistent clinical care challenging, especially for institutions that operate in a region such as the Mid-Atlantic.

Methods: After several years, and many grassroots attempts to better identify cases of cCMV, a team of professionals joined together to benefit from diverse knowledge, past experiences, and differing resources. A Mid-Atlantic CMV Consortium has begun to take shape. This team of diverse professionals aimed to engage government institutions, hospitals, birth centers, the National CMV Foundation, American Cochlear Implant Alliance, Early Hearing Detection and Intervention programs. Meetings were established with multiple stakeholders; parents, physicians, audiologists, and government relations professionals from Delaware, Maryland, New Jersey, Pennsylvania, and Washington DC to share ideas and develop goals.

Results: The organization of multiple professionals into a Mid-Atlantic CMV Consortium has resulted in improved collaboration and communication, discussion of pathways for successful identification using dried blood spot testing, offering public education and awareness, and the drafting of legislation for consideration at the next Delaware state session by modeling legislation from other states that successfully passed CMV related bills.

Conclusion: A diverse group of professionals with shared goals, but different resources and background, can move an agenda farther and faster than any one group alone. Making change requires dedicated individuals who bring varied perspectives to the table. Our experience in attempting to move this forward with only our in-house team was not successful as compared to the move achieved since the consortium was developed. The work of the consortium is not yet complete. The current focus is comprehensive legislation for the state of Delaware with the goal of mandated education for women of childbearing age, expectant mothers, and professions. Additionally, language is being drafted for universal newborn screening for cCMV to ensure that the newborn screening being conducted in DE is inclusive of physiologic, genetic, and cytomegalovirus testing. Experiences and lessons learned during this process will be shared during the presentation.

Primary Author/Presenter: Yell Inverso, AuD, PhD

Author Block: Julie M. Verhoff, AuD, PhD, CCC-A, Yell Inverso, AuD, PhD, William Parkes, MD; Audiology, Nemours Children’s Health, Delaware, Wilmington, DE.

Learner Objectives:

Identify if a state has CMV legislation.

Identify the differences between a polymerase-chain-reaction (PCR) test and a dried blood spot (DBS) for testing.
Abstract Content:

Introduction: The cochlear implant (CI) has proven to be a remarkably successful treatment for patients with severe-to-profound sensorineural hearing loss, however outcome variance is still wide, and a significant number of CI recipients struggle to understand speech. The goal of this study was to determine the relationship between genetic variants in the sensory partition (organ of Corti and synapse) and the neural partition (spiral ganglion) with CI performance. We hypothesized that performance on standardized measures of speech perception tests would be poorer for CI recipients who carry deleterious genetic variants in the neural partition as compared to CI recipients who carry deleterious genetic variants in the sensory partition.

Methods: Blood samples collected from study participants meeting inclusion criteria were tested for a novel panel of genetic variants looking at 54 genes of interest with high-throughput sequencing. AzBio sentence, Consonant-vowel-Nucleus-Consonant, and Hearing-in-Noise tests were measured for speech understanding pre-operatively and at 3, 6, and 12 months post-operatively.

Results: Thirty-six cochlear implant patients have now undergone genetic testing and speech understanding measurements. Of the 54 genes that were interrogated, four patients (11%) demonstrated a pathogenic mutation in the neural partition (within the CABP2 and TMPRSS3 genes) and three patients (8%) demonstrated a pathogenic mutation in the sensory partition (within the PTPRQ, OTOGL, and LOXHD1 genes). In addition, 1 patient (3%) had an isolated neural partition variance of unknown significance (VUS), 11 patients (30%) had an isolated sensory partition VUS, 5 patients (14%) had a variant in both neural and sensory partition, and 12 patients (32%) had no mutation or variant identified. There was no statistical difference when comparing outcomes between patients with pathogenic mutations in the neural or sensory partitions, or when comparing outcomes between patients with neural pathogenic variant mutations and patients without neural pathogenic variant mutations (P value > 0.05).

Conclusion: The impact of genetic mutations on post-operative outcomes in cochlear implant patients is heterogeneous. Although CABP2 and TMPRSS3 are associated with the neural partition, the specific mutations identified did not translate to worse cochlear implant performance. Previous literature demonstrates the role of genetic testing as a non-invasive measure of spiral ganglion health. Our results highlight the importance of further research to determine exact mutations within target genes that provide reliable prognostic utility.

Primary Author/P presenter: Justin Cotrell, MD

Author Block: Justin Cotrell, MD, Lianna Kyriakopoulou, PhD, Talia Silver, MSc, Peter Dixon, MD, Joseph Chen, MD FRCSC, Vincent Lin, MD FRCSC, Andrew Dimitrijevic, PhD, Trung N. Le, MD PhD FRCSC; Otolaryngology Head & Neck Surgery, Univ. of Toronto, Toronto, Canada.

Learner Objectives:

At the end of the session, participants will be able to describe different potential genes implicated in non-syndromic hearing loss.

At the end of the session, participants will be able to discuss the role of genetic testing in cochlear implant performance.
Abstract Number: 201

Abstract Title: Is Cochlear Implant Performance in Children Deafened by Congenital Cytomegalovirus due to Cognitive Impairment?

Abstract Content:

Introduction: Many studies conclude that children with congenital cytomegalovirus (cCMV) have worse cochlear implant (CI) performance compared to non-cCMV children and that this performance can be attributed to central nervous system abnormalities. With the advent of early CMV testing and screening approaches, more children are being identified. A major question is whether central nervous system abnormalities are responsible for CI outcomes in these children. The objective of this presentation is to evaluate the current literature from published studies and from our recent research on the current state of speech outcomes in this patient group. Methods: Systematic review of pediatric CI performance and speech and language outcomes from the literature and from a large statewide database of cCMV children. We will present speech and language outcomes from over 40 children with and without cCMV and SNHL. Results: Fifteen studies were evaluated for the systematic review. Ten of 15 studies reported worse performance after CI in cCMV infected children compared to those without cCMV. Worse performance was attributed to cognitive impairment. However, we performed a cross-sectional study examining the speech and language outcomes of cCMV positive and negative children with and without hearing loss. We found that hearing loss and not the cCMV status is the major driver for speech and language delay. Seven (47%) of the cCMV positive cohort had central nervous system abnormalities based on imaging. Conclusion: Our preliminary results suggest that cognitive impairment may not account for poorer CI outcomes in cCMV infected children. We would encourage that other factors such as social determinants of health be investigated in future studies.

Primary Author/Presenter: Albert Park, MD

Author Block: Albert Park, MD, Anamika Blomgren, BS, Marissa Diener, PhD; Univ. of Utah, Salt Lake City, UT.

Learner Objectives:

Participants will be able to discern the different outcomes in children with and without cCMV infection who undergo cochlear implantation.

Participants will be able to list other factors rather than cognitive ability that may impact cochlear implant outcomes in cCMV infected children.
Concurrent Session: Concurrent Session 4-3 "Cytomegalovirus (CMV) and Genetics"

Abstract Number: 220

Abstract Title: Outcomes after cochlear implantation of children with congenital cytomegalovirus

Abstract Content:

Introduction: Congenital cytomegalovirus (cCMV) is considered the most common non-inherited etiology of congenital and early progressive sensorineural hearing loss in children. This study evaluates audiometric and speech and language outcomes among children with cCMV who underwent cochlear implantation (CI).

Methods: This retrospective review was conducted at a single academic tertiary care center. Institutional database was queried to identify children with congenital CMV who had undergone CI surgery within the last 30 years. Children who underwent CI surgery for single-sided deafness were excluded. Children were grouped into categories based upon date of surgery -- whether it had occurred >10 years ago versus within the last 10 years - and based upon whether they had symptomatic versus asymptomatic CMV. Speech discrimination and receptive language scores were compared among groups using the most recent Consonant-Nucleus-Consonant (CNC) word scores and Peabody Picture Vocabulary Test (PPVT) scores, respectively. Comparisons were made using Kruskal-Wallis Rank-Sum test.

Results: There were 72 children who had undergone CI surgery for bilateral SNHL due to cCMV: 53 underwent surgery >10 years ago, while 19 had surgery within the last 10 years. Children implanted within the last 10 years were significantly younger at time of activation, median age 22 months (range 7-32 months), compared to children implanted more than 10 years ago, median age 61 months (range 14-99 months), p-value <0.001. Children implanted within the last 10 years were more likely to receive bilateral implants, 14/19, compared to children implanted more than 10 years ago, 12/53, p-value <0.001. CNC word scores were available for 28 children. Median CNC word scores were 88% (range 80-96) for children implanted within the last 10 years compared to 72% (range 0-100) for children implanted more than 10 years ago, p-value 0.2. Median CNC word scores were 76% (range 0-84) for children with asymptomatic CMV compared to 60% (range 72-56) for children with symptomatic CMV, p-value 0.4. These differences were not significant, possibly due to small sample size. PPVT scores were available for 32 children. Median PPVT scores were higher for children implanted within the last 10 years, 78 (range 67-145), compared to 55 (range 23-108) for children implanted more than 10 years ago. This difference trended toward significance, p-value 0.05. Median PPVT scores were significantly higher for children with asymptomatic cCMV, 70 (range 33-145), compared to symptomatic cCMV, 51 (range 23-104), p-value 0.02. Conclusion: Over the last 30 years, children with cCMV-associated SNHL have experienced improvement in age to implantation with associated trends toward improvement in outcomes. Children with asymptomatic cCMV have significantly higher receptive language scores post-implantation than children with symptomatic cCMV.

Primary Author/Presenter: Shivani Shah-Becker, MD

Author Block: Shivani Shah-Becker, MD , Brandi Griffin, AuD, Jennifer Still, MHS, CCC-SLP, Patricia L. Purcell, MD MPH;Otolaryngology-Head & Neck Surgery, Univ. of Michigan, Ann Arbor, MI.

Learner Objectives:

At the end of the session, participants will be able to describe how access to cochlear implantation, including age at activation, has changed over time for children with congenital cytomegalovirus.

At the end of the session, participants will be able to compare post-implantation audiometric and speech and language outcome measures between children with asymptomatic versus symptomatic congenital CMV.
Introduction: The effects of hearing loss (HL) related to congenital cytomegalovirus (cCMV) are well-documented; however, in many of these cases, hearing was assessed as a result of other medical conditions that were diagnosed prenatally or during early infancy (i.e., symptomatic cCMV). There is significantly less known about the effects of cCMV for children who are asymptomatic or present only with congenital HL. With the implementation of newborn hearing screenings (NBHS), today many children are being tested for cCMV after a failed NBHS, resulting in the diagnosis of more cases of asymptomatic or less severe symptomatic cCMV. The aims of this study are the following: (1) Determine course/degree of HL in children with a cCMV diagnosis (symptomatic vs asymptomatic cCMV); (2) Examine pattern of HL (e.g. bilateral symmetric SNHL, asymmetric SNHL or unilateral SNHL) in children diagnosed with cCMV; and, (3) Evaluate the progression of HL with/out antiviral treatment for cCMV. This work will help to provide evidence of the long-term prognosis for HL for children diagnosed with cCMV, with/out antiviral treatment. Ultimately, results will aid in counseling families regarding hearing and potential treatment options.

Methods: This work involves a retrospective case series of children diagnosed with cCMV who have or have not undergone antiviral treatment. The following variables will be collected and reviewed: age at onset of HL, hearing status overtime, antiviral treatment course and duration, and hearing assessments (NBHS, diagnostic ABR, DPOAE, and behavioral audiometric results). Both within and between subject results will be analyzed. Specifically, we will investigate (1) the relationship between age and progression/degree of HL and (2) the laterality and symmetry between ears within an individual. Results: It is hypothesized that HL progresses for children diagnosed with both asymptomatic or symptomatic cCMV, regardless of antiviral treatment course. Our results will better establish the timeline and hearing profile of when these changes occur in both groups. Results will also help to determine if antiviral treatment for cCMV has any effect on long-term hearing thresholds. Conclusion: Ultimately, this work will help to provide more accurate and timely counseling to families of children with cCMV regarding hearing healthcare options and treatment.
Concurrent Session: Concurrent Session 4-3 "Cytomegalovirus (CMV) and Genetics"

Abstract Number: 272

Abstract Title: An international multi-center study on the natural history of <i>TMPRSS3</i> and related cochlear implant outcomes

Abstract Content:

Introduction: Many genetic variants have been linked to non-syndromic hearing loss (NSHL). One gene of particular interest is <i>TMPRSS3</i>, transmembrane serine protease, which is expressed in cells in the inner ear. Mutations in <i>TMPRSS3</i> lead to autosomal recessive NSHL. Presently, genotype-phenotype correlation studies of <i>TMPRSS3</i> exist with low sample sizes. It is critical that there be a better understanding of the genotype-phenotype presentation as gene therapies are developed to treat NSHL. The present study is the largest multi-center, international study of the natural history of the <i>TMPRSS3</i> gene to date.

Methods: An invitation was extended to 14 institutions in six countries. In total, we received data from 10 institutions including demographic information, audiologic history, and genetic test results confirming <i>TMPRSS3</i> mutation. Serial audiograms were collected as available. Patients were divided into groups based on missense (M) and loss-of-function (LoF) alleles, and the protein domain where the variant occurred. Outcome data relative to hearing loss treatment (cochlear implant or hearing aid) were also collected when available. Three-dimensional modeling and structural analysis will be used to provide a theoretical bases for pathogenicity of <i>TMPRSS3</i>. Results: A total of 148 individuals with confirmed <i>TMPRSS3</i> variants have been included to date. Patients with other identified variants were excluded from analysis (n=9). In this group, 56% of patients were female and 44% were male. A majority of patients identified as White (n=83), followed by Asian (n=53) and Black/African American (n=2). Race was not specified for 8 patients. Grouping by genotype showed 55% M/M, 27% M/LoF, 14% LoF/LoF, and 4% M/WT. The most commonly mutated domain was SRCR domain. In this group, 13 patients (8.8%) used no device, 29 (19.6%) used hearing aids, and 80 (54.1%) used a cochlear implant (unilateral, bilateral, or bimodal). 26 patients (17.6%) were missing device data. Audiologic phenotype analysis by genotype group, demographics, and protein domain are in progress and will be completed by the time of presentation. In the existing cohort 54 patients have aided word recognition testing available for review. Cochlear implant outcomes will be analyzed by genotype group to assess aided speech perception by variant and protein domain.

Conclusion: <i>TMPRSS3</i> is a relatively rare cause of NSHL that shows promise as a candidate for future gene therapies. Understanding the natural history of <i>TMPRSS3</i> and the genotype-phenotype correlations will strengthen clinical decision making and future research surrounding gene therapy. Based on these data, we will be better able to follow the severity and progression of each genotype and understand the efficacy of hearing loss treatment options by genotype. Our data improve upon previous evidence that cochlear implantation is an appropriate treatment for patients with <i>TMPRSS3</i> variants.

Primary Author/Presenter: Molly Smeal, AuD

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Learner Objectives:

Identify common genotype-phenotype presentation for TMPRSS3.

Summarize hearing loss treatment outcomes for patients with TMPRSS3 mutations.
CONCURRENT SESSION: Concurrent Session 5-1 "Bone-anchored Hearing Devices"

ABSTRACT NUMBER: 137

ABSTRACT TITLE: Updated institutional experience with a new active transcutaneous bone anchored implant

ABSTRACT CONTENT:

ACIA 2023 ABSTRACT Updated institutional experience with a new active transcutaneous bone anchored implant

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Objective: To describe our institutional experience to-date using a specific active transcutaneous bone anchored implant.

Methods: Retrospective cohort study of those patients undergoing implantation with a new active transcutaneous bone anchored implant with or without concurrent otologic procedures. Outcome measures included operative time, rates of dural exposure and compression, and use of lifts.

Results: Twenty patients underwent BAI and mean age and follow-up were 39.0 years and 3.8 months, respectively. The most common indications were atresia/microtia, chronic suppurative otitis media, cholesteatoma (each 25.0%), and single-sided deafness (10.0%). Of the 20 patients, 65% (n=13) underwent implantation without concurrent procedures and the mean operative time for those patients was 91.3 minutes (median 80.0, range 55.0-136.0 minutes). Placement in the mastoid was possible in 80.0%, at least one lift required in 55.0%, dural exposure necessary in 40.0%, and dural compression required in 15.0%. Patients were qualitatively pleased with the sound quality and only reported issues in 5.0% of cases. While not meeting the threshold for significance, many more patients undergoing a concurrent procedure required retrosigmoid placement compared to those in which the implant placement was the only procedure performed (42.9% versus 7.7%, p=.061). Similarly, more patients undergoing concurrent procedures required dural exposure (57.1% versus 30.8%, p=.251). Primary pathology did not affect any of the outcomes of interest. There were no complications.

Conclusions: Placement of the Bonebridge BCI 602 is safe and has excellent results. In a tertiary setting, patients often require lifts and dural exposure.

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Learner Objectives:

Describe the technical difficulties associated with placement of a new active transcutaneous bone anchored hearing implant.

Discuss the implications of concurrent pathology on implant placement.
Abstract Number: 145

Abstract Title: Bone Density Based Selection of Optimal Stimulation Sites for Bone Conduction Implants

Abstract Content:
Introduction: Bone conduction implants are used to treat conductive or mixed hearing loss and single-sided sensorineural deafness. Recently, we proposed to consider the temporal bone mineral density in the preoperative planning procedure using quantitative computed-tomography (CT) [1]. We hypothesized that regions of denser bone should be preferred for implant placement to ensure optimal transmission of mechanical vibrations. In this ex vivo validation study, we aimed to investigate whether positions with higher bone density indeed lead to better mechanical transmission to the cochlea.

Methods: Quantitative CT imaging was performed in a Thiel-fixed whole head cadaver specimen. For both ears, the temporal bone thickness and density were assessed at retroauricular positions. Topographic bone density maps were computed using the column density index (CODI) as de fined by Talon et al. [1] The transducer from a bone anchored hearing aid (BAHA 110 Power<sup>TM</sup>, Cochlear, Australia) was used for stimulation. Retroauricular positions covering CODI values from 2 to 10 mg HA/mm<sup>2</sup> were identified to fix the abutment screw. Laser Doppler vibrometry was used to measure the velocity of the cochlear promontory under bone conduction stimulation between 100 Hz and 10 kHz. The displacement and acceleration of the cochlear promontory were also computed from the velocity. In addition, the output force level of the actuator was measured within artificial mastoid (Type 4930, Bruel & Kjaer, Denmark).

Results: Overall, our measurements are in accordance with literature [2]. We found a clear association between the CODI and cochlear promontory acceleration. The effect was most pronounced between 0.5 to 4 kHz, with an average improvement of the cochlear promontory acceleration of 2.25 dB re 1 mm/s per unit of CODI. From a CODI of 2 mg HA/mm<sup>2</sup> to a CODI of 10 mg HA/mm<sup>2</sup> the improvement in acceleration was of 17.6±3.2 dB re 1 mm/s. No differences were found for frequencies above 4 kHz. In addition, the CODI was not relevant for lower frequencies (<i>0.5 kHz</i>) in which the head fixation affects the vibrations [3].

Conclusion: Regions with higher CODI values seem to provide better transmission for bone conduction. In temporal bones, a local concentration of mass (and higher CODI values) can be found posterior to the supramastoid crest, which could be a preferable location for bone conduction implants. The CODI can be used to provide preoperative visualization of the bone density, adding a new dimension to implant positions besides bone thickness. Future work needs to confirm these results in more specimens and evaluate the influence of possible confounding factors (e.g., the distance to the cochlea).

References:

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Learner Objectives:
Identify the role of a density-based index in the mechanical transmission of bone vibrations

Define ideal position of bone conduction implants based on bone density measurements
Abstract Number: 235

Abstract Title: Bonebridge Implantation in Pediatric Patients Age 11 Years and Younger: Is it Safe and Effective?

Abstract Content:

Introduction: Bone conduction implants (BCI) are a viable option for many pediatric patients suffering from conductive hearing loss. New active transcutaneous BCI are currently approved by the FDA for patients age 12 years and older. We present our experience of patients younger than 12 years who underwent Bonebridge implantation.

Methods: Patients 11 years old and younger who underwent Bonebridge implantation were included in a retrospective cohort study. Hearing outcomes were collected at implant activation follow-up completed 4 - 8 weeks post-operatively; method of assessment was determined by the treating audiologist. Patients who did not have post-operative audiology documentation of activation were considered lost to follow-up.

Results: The inclusion criteria yielded 19 patients (9 male, 10 female) for a total of 25 ears implanted. Ages ranged from 5 to 11 years old (median 6 years). Five implants were placed via transmastoid approach; the remaining 20 implants were placed above the temporal line. Eighteen patients (95%) achieved adequate post-operative pain control with acetaminophen and ibuprofen. Sixteen of 17 patients (94%) reported subjective benefit from their implants. Median pre-operative air-bone gap was 46 dB HL. Median pre-operative SRT (speech reception threshold) was 57 dB HL; median post-operative SRT was 22.5 dB HL. Post-operative complication rate was low: two patients experienced minor external processor malfunction, and 1 patient developed bilateral surgical site hematomas. Two patients were lost to follow-up.

Conclusion: Our younger pediatric patients showed significant benefit from off-label Bonebridge implantation for management of conductive and mixed hearing loss. Pediatric patients younger than 12 years can be considered Bonebridge implant candidates if clinically indicated; Bonebridge implantation in this age group is safe and technically feasible.

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Learner Objectives:

Define safety and post-operative complications for Bonebridge implantation in young pediatric patients

Define audiometric outcomes for younger pediatric patients undergoing Bonebridge implantation and compare to older pediatric patients.
Introduction: Congenital aural atresia is the failure to develop the external auditory canal and is often associated with microtia and compromise of the middle ear. It affects 1 in every 10,000 births. Conductive hearing loss is the most common audiological finding. Treatment options include a functional and an aesthetic approach. OSIA OSI200 is an active transcutaneous bone conduction implant (ATBCI) available since 2019 that is supposed to be placed in a retroauricular position. Since a retro auricular incision limits the aesthetic pinna reconstruction, the aim of this study is to describe the middle fossa location as a new surgical alternative and the audiological results in children with microtia and external auditory canal atresia (EACA) who cannot undergo traditional surgery for an ATBCI due to their altered anatomy or desire for future aesthetic reconstruction.

Methods: A prospective descriptive study was designed. The middle fossa location technique was developed. Pre-operative and post-operative information from 4 patients with EACA implanted with ATBCI OSIA OSI200 was analyzed. Surgical and audiological outcomes as the results of quality-of-life (QoL) surveys (PEACH and KIDSCREEN-10) were registered preoperatively, 1, 3 and 6 months after surgery and analyzed.

Results: A total of 4 children with EACA received the implant in the middle fossa location. None had dural exposure. This placement corresponds anatomically with the middle fossa, but it is not placed “in” it. Their average age was 11 years old. The follow-up was 6 months. The surgery in this location is easier and faster than the one suggested by the manufacturers due to the flat bone in this anatomical region of the skull. All the patients had a conductive hearing loss. The audiological and QoL results were according to the expected for this device.

Conclusion: Middle fossa location for the active transcutaneous bone conduction implant OSIA OSI200 was proven to be safe and effective for treating pediatric patients with external auditory canal atresia who desire future aesthetic reconstruction. This new surgical technique is friendly for the surgeon and fast. The outcomes are comparable to those obtained with the traditional location described for this device.
Abstract Number: 298

Abstract Title: Early application of surgical bone conduction aids: suitability of Osia® implants in children as young as 5 years of age.

Abstract Content:

Introduction: The objective of this study is to report surgical candidacy, feasibility and outcomes in pediatric patients receiving the Osia® implant at ages as young as 5 years. The osseointegrated steady-state implant(Osia®) system is an active transcutaneous bone-conduction device(BCD) which is suitable for intervention for unilateral or bilateral conductive hearing loss or single sided deafness in children, when other forms of amplification (e.g. conventional hearing aids/cochlear implants) cannot be used. Access to high fidelity sound in paediatric patients improves developmental outcomes, motivating the provision of Osia® at the earliest age possible.

Methods: A retrospective review of patients (<18 years of age) receiving Osia® in our centre from 2018-2022 was conducted. The primary outcome measured was adverse events requiring re-operation. Operative time was also assessed. Results: 87 patients received unilateral (n=79) or bilateral (n=8) Osia® for a total of 95 implants. Age-at-implantation was mean(±SD) = 11.4(4.07), range=4.9-17.7 years. Genetic or syndromic comorbidities were present in 31%. 84%(73/87) of children had prior experience with BCDs; 48% wore non-surgical devices such as the softband BCD and 37% had a prior surgical BCD (e.g. BAHA®Connect). Mean(±SD) operative time was 76(23) minutes. Bilateral Osia® were implanted sequentially with mean(±SD) interval of 388(259) days. Five adverse events required re-operation in three patients who were 9 years of age or older. Two experienced surgical-site haematoma and infection, leading to device-exposure and explantation; one received re-implantation and is awaiting skin flap reduction to facilitate device-retention. The third patient also required re-operation for skin flap reduction. All three had significant comorbidities; both patients with device-loss had significant developmental delay.

Conclusion: Osia® devices were provided in our centre to children across a wide age-range with low morbidity rates and is a reasonable form of amplification to consider in children as young as 5 years-of-age.

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Learner Objectives:

To understand the candidacy criteria for surgical bone conduction aids and children.

To describe the nature of adverse events in the application of bone conduction aids in children.
Abstract Number: 58

Abstract Title: The degree of hearing loss moderates the benefit of pre-operative hearing aid use in preserving children’s auditory cortex

Abstract Content:

Introduction: Although amplification does not provide pediatric cochlear implant (CI) candidates with adequate audibility of spoken language, earlier fitting of hearing aids (HA) is considered advantageous. Few studies have focused on the influence of auditory input on cortical structures in children who are CI candidates. This study evaluated the influence of pre-CI auditory input on brain structure.

Methods: T1-weighted whole-brain MRI of 98 CI candidates with congenital bilateral sensorineural hearing loss (SNHL) and no significant imaging brain abnormalities were compared to 82 normal hearing children from an NIH brain bank. Multivoxel pattern similarity analysis was used to examine gray matter morphology of the auditory cortex for CI candidates in comparison to controls. Multiple regression model and machine learning were used to examine the effects of residual hearing and length of amplification on auditory cortical changes controlling for age and gender.

Results: Children with longer HA use showed less cortical change in the left Heschl’s gyrus ($\beta = 0.196, p < 0.09$). Such association was moderated by residual hearing ($\beta = 0.276, p < 0.009$). Specifically, children whose residual hearing were at and below the mean level (PTA $\geq 97.61$ dB HL) showed significant association between HA use and cortical changes (below: $B = 0.051, p < 0.008$; mean: $B = 0.023, p < 0.09$), whereas children whose residual hearing were above the mean level (PTA $< 97.61$ dB HL) showed a weak and nonsignificant association ($B = -0.005, p = 0.74$). Conclusion: Pre-operative HA use may prevent structural change in the auditory cortex, especially for CI candidates with profound SNHL. Despite not providing adequate audibility, amplification may mitigate the impact of auditory deprivation. Further research is needed to determine if preservation of morphology is predictive of better speech perception and language post-CI.

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Learner Objectives:

Describe the influence of auditory input on cortical structural changes in children with sensorineural hearing loss.
Introduction: Children with normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss have been receiving cochlear implants (CIs) as an off-label practice and demonstrating benefits. When these non-traditional pediatric CI recipients maintain residual hearing, they can be fit with electric-acoustic stimulation (EAS). When residual hearing is lost, they are fit with full-electric stimulation (FES). A growing body of research using standard speech perception batteries has shown that these children are able to benefit from cochlear implantation over acoustic amplification alone whether they maintain residual hearing or not. The present report reviews preliminary data from a prospective clinical trial examining outcomes in children who maintain residual hearing and use EAS and those who lose residual hearing and are fit with FES. Participants are tested with traditional speech perception measures and a prosodic identification task to identify the contributory benefits of residual hearing in children.

Methods: Pediatric CI recipients who presented with a low-frequency pure-tone average (LFPTA; 125, 250, and 500 Hz) of 75 dB HL or better at the preoperative evaluation were considered for inclusion. Those who maintained acoustical hearing were fit with EAS and those whose LFPTA exceeded 75 dB HL were fit with FES. At the time of analysis, 26 children had participated, with an approximately even split between EAS and FES users. Performance was assessed with recorded speech perception materials (i.e., CNC words and BKB-SIN), and a prosodic perception task. The prosodic task required the participants to repeat a semantically neutral sentence that varied in pitch to indicate a question versus a statement. Their repetitions were recorded and rated as either questions or statements by blinded reviewers. These ratings were analyzed for accuracy. All data were analyzed after 12 months of device use.

Results: At 12 months post-activation, there was no significant difference in speech perception for CNC words or BKB-SIN between groups. The EAS group outperformed the FES group on measures of prosodic perception. The degree of low-frequency hearing post-activation was strongly correlated with prosodic accuracy for both groups.

Conclusion: Children with normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss may demonstrate similar outcomes in word recognition and sentence recognition in noise whether hearing is preserved or not. Children who were fit with EAS are significantly better at identifying questions vs statements when compared to those using FES. However, for both groups the degree of post-activation residual hearing is strongly correlated with performance on prosodic identification tasks. Hearing preservation in children plays an important role in accessing critical pitch cues that impact spoken language development.
**Abstract Title:** Spatial listening in CI users with Single-Sided Deafness: Brain and behavioural measures of listening effort.

**Abstract Content:**

Introduction: The benefits of cochlear implant (CI) in Single-Sided Deafness (SSD) have been described as improvements in spatial hearing and better speech intelligibility. Anecdotally, SSD CI users have reported that having a CI with normal hearing on the non-implant side is a positive life-changing event associated with better quality of hearing and listening effort. Building upon our previous work showing that neural correlates of listening effort were associated with changes in brain alpha rhythms, we sought to determine if such changes could be observed in CI users with SSD.

Methods: Eighteen adult CI users with at least one-year of CI experience and normal acoustic hearing thresholds on the non-implanted ear were recruited through the Sunnybrook Health Sciences Cochlear Implant Program. While recording a high-density electroencephalography (EEG), participants listened to triple digits while sitting in a 5-speaker array at +/- 45, 90, and 0 degrees azimuth. Digits were presented at random locations at a single speaker while babble noise was presented at the other 4 speakers (babble is presented from all other speakers). Participants were instructed to repeat the digits, indicate what speaker the digits came from, and indicate subjective listening effort for performing the task. Participants were tested with and without their CI.

Results: Performance was greater and listening effort was reduced when participants wore their CI. Importantly, electrophysiological correlates of this change (with vs. without CI) were observed. When the CI was turned on, alpha oscillations were found to decrease contralateral to the CI side indicating that the auditory/parietal cortex spatial listening neural network is activated. Interestingly, when the CI was turned off, alpha oscillations increased ipsilaterally. This is consistent with previous findings suggesting that increases in alpha are associated with stimulus ambiguity. Importantly, the degree of alpha power was found to be significantly correlated to self-reported listening effort.

Conclusion: We found electrophysiological correlates of listening effort in CI users with SSD. In previous reports we showed a similar finding for speech in noise perception. However, in the current study, we find that listening effort for spatial listening has a similar underlying neural mechanism as for speech in noise perception.

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**Learner Objectives:**

Identify how listening effort can be quantified using EEG

Identify how spatial speech perception performance can be quantified
**Concurrent Session:** Concurrent Session 5-2 "Single-sided Deafness and Asymmetric Hearing Loss"

**Abstract Number:** 324

**Abstract Title:** New Cochlear Implant Candidacy Protocol for Patients with Asymmetric Sensorineural Hearing Loss

**Abstract Content:**

Introduction: Traditional cochlear implant candidacy criteria and single sided deafness protocols allow for cochlear implantation for those with bilateral moderate to profound sensorineural hearing loss and single sided deafness respectively. However, those with asymmetric sensorineural hearing loss are missing out on the benefits of cochlear implantation as their better hearing ear can often disqualify them with current testing protocols. Medicare candidacy criteria states a patient must score <60% on open-set sentence tests in the best aided listening condition, however, Medicare does not dictate the presentation protocol during evaluation. This presentation will cover a high-volume cochlear implant center’s cochlear implant asymmetrical presentation protocol methodology and early speech outcomes in an adult population.

**Methods:** Data was obtained from a group of 9 adult subjects. All patients were diagnosed with asymmetric, bilateral sensorineural hearing loss and were implanted with a cochlear implant in their poorer hearing ear. The Minimum Speech Test Battery was used for evaluation with individual ear scores obtained at 0º azimuth. Binaural scores were obtained in a +5 SNR condition presented in the most difficult listening scenario for patients with asymmetric hearing loss. The speech signal was presented to the poorer hearing ear and the noise stimulus was presented to the better hearing ear (90º and 270º azimuth). Audiometric outcome data including speech in quiet testing using AzBio sentences and monosyllabic CNC words and speech in noise testing with AzBio sentences with +5 SNR at 0º azimuth were obtained pre-operatively and six months post-operatively.

**Results:** Results indicate an average preoperative score of 14.4% and an average six month postoperative score of 68.0% for AzBio sentences in +5 SNR in the asymmetrical presentation protocol. In addition, at six months postoperative, an average improvement of 7.9% was found for binaural AzBio sentences in quiet, 18.9% for binaural AzBio sentences in noise at 0º azimuth, and 10% for binaural CNC words when compared to the respective preoperative scores.

**Conclusion:** As current Medicare cochlear implant guidelines do not specify the testing protocols for the “best aided condition”, the asymmetric presentation protocol allows patients with asymmetric hearing loss to simulate their most difficult listening scenario, where the need for a cochlear implant is the strongest. Early data outcomes indicate that all speech scores are the same or better following cochlear implantation. This protocol has increased access to improved hearing for patients with asymmetric hearing loss that would otherwise not meet more traditional cochlear implant candidacy criteria.

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**Learner Objectives:**

Describe alternate cochlear implant candidacy protocols for asymmetric hearing loss.

Review benefits of implanting patients with asymmetric hearing loss.
**Concurrent Session:** Concurrent Session 5-2 "Single-sided Deafness and Asymmetric Hearing Loss"

**Abstract Number:** 400

**Abstract Title:** Long-Term Speech Perception Outcomes of Subjects That Have Lost Residual Acoustic Hearing Following Placement of Shorter Electrodes

**Abstract Content:**

Background: Preservation of residual functional acoustic hearing significantly enhances word understanding in quiet and noise compared to subjects using electric speech processing only. There is also an advantage for music perception and spatial hearing if acoustic hearing is preserved in both ears. These listeners with preserved residual hearing on the implanted ear utilize the cochlear implant (CI) along with bilateral acoustic hearing (CI+Bilateral HA). Some listeners, however, lose functionally aidable acoustic hearing on the implanted ear immediately following surgery or at some point following activation. These listeners utilize a CI along with a hearing aid on the nonimplanted ear (CI + HA or bimodal). The loss of residual hearing can happen in subjects implanted with all lengths of devices, even those with shorter electrodes between 10-20 mm. We have a history of implanting listeners with shorter electrodes beginning in 1999. This presentation will describe long-term outcomes of hearing preservation and speech perception for those without functionally aidable acoustic hearing in the implanted ear.

Methods: This report will describe a group of 35 subjects that have lost residual hearing either by initial activation or after using either 10 mm Nucleus S8 or S10 electrode arrays (N=7/37) or a 16 mm Nucleus Hybrid L24 electrode array (N=28/84). Longitudinal CNC word scores in quiet and AzBio sentence scores in 5 dB signal-to-noise ratio are reported in the CI+Bilateral HA or CI+HA. In addition, outcomes of five subjects that had their 16 mm implant explanted and reimplanted with a longer length electrode array are described.

Results: Averaged scores on CNC words in quiet for all subjects tested in the CI+Bilateral HA condition prior to losing their residual hearing (74%) were similar to the CI+HA condition after losing their residual hearing (75%). When comparing the average CNC word score of these CI+HA subjects who lost residual hearing on the implanted ear to a group of CI+HA subjects (N=146; 65%) who did not attempt to preserve residual hearing and were implanted with a longer length electrode arrays, there was no significant difference in scores. Averaged scores on AzBio Sentences in 5 dB SNR for subjects tested in the CI+Bilateral HA condition prior to losing their residual hearing (50%) performed poorer in the CI+HA condition after losing their residual hearing (31%). Comparison of averaged results for AzBio Sentences in 5 dB SNR for the CI+HA subjects who lost residual hearing to a group of CI+HA subjects (N=74) who were implanted with a longer length electrode arrays were better for those implanted with a longer electrode array (31% versus 41%). Finally, five subjects that had their L24 devices replaced with standard electrodes demonstrated mixed results. One experienced a significant improvement while four demonstrated a modest or no improvement.

Discussion: Preservation of residual functional acoustic hearing following implantation was of great benefit to this group of subjects experiencing improvement in CNC words in quiet and performance in a difficult 5 dB SNR AzBio sentence test. Following loss of functionally aidable residual hearing, reprogramming the processor to expand the frequency range over the entire electrode array along with the use of the contralateral HA (CI+HA) resulted in CNC word scores similarly to those prior to loss of hearing. Scores in a 5 dB SNR demonstrated a significant reduction of performance following loss of residual hearing. Most subjects are still using their shorter electrodes and have not requested revision surgery. For those that have had their short electrodes replaced, only one gained significant improvement demonstrating the auditory systems great capacity to accommodate to altered place pitch information.
CI2023 Dallas: Cochlear Implants in Children and Adults

Primary Author/Presenter: Bruce Gantz, MD

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Learner Objectives:
Concurrent Session: Concurrent Session 6-1 "Cochlear Implantation in Vestibular Schwannoma and Other Surgical Considerations"

Abstract Number: 120

Abstract Title: Impact of Preoperative Antibiotic Use in Preventing Complications of Cochlear Implantation Surgery

Abstract Content:
Introduction: There is no clear evidence or guidelines on the use of preoperative antibiotics in cochlear implant surgery. The purpose of this study is to examine the impact of preoperative antibiotic prophylaxis on the occurrence of postoperative complications.

Methods: Data of 491 patients undergoing cochlear implantation were included in a non-randomized retrospective comparative cohort study conducted according to STROBE guidelines. The patients' demographic data, cochlear implant and surgical details, use of preoperative antibiotics and occurrence of postoperative complications were analysed. The primary endpoint was the occurrence of postoperative infection requiring revision surgery. Associations between variables were assessed using a binary logistic regression model.

Results: There were 317 patients (64.56%) who did not receive preoperative antibiotic prophylaxis and 174 (35.44%) patients who received preoperative antibiotic prophylaxis with ceftriaxone. The overall rate of complications requiring surgical treatment was 2.85%. Younger patient age was identified as a positive predictive factor for administering preoperative antibiotic prophylaxis (p<0.001, OR 1.05 CI 95% 1.0124-1.0826). Younger surgeons were less inclined to give antibiotics, and no difference in complication rate was observed between the two groups. The model showed no correlation between sex, age, manufacturer, surgeon and postoperative complications regardless of the type of complication (p=0.45).

Conclusion: There is insufficient evidence to inform decision making regarding preoperative intravenous ceftriaxone use for prevention of infection after cochlear implantation surgery, with data failing to show that administration of preoperative antibiotics leads to a decrease in complication rate. Considering a very low overall complication rate, with few complications related to infection, routine use of preoperative antibiotic prophylaxis should be analysed further.

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Learner Objectives:
Identify preventable complications of cochlear implant surgery.

Discuss the need for perioperative antibiotic treatment in cochlear implant surgery.
Concurrent Session: Concurrent Session 6-1 "Cochlear Implantation in Vestibular Schwannoma and Other Surgical Considerations"

Abstract Number: 147

Abstract Title: The Influence of Treatment Modality on Cochlear Implant Outcomes in Sporadic Vestibular Schwannoma

Abstract Content:
Introduction: Cochlear implantation is an appropriate modality of salvage and/or preservation of functional hearing in patients with vestibular schwannoma. However, the ability to attain usable hearing with a CI in this population, may be dependent on the treatment used for their tumor. This study presents the largest, single study evaluating cochlear implant outcomes in the sporadic vestibular schwannoma population, and stratifies those outcomes via treatment modality employed for the patients’ disease: observation, microsurgery, or radiosurgery

Methods: The authors conducted a retrospective chart review of patients who underwent treatment of vestibular schwannoma followed by cochlear implantation from 2003 to 2022. Patient demographics, tumor characteristics, treatment modality of vestibular schwannoma, and audiometric outcomes are presented.

Results: 27 patients undergoing cochlear implantation for moderate-to-profound hearing loss with a history of ipsilateral sporadic vestibular schwannoma were identified. Of the 27 patients meeting inclusion criteria, 11 had microsurgery, 9 radiosurgery, and 7 continued observation of their vestibular schwannoma at time of cochlear implantation. No patient had undergone multimodal therapy. Average speech perception scores after cochlear implantation were 47.1±26.2% CNCw, 59.6±27.3% CNCp and 55.7±33.0% AzBio Quiet at an average of 16.3±15.9 months after implantation. Implant outcomes among microsurgery, radiosurgery, and observation cohorts were 37.1±28.0%, 51.1±25.5%, and 55.7±21.5% for CNCw, respectively (p=0.152); 48.9±32.5%, 64.0±24.3%, and 70.1±16.3% for CNCp, respectively (p=0.118), and 44.2±34.9%, 66.0±28.7%, and 61.4±31.6% for AzBio Quiet scores, respectively (p=0.246). Controlling for age at implantation and tumor size, we noted that treatment with surgery was the largest negative predictive factor for CNCw (β=-16.448), CNCp (β=-14.269), AzBio Quiet (β=-23.855), but this association was not significant (p>0.05 for all). Only two patients failed to achieve open-set speech recognition, both in the microsurgery cohort.

Conclusion: Overall, cochlear implantation appears to offer benefit in the setting of hearing loss related to sporadic vestibular schwannoma in selected patients. We note that no patients in either nonsurgical cohort failed to attain open-set speech recognition. We also note that scores for the surgical cohort were lower than observation and radiosurgery cohorts; however, these differences did not achieve statistical significance.

Primary Author/Presenter: James Dornhoffer, MD

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Learner Objectives:
At the end of the session, practitioners and researchers will recognize important differences in cochlear implant outcomes in sporadic vestibular schwannoma depending on modality of treatment, and use this to inform research goals and counselling of patients considering cochlear implantation in the setting of vestibular schwannoma.
**Concurrent Session:** Concurrent Session 6-1 "Cochlear Implantation in Vestibular Schwannoma and Other Surgical Considerations"

**Abstract Number:** 148

**Abstract Title:** Comparison of Cochlear Implant Outcomes in Vestibular Schwannoma between Sporadic and Neurofibromatosis Type 2 Populations

**Abstract Content:**

Introduction: Cochlear implantation is a valuable tool to salvage and/or preserve functional hearing in patients with vestibular schwannoma. However, most data on implantation with vestibular schwannoma comes from the neurofibromatosis type 2 (NF2) population, despite the fact that the majority of all schwannomas are sporadic. As such, we must understand differences in cochlear implant outcomes between these two populations to most appropriately counsel patients and further research on such care. As such, the goal of this study is to compare cochlear implant outcomes between patients with sporadic vs NF2-related vestibular schwannoma.

Methods: The authors conducted a retrospective chart review of patients who underwent treatment of vestibular schwannoma followed by cochlear implantation from 2003 to 2022. Patient demographics, tumor characteristics, treatment modality of vestibular schwannoma, and audiometric outcomes are presented.

Results: 60 patients (64 ears) undergoing cochlear implantation for moderate-to-profound hearing loss in the setting of vestibular schwannoma were identified. Of these, 27 presented with sporadic disease, and 33 with NF2. Average speech perception scores after cochlear implantation were 39.0±29.8% CNCw, 51.8±33.0% CNCp, 50.9±35.2% AzBio Quiet at an average of 18.7±16.6 months after implantation. Overall, patients with sporadic disease performed better than their NF2 counterparts in CNCw (47.1±26.2% vs 32.8±31.3%, p=0.038), CNCp (59.6±27.3% vs 44.7±36.6%, p=0.066), and AzBio Quiet (55.7±33.0% vs 46.9±37.0%, p=0.184). When comparing patients with observation or radiosurgery, there was no significant difference in cochlear implant outcomes between the NF2 or sporadic groups. In patients who had microsurgery, those with sporadic disease had significantly better outcomes than those with NF2: CNCw (37.1±28.0% vs 7.0±12.5%, p=0.006), CNCp (48.9±32.5% vs 5.9±16.6%, p=0.002), and AzBio Quiet scores (44.2±34.9% vs 18.1±28.2%, p=0.037). In patients with surgery, 6 out of 14 with NF2 failed to achieve open-set speech recognition, compared to 2 out of 11 with sporadic disease. All patients treated with radiosurgery or observation achieved open-set speech recognition.

Conclusion: Patients with hearing loss relate to vestibular schwannoma may benefit from cochlear implantation. However, patients with NF2 may have worse speech recognition with an implant than those with sporadic disease, specifically those with a history of microsurgical resection.

**Primary Author/Presenter:** James Dornhoffer, MD

**Author Block:** James R. Dornhoffer, MD, Travis Haller, MD, Brian A. Neff, MD, Colin L. W. Driscoll, MD, Matthew L. Carlson, MD; Otolaryngology, Mayo Clinic, Rochester, MN.

**Learner Objectives:**

At the end of this session, practitioners and researchers will recognize important differences in cochlear implant outcomes between patients with sporadic and NF2-associated vestibular schwannoma, and use this to inform research goals and counselling of patients considering cochlear implantation in the setting of vestibular schwannoma.
Introduction: Cochlear implants (CI) are implantable medical devices that aid patients in overcoming hearing loss when the benefit of hearing aids is insufficient. Improvements in device reliability and patient access have increased the number of patients choosing to undergo CI surgery. Although this procedure has a low incidence of complications, device related problems can occur necessitating revision surgery or reimplantation in 5% to 10% of cases. While the rate of revision has decreased, not much is known about device integrity by manufacturer. The purpose of this study was to analyze the device failure rate, in adult and pediatric populations of a U.S. integrated health system.

Methods: Patients who underwent CI placement in California, Northwest (Oregon and Washington), and Hawaii regions between 2010 and 2021 comprised the cohort. CI implants were represented by 3 suppliers: Manufacturers A, B, and C. The outcome of interest was revision for any reason following index CI placement. Implant manufacturer was the exposure of interest with “A”, the highest volume manufacturer, as the reference group. Multivariable Cox proportional hazard regression was used to evaluate revision risk during follow-up and adjusted for age, sex, body mass index, race/ethnicity, American Society of Anesthesiologist’s (ASA) classification, and operating surgeon. Separate models were created for pediatric (age <18) and adult (age ≥18) cohorts. A time-interaction term was included in the adult population model. Hazard ratios (HR) and 95% confidence intervals (95% CI) are presented.

Results: A total of 2,347 patients underwent a primary cochlear implant placement by 37 operating surgeons during the study period. Manufacturer A was most implanted (51.5%), followed by B (35.2%), and C (13.3%). 37.9% of all implanted CI were identified as recalled devices. For all patients combined, 86.4% of revisions were in patients implanted with a recalled device from Manufacturer B and 45.7% of revisions in patients implanted with a recalled device from Manufacturer A. None of the revisions by patients implanted with Manufacturer C had recalled CIs. In age <18 at 7 years follow-up overall revision was 8.0% (95% CI=5.3-11.4%); the cumulative revision rate was 10.9% for Manufacturer B, 5.4% for A, while C had insufficient cases. In age ≥18 at 7-years follow-up the overall revision was 6.0% (95% CI=4.7-7.4%); the cumulative revision rate was 9.1% for Manufacturer B, 4.5% for C, and 3.5% for A. After adjustment for covariates, no difference was observed between manufacturers for age <18 (B vs A: HR=1.92, 95% CI=0.84-4.43). After adjustment in age ≥18, Manufacturer B had a 66% higher revision risk (HR=1.66, 95% CI=1.01-2.71), while no difference observed with C (HR=1.22, 95% CI=0.62-2.39) compared with manufacturer A.

Conclusion: Consistent with prior research, we found that pediatric patients had higher rates of lifetime revision compared to adult patients. After adjustment, we failed to detect a difference by major device manufacturers within age <18, however a higher revision risk was observed in one manufacturer in the ≥18 patient age group. Longer follow-up of patient populations and additional research can further clarify reasons for revision by manufacturer.

Primary Author/Presenter: Sarah Connell, MD

Learner Objectives:

Analyze the Cochlear Implant device failure rate, in adult and pediatric populations of a U.S. integrated health system.
Concurrent Session: Concurrent Session 6-1 "Cochlear Implantation in Vestibular Schwannoma and Other Surgical Considerations"

Abstract Number: 302

Abstract Title: Hearing and Quality of Life Outcomes in Cochlear Implantation for Sporadic Vestibular Schwannoma

Abstract Content:
Title: Hearing and Quality of Life Outcomes in Cochlear Implantation for Sporadic Vestibular Schwannoma
Authors: Donald Tan, MD; Kristen L. Yancey, MD; Zabi Wardak, MD; Walter Kutz, MD; Brandon Isaacson, MD; Jacob B. Hunter, MD

Introduction
There is emerging evidence that patients with sporadic vestibular schwannoma (VS) may derive benefit from cochlear implantation (CI). Limited data exists regarding hearing outcomes and quality of life (QOL) changes in CI of patients with sporadic VS. In this study, we report hearing and QOL outcomes with CI in patients with sporadic VS.

Methods
A single institutional retrospective chart review was conducted of adult CI patients with an ipsilateral sporadic VS. Speech perception outcomes were assessed using ipsilateral AzBio sentence scores in quiet. Quality of life was evaluated with the Cochlear Implant Quality of Life Item Bank (CIQOL-35).

Results
Six sporadic VS patients received ipsilateral CIs, with a mean post-CI audiometric follow-up of 15.7 months (range, 1-51). The average patient age was 59 years (range, 43-77). The mean maximum linear tumor size was 1.4 cm (range, 0.6 – 2.3). Three patients were treated with gamma knife radiosurgery (GKS), one patient was implanted simultaneously with a translabyrinthine tumor resection, and one patient was implanted 62 months following a middle cranial tumor resection with immediate post-operative profound sensorineural hearing loss. The remaining CI was placed in a 76-year-old who had not pursued treatment. The average preimplantation, ipsilateral best aided AzBio in quiet was 0.6% (range, 0 – 3%), compared to 41.6 % (range, 0-97%) following activation. Datalogging at the time of the best post-operative speech perception testing demonstrated an average daily use of 11.4 hours (range, 6.7 – 14.1). QOL data was available for four patients pre- and postimplantation, at an average of 10.8 months (range, 1-24) following activation. In the two patients able to serve as their own controls, with 1- and 9-month follow-ups, the average increase in the CIQOL-35 sub-domains of communication, entertainment, environment and listening effort were 4, 5, 5.5, and 7, respectively.

Conclusion
CI may offer significant benefits to select patients with hearing loss due to VS, with a majority of patients in our series (5 of 6) logging over 10 hours of daily use. However, there remains a dearth of information to help guide patient selection. Additional work with larger sample sizes is needed with use of validated QOL instruments.

Character Count: 2,434

Primary Author/Presenter: Donald Tan, MD

Author Block: Donald Tan, MD , Kristen L. Yancey, MD, Zabi Wardak, MD, Walter Kutz, MD, Brandon Isaacson, MD, Jacob B. Hunter, MD; Otolaryngology - Head and Neck Surgery, UT Southwestern, Dallas, TX.

Learner Objectives:
Discuss hearing outcomes in cochlear implantation in patients with sporadic vestibular schwannoma
Discuss quality of life outcomes in cochlear implantation in patients with sporadic vestibular schwannoma
**Abstract Number:** 53

**Abstract Title:** Comorbid Neuropsychological Disorders in Children with Unilateral Hearing Loss Undergoing Cochlear Implantation Evaluation

**Abstract Content:**

Introduction: Children with unilateral hearing loss (UHL) have difficulty hearing in noisy environments and localizing sounds, which can impact learning and social opportunities. Using a visible device like a cochlear implant (CI) may improve hearing function but also creates psychological risks, such as increased risk for bullying. Audiological measures alone are insufficient for predicting social, emotional, educational, adaptive, and quality-of-life post-operative outcomes. Extending beyond audition to consider the “whole child” through neuropsychological evaluation may produce a sharper picture of potential outcomes, with or without surgical/audiological intervention. Here we describe neuropsychological profiles of children with UHL who underwent CI candidacy evaluation at a tertiary pediatric hospital.

Methods: During pre-operative clinical care, CI candidates completed targeted neuropsychological evaluation to identify patient- and family-level factors that could impact CI use and outcomes from surgery. Cognitive, language, attention/executive, visuoperceptual/visuomotor, academic, adaptive, and emotional/behavioral functioning were assessed. Evaluations integrated history, observations, caregiver report forms, and performance-based test data.

Results: To date, 18 individuals aged 7 months to 16 years were evaluated. Most had left-sided UHL (67%) and were male (61%). Known hearing loss etiologies were congenital cytomegalovirus (n=5), enlarged vestibular aqueduct (n=1), traumatic brain injury (n=1), meningitis (n=1), cholesteatoma (n=1), neurofibromatosis type 1 (n=1), and Waardenburg syndrome (n=1). Indices of general cognitive ability were generally low average to average. Patterns of cognitive impairment were not restricted to language-based tasks (e.g., visual motor integration weaknesses observed on Beery VMI-6: range 56-109, M=89.42, SD=16.27). Eight (44%) had a behavioral health diagnosis: Attention Deficit Hyperactivity Disorder (n=2), Global Developmental Delay (n=2), Unspecified Neurodevelopmental Disorder (n=2), Autism Spectrum Disorder (n=1), and Depression (n=1). Thirteen (72%) received or will receive a CI, of whom 38% had a behavioral health diagnosis. Average Area Deprivation Index (a marker of socio-economic status) was lower for individuals who ultimately received CIs compared to those who did not (M=18%, compared to M=25%).

Conclusion: There may be increased rates of neurodevelopmental/psychological conditions among children with UHL, similar to rates among children with bilateral hearing loss, especially when the etiology involves the central nervous system. Findings highlight the importance of routine neuropsychological screening in children with UHL and close interdisciplinary collaboration to ensure optimal outcomes. Additional research is warranted to understand the full range of risk and protective factors for children with UHL and, importantly, how these relate to outcomes for those who opt for cochlear implantation.

**Primary Author/Presenter:** Rachel Landsman, PsyD

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**Learner Objectives:**
Describe the prevalence of comorbid neuropsychological disorders in a clinical sample of children with single-sided deafness.

Explain the value pre-operative neuropsychological evaluation in children with single-sided deafness
Abstract Content:

Introduction: Candidacy criteria for cochlear implantation have expanded to include children with single sided deafness (SSD) who are at least 5 years of age. Pediatric cochlear implant (CI) users with SSD experience improved speech recognition with device use. There are few studies that report the hearing hour percentage (HHP) or the incidence of non-use for pediatric CI recipients with SSD. The aim of this study was to investigate factors that impact outcomes in children with SSD who use CIs, including device use. A secondary aim was to identify factors that impact device use in this population.

Methods: A clinical database query revealed 100 pediatric CI recipients with SSD who underwent implantation between 2014-2022. The clinical test battery included speech recognition assessment for CNC words with the CI-alone and BKB-SIN with the CI plus the normal-hearing ear. The target and masker for the BKB-SIN were presented in collocated and spatially-separated conditions to evaluate spatial release from masking (SRM). Multiple regression models evaluated the influence of duration of CI use, duration of deafness, HHP, and age at activation on performance (CNC and SRM). A linear mixed-effects model evaluated the main effects of age at testing, duration of device use, duration of deafness, and onset of deafness on HHP.

Results: A significant positive correlation was found between CNC word scores and both duration of device use and HHP. A significant negative correlation was found between duration of deafness and CNC word scores. Age at device activation was not found to be a significant predictor of CNC outcomes. For SRM, trends were noted in the relationship between SRM and HHP, however the overall model did not reach significance. The mean HHP was 52%. SD = 24). A significant negative correlation was found between HHP and both duration of device use and age at test. Those with sudden hearing loss were found to have a higher HHP than those with progressive and congenital hearing losses.

Conclusion: Pediatric CI users with SSD experience significant improvement in CNC word scores with the CI-alone, with performance influenced by duration of use, HHP, and duration of deafness. For SRM, performance tends to improve with higher HHP. For the present sample, age at implantation did not significantly influence outcomes. Notably, older children use their CI less than younger children and device use decreases the longer children have the device. Children with sudden hearing loss are the most consistent users of their CI. Understanding these factors can help clinicians provide better counseling and care for pediatric CI recipients with SSD.
Concurrent Session: Concurrent Session 6-2 "Advancing Management of Single-sided Deafness"

Abstract Number: 174

Abstract Title: Underlying etiologies of single sided deafness in a large cohort of children receiving a cochlear implant

Abstract Content:

Introduction: Study aims were to assess the prevalence of known vs unknown etiologies of single sided deafness (SSD) in 60 children who have received cochlear implants in our centre and to determine effects of etiology on access and decision to implantation. Etiologies of deafness in SSD can be identified through genetic, radiologic, and serologic testing as well as by clinical history (i.e. trauma) and may be important factors in choosing a cochlear implant and in the outcomes thereafter. SSD is a new indication for cochlear implantation in children and thus effects of etiology have not been previously explored. Methods: Etiology of SSD was examined in children who are participating in an ongoing prospective study of cochlear implantation with limited delay in children with single sided deafness. Testing included PCR analysis of the neonatal dried blood spot to identify congenital cytomegalovirus (cCMV); genetic testing of blood samples collected either prior to or during cochlear implant surgery; MRIs of the head to identify white matter lesions characteristic of CMV and anatomic abnormalities of the inner and VIII cranial nerve. Children with aplasia of CN VIII were excluded from further study as they were deemed not to be candidates for implantation. The clinical history identified children who were referred to otolaryngology and/or audiology from the newborn hearing screening (NHS) program or from other sources. Results: The etiology of SSD was identified in most (42/60) children (70%) who went on to receive CI. The most common finding was evidence of cCMV through bloodspot testing and/or MRI 23/60 (38%). Of these children, most (20/23) were also identified with hearing loss at birth by the NHS program. Three children with cCMV passed NHS; 1 child experienced rapid deterioration of hearing and SSD by 6 months of age and 2 children experienced slower progression of SSD peri-lingually. Cochlear or vestibular anomalies were reported in 6/60 (10%) children; newborn screening was completed in 5 of these children and 2 passed. Two children had syndromic hearing loss identified by NHS (3%). Four children (12-16 years of age) were referred for sudden hearing loss occurring after trauma and 1 child (3 years of age) experienced meningitis after trauma (5/60, 8%). Another 5 children developed SSD after meningitis (5/80, 6%); 4 of these were infants. Two of the children had unilateral cholesteatomas. Conclusion: Congenital CMV was the prevailing etiology of SSD in children who received a cochlear implant. These children are at risk of delayed detection as not all had congenital loss detected on NHS. Children with cCMV are at risk of progression to bilateral hearing loss as well as dual cochleovestibular loss, both important considerations in counselling around implantation in SSD. Other prevalent etiologies were cochlear/vestibular anomalies and acquired losses secondary to trauma and/or meningitis. Recognizing etiology will provide a foundation for examining variability in outcomes following implantation in SSD.

Primary Author/Presenter: Karen Gordon, PhD

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Learner Objectives:

Identify a common congenital etiology of single sided deafness in children receiving cochlear implants

identify a common etiology of acquired sudden single sided deafness in children receiving cochlear implants.
Clinical Outcomes for Adult Single Sided Deafness Cochlear Implant Recipients Exceeding the 5% Candidacy Criterion

Introduction: While single-sided deafness cochlear implants (SSD-CIs) are now approved by the U.S. Food & Drug Administration (FDA), candidate-ear candidacy criteria (no better than 5% word-recognition score, WRS) are stricter than for traditional CI candidates (50-60% speech recognition, best-aided condition). SSD implantation in our center began prior to FDA approval, using a criterion derived from traditional candidacy: 50% consonant-nucleus-consonant (CNC) WRS in the candidate ear. A retrospective analysis investigated whether SSD patients exceeding the FDA criterion nevertheless benefitted from CI.

Methods: A retrospective chart review assessed the clinical experience of a single CI center. Subjects consisted of adult CI recipients with SSD (>90% unaided WRS) or asymmetric hearing loss (AHL, 70-90% unaided WRS in the better ear) implanted between Sep 2019 and Dec 2021 with at least 3 months of post-operative follow-up. Subjects were divided into “Meets” or “Exceeds” groups, based on pre-operative CNC scores, measured under best-aided conditions with a behind-the-ear hearing aid in the sound field at 1 m from a front loudspeaker, with the better ear masked using an insert earphone with 45-50 dB HL speech-weighted noise. The clinical protocol also included AzBio sentences in the same conditions as CNC; binaural spatial testing (broadband-noise sound localization, SL, and matrix-sentence speech-reception thresholds in spatially separated noise, SIN) using a custom-built 7-speaker array; and a CI Quality of Life (CIQOL-35) survey. Spatial tests were completed with and without a device [pre-operative = contralateral-routing-of-signal (CROS) or BI-CROS hearing aid; post-operative = CI]. To evaluate CI benefit, preoperative unaided performance was compared to post-operative binaural (acoustic ear + CI ear) performance at a clinic visit closest to 6 months post-surgery.

Results: Of 28 SSD-CI recipients, 13 exceeded the 5% criterion. The Exceeds group improved on the 5 primary study outcome measures (CI-alone CNC and AzBio, binaural SIN and SL, and CIQOL) in similar proportion to the Meets group. For both groups, all but 1-2 patients improved in CNC, AzBio, SIN, and CIQOL, while all but 3-4 patients improved in SL. Mean improvement magnitude in CNC, AzBio, and SIN was slightly smaller for the Exceeds group, but only because pre-operative performance was better; post-operative scores were similar for the two groups. SL and CIQOL pre-operative scores, post-operative scores, and improvement magnitudes were similar for the two groups.

Conclusion: SSD-CI recipients exceeding FDA SSD-CI candidacy criteria improved in CI-alone speech perception, spatial hearing, and subjective outcomes in similar proportion and magnitude to those meeting the criteria. Larger-scale clinical trials should be completed to evaluate SSD-CI efficacy using a less-stringent candidate-ear criterion, such as the 50% speech score used for traditional CI candidates.

Primary Author/Presenter: Elicia Pillion, AuD

Author Block: Elicia M. Pillion, Au.D , Anthony M. Tolisano, MD, Josh G. W. Bernstein, Ph.D; Department of Surgery, Walter Reed NMMC, Bethesda, MD.

Learner Objectives:
Describe the differences in cochlear-implant candidacy criteria between patients with single-sided deafness and traditional candidates with bilateral severe-to-profound hearing loss.
Understand how spatial hearing and quality of life are critical in the assessment of single-sided deafness cochlear-implant outcomes.
**Abstract Content:**

Introduction: Cochlear implantation (CI) in adult patients with single-sided deafness (SSD) has been shown to suppress tinnitus, improve speech perception, and improve binaural auditory input, yet many patients who qualify may opt out of implantation. The objective of this study is to understand the demographic and audiometric factors that underlay patient decision-making.

Methods: A retrospective chart review of patients with SSD who underwent CI evaluation from 2021-2022 was conducted. Descriptive statistics, univariate analyses and regression analyses were performed on the cohort of CI recipients versus those who chose not to proceed with implantation.

Results: Of 61 patients, 45 adults with SSD met inclusion criteria. The mean age at time of CI evaluation was 54 (Range 20-80 years), with a mean age of 42 at onset of deafness (Range 0-76 years). The average duration of deafness was 12 years (Range 0-64). 67% of the etiology of deafness was sudden sensorineural hearing loss (SSNHL). 76% of patients had tinnitus of which 97% had it in the affected ear. 49% of patients elected to get a CI, which occurred on average 122 days (4 months) after CI evaluation (range 22-513 days). Of those who did not elect for CI, 48% were lost to follow up, 30% selected hearing aids, and less than 1% underwent implantation of a bone-anchored hearing aid (BAHA). Patients who opted to undergo CI had significant tinnitus in the unaffected ear (p=0.01). Those who underwent CI had significantly higher pure tone average (PTA) of the affected ear (96 dB vs 82 dB, p=0.01), and speech reception threshold (SRT) of the affected ear (91 dB vs. 77 dB, p=0.01). Demographics including marital status, insurance, or employment status, age at onset of deafness, duration of deafness, and tinnitus of the affected ear were not significant predictors.

Conclusion: While CI has been shown to improve quality of life and audiometric outcomes in those with SSD, further research is needed to understand what factors may influence a patient to undergo implantation. Delineation of these factors can aid in patient candidacy decisions and realistic outcomes counseling.

**Learner Objectives:**

Compare patients with single sided deafness who opted to received a cochlear implantation to those who decided not to proceed

Identify patient demographic and audiometric factors that predicted cochlear implantation adoption rates in patients with single-sided deafness
**Concurrent Session:** Concurrent Session 7-1 "Robotics and Fully Implantable Cochlear Implants"

**Abstract Number:** 109

**Abstract Title:** Long-term Audiological Outcomes Of Robot-assisted Cochlear Implant Surgery

**Abstract Content:**

Introduction: Recently, image-guided robot-assisted techniques have been introduced in otology which facilitate minimally invasive keyhole access for cochlear implantation. Significant technological innovations in terms of navigation accuracy allowed a safe and reliable middle and inner ear access and a correct manual electrode array insertion. Although a full and correct positioning of the electrode array in the inner ear is crucial, the audiological outcomes of implanted patients are as important. Therefore, the main objective of this study is to evaluate the short-term and long-term audiological outcomes in patients who underwent cochlear implantation with a robot-assisted system to enable access to the cochlea, and to compare outcomes with a matched control group of patients who underwent cochlear implantation with conventional access to the cochlea.

Methods: In total, 23 patients were implanted by robot-assisted cochlear implant surgery (RACIS), including 21 patients with bilateral severe-to-profound sensorineural hearing loss (SNHL) and 2 patients with single-sided deafness (SSD). In order to evaluate the effectiveness of robotic surgery in terms of audiological outcomes, a statistically balanced control group of conventionally implanted bilaterally deaf patients was created, based on the following covariates: (1) age at onset of the SNHL (2) age at onset of bilateral severe-to-profound SNHL (3) duration of bilateral severe-to-profound SNHL (4) etiology of hearing loss (5) hearing aid use pre-implantation (6) age at implantation (7) pre-operative residual hearing and (8) pre-operative aided speech perception in quiet of the implanted ear. Furthermore, an SSD cohort group of 8 conventionally implanted patients was created in order to interpret the results of the SSD patients.

Minimal Outcome Measures (MOM), consisting of pure-tone audiometry, speech understanding in quiet, speech understanding in noise, binaural effects and sound localization, were performed pre-operatively and at 3 months, 6 months, 12 months and 2 years post-activation of the audioprocessor.

Results: There was no statistically significant difference in pure-tone audiometry, speech perception in quiet and speech perception in noise between bilaterally deaf robotically implanted and conventionally implanted patients pre-operatively, 3 months, 6 months, 12 months and 2 years post-activation. A significant improvement in pure-tone hearing thresholds, speech understanding in quiet and speech understanding in noise with the cochlear implant has been quantified as of the first measurements at 3 months and this significant improvement remained stable over a time period of 2 years for robotically implanted patients. Furthermore, robotically implanted SSD patients perform similar to a conventionally implanted SSD cohort in terms of binaural effects and sound localization performance.

Conclusion: Clinical outcomes in robot-assisted cochlear implant surgery are comparable to conventional cochlear implantation.

**Primary Author/Presenter:** Emilie Heuninck, MSc

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**Learner Objectives:**

Describe short- and long-term hearing outcomes of patients who underwent cochlear implantation with a robot-assisted system
CI2023 Dallas: Cochlear Implants in Children and Adults

Compare short- and long-term hearing outcomes of robotically implanted patients with a matched control group of patients who underwent conventional cochlear implantation.
**Abstract Content:**

Introduction: Binaural pitch mismatch has been associated with poor spatial hearing ability in cochlear implant recipients, both in those with acoustic hearing in the contralateral ear (bimodal and single-sided deafness (SSD) users) and in bilateral cochlear implant (CI) users. A robotics-assisted CI insertion system has recently been developed to allow more controlled, slow (0.1 to 0.5 mm/sec) electrode insertions with the goal of improving hearing preservation and CI outcomes. In this study, we report a novel use of the robotic-assisted CI insertion system that takes advantage of this reduced insertion speed to perform real-time intra-operative pitch matching between the cochlear implant and normal hearing ear in a patient with SSD.

Methods: This is a clinical case study with a video demonstration of a 63-year-old female with right-sided profound SNHL due to uncontrolled Meniere’s disease and labyrinthectomy who received robotic-assisted CI for SSD under monitored anesthesia care (MAC). Before surgery, the patient was instructed on the pitch-matching task using low-frequency tone bursts. The procedures for pitch ranking (high vs. low) and pitch discrimination (same-different) were practiced. IotaSOFT™ (iotaMotion, Inc., USA) FDA-approved robotics-assisted CI insertion was performed. When the electrode array was halfway inserted into the cochlea (6 electrodes intracochlear) in a stable position, the patient participated in loudness scaling of the most apical electrode. When the array was further advanced into the cochlea, the most apical electrode was stimulated with discrete presentations of pulse trains. A 250Hz tone was presented to the normal hearing ear simultaneously. Once the electrode array was in the final position, the apical electrode was stimulated while the tone burst frequency was varied in the normal hearing ear.

Results: With six electrodes in the cochlear, the patient judged electrical stimulation to the most apical electrode as “higher” in pitch than the 250 Hz stimulus to the normal hearing ear. The patient continued to judge the electric stimulus as higher in pitch from 7 to 10 electrodes inserted. With 11 electrodes inserted, the patient judged the electric stimulus to be “closer,” and with 12 electrodes inserted, the electric stimulus was “lower” than 250Hz. After full insertion, the patient matched the electrical stimulation of the most apical electrode to a 125 Hz tone burst in the normal hearing ear.

Conclusion: Pitch-perception tasks are often challenging for CI recipients. The current study demonstrates the feasibility of using robotic-assisted technology to perform real-time intraoperative pitch-matching. We plan to repeat this testing with several SSD patients to explore the possibility of using intraoperative pitch-matching results for clinical decision-making, both during implantation and CI programming postoperatively.

**Primary Author/Presenter:** Armine Kocharyan, MD

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**Learner Objectives:**

Learn about binaural pitch matching and its importance in spacial hearing

Learn about robotic-assisted CI insertion and how the reduced speed insertion can be used for intra-operative pitch matching
Concurrent Session: Concurrent Session 7-1 "Robotics and Fully Implantable Cochlear Implants"

Abstract Number: 206

Abstract Title: Robotic cochlear implant surgery - first experience

Abstract Content:
Introduction: Robotic surgery has entered the field of cochlear implantation with the aim of achieving a minimally invasive approach to the inner ear. High expectations are raised to better preserve the residual hearing due to a reduced trauma to the inner ear. In robotic cochlear implant surgery, a tunnel to the inner ear is directly drilled through the mastoid. A minimal distance to the facial nerve, chorda tympani and the stapes footplate is necessary to successfully plan a safe trajectory. We present our experience with the first cases of cochlear implant surgery with a robot.

Methods: Patients at the age of 18 or older, who were planned for cochlear implant surgery, were screened. To assess whether surgery can be performed with the robot, data of computed tomography imaging were analyzed with a surgical planning software. A sufficient image resolution of at least 0.3 mm or less was necessary to identify all relevant anatomical landmarks. Patients in whom a safe trajectory to the inner ear could be successfully planned, were asked for their consent to perform the surgery with the robot.

Results: Up until abstract submission two patients were implanted with the robot. The main reason for planning failures during patient screening was insufficient imaging resolution. The first patient who was successfully screened for robotic surgery had an ossification at the round window. By adapting the planning procedure, a safe trajectory was planned, and robotic cochlear implant surgery was successfully performed. The surgeries included the following steps: patient preparation, incision and fiducial screw placement, intraoperative imaging and planning, drilling a middle and inner ear access including multiple safety checks for facial nerve monitoring, electrode insertion and postoperative imaging and analysis.

Conclusion: Cochlear implant surgery can be successfully performed with a robot. Sufficient imaging resolution is necessary to assess relevant anatomical landmarks and to calculate a safe trajectory to the middle and inner ear by a surgical planning software.

Primary Author/Presenter: Alice Auinger, MD

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Learner Objectives:
- explain the different steps of performing a robotic cochlear implant surgery.
- identify the importance of computed tomography image resolution for patient screening in robotic cochlear implant surgery.
Abstract Number: 225

Abstract Title: Cochlear Implantation - First Clinical Results of a Novel Minimally Invasive Approach

Abstract Content:
Introduction: Cochlear Implants are prostheses for the inner ear to treat sensorineural hearing loss. The implantation procedure is a microsurgical challenge, due to the nearby risk-structures embedded in the temporal bone and the difficult insertion of the electrode array into the scala tympani of the inner ear. The clinical need to replace the manual conventional surgery with a safe, fast and simple implantation is high because the healthcare system is facing an increasing demand for CI, driven by the demographic change.

Methods: The surgical system that we developed consists of a mini-stereotactic frame which is temporarily fixated to the skull behind the ear. An in-house developed planning software is used to define a safe access trajectory suited for an optimal electrode array insertion. This trajectory is transferred to an automated robotic on-site medical device production system for creating a patient matched positioning jig. This jig is is to be attached onto the mini-stereotactic frame and its purpose is to guide drill bits along the previously defined trajectory. An interventional feasibility study at a large German University Hospital has been designed in three phases: In the first phase, no real minimally invasive drilling has been performed but only sham drill bits have been used after a conventional mastoidectomy and posterior tympanotomy in order to evaluate whether the system produces a safe access path in situ. In the second phase, the minimally invasive drilling is performed along the first "safe" part just before reaching the risk structures like the facial nerve and the chorda tympani and then, under visual control by a partly conventional mastoidectomy, the passage through the facial recess is drilled. The third phase will include opening the round window membrane and handling of the CI electrode array in the drilled tunnel to perform an insertion.

Results: The feasibility study is being performed and the first phase, including six patients, is completed and sham drill bits of 1.52 mm ø could successfully be passed through the facial recess. The second phase is ongoing and includes, so far, three patients demonstrating that the jig-based minimally-invasive drilling can be implemented without mechanical and without heat damage to the risk structures, particularly the facial nerve.

Conclusion: A safe and simple minimally invasive cochlear implantation is feasible and can be integrated into the hospital routine to help surgeons meet the expected future demand. It is noteworthy that with the chosen diameter of the drill bit passing through the facial recess and keeping a planned distance of 0.3 to 0.4 mm to the facial nerve, so far, no patient had to be excluded.

Primary Author/Presenter: Thomas Lenarz, MD, PhD

Author Block: Thomas Lenarz, MD, PhD, Max Fröhlich, MD, Marcel Kluge, -, Jan Stieghorst, -, Rolf Salcher, MD, Samuel John, Dipl.-Inform., Department of Otorhinolaryngology, Hannover Med. Sch., Hannover, Germany, MED-EL Res. Ctr., Hannover, Germany, OtoJig GmbH, Hannover, Germany.

Learner Objectives:
Identify benefit of a future minimally invasive cochlear implantation.
Abstract Title: First Experience in Robotic Cochlear Implantation

Abstract Content:

Introduction: The project of Robotic Cochlear Implantation started before 2005. Since that time the author of this abstract is involved into the program. Until 2010 the project was financed by a found. In the beginning we started with industrial roboter-arms. Over the years a more and more stable, complex, reliable, safe and accurate system could be built. The name of this recent Cochlear Implant Robot is not written in this abstract. The worlds first robotic CI surgeries were done in 2 other departments, followed by our team as 3rd department worldwide in 2021. The system needs training from a team of surgeon, nurse and computer-technicians. All the surgery is planed by Otoplan System prior to the surgery. Once the Otoplan setting is done, the surgeon observes the surgery performed by the Robot only. Methods: So far we implanted 44 patients by the Robot. At the moment the system is thought for adult patient only. All Cochlear Implantations were successful in adult patients. The accuracy of the system is 0,01mm. Nevertheless the surgery is still supervised by an experienced CI surgeon. The legal responsibility for the surgery is at the surgeon. All robotic cochlear implanted patients were carefully preselected through MRI, CT and Otoplan planning. About one out of 8 adult CI candidates was eligible for robotic surgery. This is related to the high safety standards at the moment, testing the system. In all cases we could achieve full electrode insertion for 28mm insertion depth. Results: We show and report about the first cases and the experience from our team. The mean surgical time was 5.5 hours. No complication at all could be observed. In all cases we could achieve full electrode insertion for 28mm insertion depth. We could not observe any negative side effect, the system works reliable , reproducible and safe. Conclusion: The Cochlear Implant Robot is a big step into the future and proves that safe CI surgery in a high number of cases in adult patients already now can be safely performed by a robot.

Primary Author/Presenter: Wolf-Dieter Baumgartner, Prof MD PhD MBA

Author Block: Wolf-Dieter Baumgartner, Prof MD PhD MBA ENT, Med. Univ. Vienna, Vienna, Austria.

Learner Objectives:

There exists a robot , which can do autonomous cochlear implant surgery

safe cochlear implant surgery in adult patients
**Concurrent Session:** Concurrent Session 8-1 "Cochlear Implantation in the Very Young"

**Abstract Number:** 60

**Abstract Title:** Safety and early outcomes of cochlear implantation in infants: A multi-centre study

**Abstract Content:**

Introduction: The aim of this study was to determine whether previously off-label use of cochlear implants in children under 12 months is safe and effective. Prior to 2020, many countries provided approval for cochlear implantation in children as young as 12 months of age. Yet, evidence to support the importance of identifying hearing loss and providing access to sound in infants by 6 months of age has become increasingly clear. Several cochlear implant centres provided cochlear implants to infants below 12 months on this basis.

Methods: A multi-centre retrospective chart review of cochlear implantation provided to infants < 12 months of age was conducted. In Stage 1, outcome measures included surgical and recovery times and adverse events up to 6 months post-operatively in a group of 84 infants implanted at 9.00-11.99 months of age between January 1, 2012–December 31, 2017. These data have been reported previously. In Stage 2, data collection expanded to include adverse events over a longer period, up to 24 months post-operatively, in the original group (Cohort 1) and measures of post-operative hearing (audiograms, parental questionnaires of post-implant hearing and speech-language development). In addition, a new group of 51 infants implanted between January 1, 2018 and May 15, 2020 were recruited for review of the same outcome measures.

Results: Data were obtained from 5 different centres. Age at implantation for Cohort 2 was mean(SD)= 10.4 (0.9) months and 31% of all subjects (Cohort 1 & 2) were implanted prior to 10 months. Most of the surgeries were simultaneous bilateral procedures (92/134) and surgical outcomes were duration under anaesthesia, estimated blood loss, and duration in recovery. The rate of adverse events up to 6 months post-implant was slightly lower in Cohort 2 (19.6%) than Cohort 1 (26.5%), primarily due to reduced instances of thermoregulation in surgery. The most common post-operative issue was ear-related infections experienced by 12/134 infants up to 6 months post-implant and 4/134 infants from 6-24 months post-implant. Outcomes of cochlear implantation revealed aided access to conversational speech sounds (aided PTA mean(SD)=dB HL) and significant improvements in hearing and language development measured on the LitlEars questionnaire (p<0.0001).

Conclusion: Stage 2 of this multi-centre study confirmed the safety of cochlear implantation in infants reported from Stage 1. Earlier surgical issues of thermoregulation appear to have been addressed in these centres. Ear infections, common to this age group, and other potential post-operative events should be monitored. Outcomes reveal early hearing and language development promoted by cochlear implant use.

**Primary Author/Presenter:** Karen Gordon

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**Learner Objectives:**

Explain why cochlear implants should be provided to children below 12 months of age.

Describe a hearing outcome of cochlear implantation in infants.
**Abstract Title:** Early Clinical Experience with Same Day/Next Day Cochlear Implant Activations

**Abstract Content:**

Introduction: Projected estimates indicate that less than 5% of those who can benefit from a cochlear implant have access to this life-changing technology. Many obstacles to this technology are noted including lack of awareness about cochlear implants as a possible intervention, fear of surgery, concern regarding loss of residual hearing and travel related costs associated with follow-up visits. Numerous solutions to improving access have been proposed including meeting with primary care physicians, ENTs and audiologists to improve awareness about the technology, establishing satellite clinics that provide access to rural areas and utilization of telehealth visits for CI evaluations and routine programming visits. Some clinics have recognized the stability of T and C/M levels over time and have reduced the number of follow-up visits required post cochlear implantation in order to minimize travel, time and cost related burdens on recipients. The implementation of same day/next day activations can prove valuable and efficacious for recipients, particularly those who live far from clinics, have limited transportation options, or who are medically fragile.

Methods: Early clinical experience is presented for 12 cochlear implant recipients ages 5 to 87 who received same day/next day activations of their cochlear implants. One of the main objectives of this study was to determine if patients who had to travel significant distances to receive services from their implant center would be interested in same day/next day activations to minimize travel required for follow-up. Another objective of this study was to determine if there were any negative consequences related to early activation and whether speech perception data at 3 months post-activation was comparable to patients who did not receive early activation.

Results: In all cases when same day/next day activation was offered to out-of-town patients, patients opted to receive early activation. Additionally, one patient who was seen for explantation and re-implantation requested early (same day) activation. Unique considerations for pediatric and adult patients who were activated on the same day as surgery or the next day after surgery are discussed, including the need to send patients home with additional magnets, and the need to create appropriately loud MAPs for patients so that remote programming can be conducted 1-month post-activation with relatively minor changes to programming. Speech perception results at 3-month post-activation are also presented and compared to data obtained for patients who did not receive early activation.

Conclusion: The implementation of same day/next day activations can prove valuable and efficacious for recipients, particularly those who live far from clinics or who need early access to sound. No negative consequences were noted following early activation, and patients achieved comparable speech perception results at 3- months post-activation compared to patients who were not activated early.

**Learner Objectives:**

Participants will be able to describe advantages to early activation of cochlear implants.

Participants will be able to describe important considerations when providing early activation.
Abstract Number: 215

Abstract Title: Cochlear Implant Cases Below 9 Months

Abstract Content:

Introduction: Increasing evidence of improved outcome in younger age at cochlear implantation has led to continuous research on the safety of decreasing the age boundary below 9 months.

Methods: This retrospective case series examined the prevalence of surgical, anesthetic, and device-related complications as well as audiological outcomes among the pediatric patients below 9 months who underwent CI from January 2019 till October 2022 in a tertiary academic referral center.

Results: Two patients younger than 9 months (6 and 7 months, weight 7.97kg and 7.8kg) were implanted in the studied period. They were diagnosed with profound SNHL by sedated ABR at age of 4 and 5 months respectively and both were confirmed with visual reinforcement audiometry at age of 6 months. Etiologic diagnostic studies found genetic mutations of uncertain significance and congenital CMV respectively. Both were bilaterally implanted, with a total time under anesthesia of 5h and 4h, estimated blood loss of 20 and 5 cc, total duration in recovery of 1h20mn and 10mn, respectively. Both were admitted for one day with no intra or postoperative complications, no temperature regulation issues, no arrhythmia, no need for readmissions and no device malfunction. Both had full electrode insertion. First patient has a three months follow up with last soundfield testing showing speech awareness threshold 20dB, Tonal testing 25dB from 500-2000Hz. Second patient has a follow up of two years and last sound field testing shows a speech awareness threshold 25dB, tonal testing 25-45 dBHL from 500-8000 Hz.

Conclusion: Two infants below 9 months were safely implanted with no surgical, anesthetic, and device related complications.

Primary Author/Presenter: Evana Francis, MD

Author Block: Evana Francis, MD, Nandini Govil, MD, MPH, Kristan P. Alfonso, MD; Pediatric Otolaryngology, Emory Univ. school of Med., Atlanta, GA.

Learner Objectives:

To describe the prevalence of surgical, anesthetic, and device-related complications among the pediatric patients below 9 months who underwent CI from January 2019 till October 2022 in a tertiary academic referral center.

To describe the audiomeric outcomes among the pediatric patients below 9 months who underwent CI from January 2019 till October 2022 in a tertiary academic referral center.
Concurrent Session: Concurrent Session 8-1 "Cochlear Implantation in the Very Young"

Abstract Number: 134

Abstract Title: Early Implantation In Children With Complex Medical Needs: A Multidisciplinary Approach

Abstract Content:
Introduction: Research suggests that earlier cochlear implantation in children with bilateral severe to profound hearing loss leads to better spoken language outcomes (Waltzman & Roland, 2005; Cuda et al., 2014). In 2020, the FDA approved implantation for children 9 months and older to facilitate improved outcomes. At a major pediatric medical center, the patient population can be diverse with regards to medical diagnoses. Our patients are medically complex and benefit from multidisciplinary care. Children of all abilities can benefit from an earlier age at implantation, though outcomes and expectations for spoken communication may differ.

Methods: A review of electronic medical records was completed for cochlear implant recipients at Children’s Hospital Colorado from 2018-2022. Inclusive criteria were infants who were diagnosed with severe to profound hearing loss by 3 months of age and had at least one other medical diagnosis. Of these patients, their cochlear implant trajectory was evaluated and compared to children who were also diagnosed by 3 months of age who did not have additional diagnoses. Information including age at implantation and outcomes (quality of life and speech perception) were collected and reviewed. All analyses were completed in SPSS.

Results: Preliminary results suggest that children who have medical diagnoses in addition to hearing loss take longer to progress through the cochlear implant evaluation process than children without additional medical diagnoses. This is due, in part, to the need for appointments with additional medical specialists (neurology, cardiology, etc.) as well as extended counseling with the cochlear implant team regarding appropriate expectations. While these children are often implanted at an older age when compared to their peers with hearing loss and no additional medical diagnosis, they are not precluded from “early implantation”. Data collection and analysis is ongoing.

Conclusion: Complex medical needs should not preclude a child from being evaluated for early cochlear implantation. However, the number of medical appointments for the child’s overall health and well-being may delay their age at cochlear implantation. Children with hearing loss are heterogeneous, however, children with complex medical needs have even greater heterogeneity. This highlights the importance of both following best practice and tailoring the evaluation process to each individual to optimize outcomes. Among the population we studied, the delays in implantation were caused by the following: 1. Additional appointments with other medical providers. 2. Increased counseling to support development of realistic expectations. Our multidisciplinary team approach is designed to support the whole child and empower the family when deciding on cochlear implantation. With appropriate counseling, families of children with complex medical needs can have realistic expectations and overall satisfaction with their child’s unique cochlear implant journey. We will continue to evaluate the additional time to support each child and their family.

Primary Author/Presenter: Laura Greaver, AuD; Dani Stern, AuD

Author Block: Laura Greaver, AuD, Dani Stern, AuD; Children's Hosp. Colorado, Colorado Springs, CO.

Learner Objectives:
At the end of the session, participants will be able to explain the importance of early implantation in patients with medical complexities.
**Abstract Content:**

Introduction: Despite the estimated prevalence of patients with hearing loss appropriate for cochlear implantation (CI), the rate of CI remains disproportionately low across the United States, which may be in part due to systemic barriers preventing timely intervention. Inequities in access to CI may be related to individual characteristics and personal beliefs regarding health care, as well as external factors that influence access to health care, including health insurance, physical environments, and community/policy supports and systems. There is a critical need to better understand the impact of these factors on access to CI, particularly those related to geographic proximity to surgical centers and the influence of the local communities in which people live. To better understand barriers and facilitators to timely intervention through an intersectional framework, the present study assessed the rates of CI across the state of Kentucky over a seven-year period.

Methods: Retrospective inpatient and outpatient patient discharge data were gathered from the Hospital Discharge Database (Health Facilities and Services Data) for all hospitals in Kentucky from 2015-2021. Patients who underwent CI were identified by relevant surgical Current Procedural Terminology (CPT) or ICD-10 Procedure Coding System (PCS) codes. Patient demographic data were extracted, including age at CI, the surgical facility, diagnosis codes, insurance status, race/ethnicity, zip code, and county. Patients who resided out of state were excluded. The rate of CI was calculated for each county and the state overall. To account for community-level factors that may influence access to care, annual County Health Rankings were used to identify the top ten and lowest ten counties in Kentucky according to health factors (e.g., health behaviors, access to clinical health care, socioeconomic factors, and quality of physical environment). County-level data, including access to primary care, life expectancy, and rurality were also extracted from County Health Rankings data.

Results: The overall rate of CI across the state of Kentucky is lower than the national average with only 2.3 implants per 10,000 people, suggesting the presence of barriers to care. A greater percentage of patients receiving CI (17%) were from higher-ranked counties (e.g., those counties with health factors more likely to support individual health) compared to lower-ranked counties (4%). However, prevalence of CI did not differ significantly when accounting for total population in the high vs low-ranked counties. In unadjusted analyses, rural counties had a higher average rate of implantation. Preliminary findings also suggest that geographic proximity to the CI surgical centers may influence patients’ ability to receive CI. Sociodemographic variables will be discussed.

Conclusion: To ensure equitable access to appropriate interventions for patients with hearing loss, barriers to CI must be critically assessed. Our findings suggest that there is limited and inequitable access to CI in Kentucky, and highlight opportunities for innovative interventions to address these barriers. More widespread research is needed to better understand the patient factors and external factors that delay or deter cochlear implantation.

**Primary Author/Presenter:** Amanda G. Davis, BA, AuD in progress

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**Learner Objectives:**
CI2023 Dallas: Cochlear Implants in Children and Adults

Identify sociodemographic factors that may impede access to cochlear implantation.

Describe intersectionality in barriers to cochlear implantation.
Abstract Content:

Introduction: Existing health utility measures fail to capture clinically important differences in hearing-related health states. As a result, cost-effectiveness analyses are at risk of conclusions that inappropriately support withholding beneficial hearing interventions including expanded cochlear implant criteria. The Hearing Health Utilities Index (HUI-Hearing) is a novel multi-attribute preference-based measure of health status and health-related quality of life designed to improve the validity of utility estimates in hearing-impaired populations. The Hearing attribute consists of 7 sub-attributes (or domains): speech recognition, environmental sounds, localization, listening effort, tinnitus, music appreciation, and assistive devices with 3 to 6 levels per sub-attribute varying from normal to highly impaired. After a respondent’s hearing status is classified by the HUI-Hearing, a scoring function must be applied to output health utility. The objective is to derive the single attribute utility function for the re-designed Hearing attribute, which is to remain nested within the greater context of the existing Health Utilities Index, Mark 3 (HUI-3) multi-attribute utility function. This nested model aims to maintain the relative importance of hearing impairment to overall health utility while improving the instrument’s ability to discriminate clinically distinct hearing states.

Methods: Valuation interviews were conducted with a sample of the general population of Toronto, Ontario Canada aged ≥ 18 years. Standard gamble and visual analog scale valuations were obtained for perfect hearing, most disabled hearing (all 7 sub-attributes at their lowest levels), no hearing, and three marker states chosen to span the intermediate space between perfect hearing and the most disabled state. Each respondent was randomly assigned to evaluate two sub-attributes and performed valuation exercises for each level of the sub-attribute of interest in hearing states consisting of level one (normal) for the other 6 sub-attributes. A multi-subattribute utility function was fit with a multiplicative functional form according to methods previously described for the HUI-3. The single attribute hearing utility estimates derived from the original HUI-3 were compared to those derived from the novel HUI-Hearing for respondents in this valuation exercise.

Results: A total of 126 respondents participated in valuation interviews (mean age 39.2, range 18-85 years) 56% female (67/126). Self-reported overall health was very good or excellent in 60.3% (76/126) and 79% (60/126) reported normal hearing. Compared with the original HUI-3 hearing attribute, variability of hearing utilities increased significantly with the HUI-hearing. Among patients with HUI-3 derived single attribute hearing utility of 1.0 (no hearing disability measured), mean HUI-Hearing utility was 0.93 (range 0.50 - 1.00), demonstrating the capacity of the novel instrument to capture hearing-related disability not measured by the legacy instrument. Conclusion: The multi-sub-attribute utility function reports single-attribute hearing utility for the 25,920 hearing states described by the novel Hearing attribute. It provides improved granularity for distinguishing hearing-related health states compared to existing utility instruments and can be used as an outcome measure in clinical studies and to facilitate appropriate health resource allocation for hearing interventions.

Primary Author/Presenter: Peter Dixon, MD, MSc

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Learner Objectives:

Appreciate the limitations of generic utility instruments in hearing loss and how condition-specific utility instruments can better evaluate the effectiveness of hearing interventions.

Understand the composition of health utility instruments and the steps involved in their design and valuation.
**Concurrent Session:** Concurrent Session 7-3 "Quality of Life and Patient-reported Outcome Measures"

**Abstract Number:** 150

**Abstract Title:** Establishing and applying the conditional minimal detectable change values for the Cochlear Implant Quality of Life-35 Profile Instrument

**Abstract Content:**

Introduction: Whether in research studies or clinical practice, it is essential to measure an individual patient’s baseline condition and precisely detect change over time. Inherent in this assessment strategy is interpreting whether the measured change is significant. Conditional minimal detectable change (cMDC) values are widely used in many disciplines, but they have rarely been established for patient-reported outcome measures and speech recognition measures used in hearing research and never in cochlear implantation. The current study (1) establishes cMDC values for the CIQOL-35 Profile instrument and (2) applies these values to better understand the impact of cochlear implantation on the functional abilities of adult CI users.

Methods: Standard error (SE) values for each possible CIQOL domain score were derived using item response theory analyses in a multi-institutional cohort of 705 adult CI users with at least one year of CI experience. SE values were then used to calculate cMDC values for every possible pre and post score combination. The cMDC values were then applied to evaluate improvement in pre-CI to 12-months post-CI CIQOL domain scores in a cohort of 42 adult CI users undergoing implantation for traditional bilateral hearing loss indications.

Results: As anticipated based on SE values, cMDC values were smaller for the Communication domain and Global measure and were larger for all domains at the extremes of the measurement scale. Overall, nearly all CI users (88.1%) demonstrated improvement beyond cMDC for at least one CIQOL domain and no patient worsened beyond cMDC for every domain. The percent of CI users demonstrating improvement beyond cMDC varied by domain, with Communication (96.0%) showing the largest number of CI users followed by the Entertainment domain (64.3%). Improvement beyond cMDC occurred for the fewest CI users for the Listening Effort and Social domains (46.4%); however, for these domains, very few patients (4.8% and 0.0%, respectively) demonstrated a detectable decrease in score beyond cMDC.

Conclusion: Without knowing cMDC values, researchers and clinicians are forced to rely on statistically determined differences (i.e., p-values) to detect a significant change in outcome measures, which rely on group-level data analyses and cannot be applied to an individual patient to monitor change. cMDC values for the CIQOL-35 Profile provides the means to monitor meaningful changes in functional abilities longitudinally across multiple domains and has the potential to influence clinical decision-making. Moreover, the extent of meaningful changes in functional abilities over time provide insight into the domains where improvement is most likely to be realized for individual patients, which can aid in patient counseling.

**Primary Author/Presenter:** Theodore McRackan, MD, MSCR

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**Learner Objectives:**

Understand the importance of knowing an instrument’s conditional minimal detectable change value

Understand the domains in which cochlear implants improve functional abilities after implantation.
**Abstract Number:** 151

**Abstract Title:** Development and Validation of the Cochlear Implant Quality of Life (CIQOL) Functional Staging System and its Application to Improve Patient Counseling

**Abstract Content:**

**Introduction:** Functional staging systems based on patient-reported outcome measures provide detailed descriptions of patients’ self-reported functional abilities in the form of clinical vignettes without sacrificing the value from the psychometrically-derived quantitative scores. Here, we describe the development and validation of the Cochlear Implant Quality of Life (CIQOL) Functional Staging System and investigate the association between patients’ pre-CI functional stage and subsequent improvement in functional abilities following cochlear implantation.

**Methods:** The CIQOL Functional Staging System was developed using an iterative, mixed-methods research design that included: item response theory analyses of CIQOL-35 Profile responses (6 domains and a global score) from 705 experienced adult CI users, expert opinion, and semi-structured key informant interviews with adult CI users. Next, we prospectively obtained CIQOL-35 Profile scores from 71 CI users prior to CI; patients were grouped based on their pre-CI functional stage for each domain. These and other outcomes (CNC words and AzBio sentences) were monitored at 3/6/12 months post-CI activation.

**Results:** Using the stepwise, mixed-methods approach, 5 statistically distinct stages for the CIQOL-35 communication domain and 3 stages for all other domains were identified. CI care team members agreed regarding the location of the cut-scores that separated stages for each domain (κ= 0.98 [0.96-0.99]). CI users found the clinical vignettes associated with each stage to be clear and agreed that stage progression represented meaningful improvements in functional abilities. For the longitudinal study, 61 (85.9%) CI users demonstrated improvement by at least one stage for at least one domain during the 12-month post-CI study period. However, outcome trajectories differed substantially based on patients’ pre-CI functional abilities. For all domains, patients at higher pre-CI domain-specific CIQOL stages (higher pre-CI functional abilities) were less likely to demonstrate post-CI improvements than those at lower pre-CI CIQOL stages. For example, only 25.0% (n=4 of 16) of patients in pre-CI communication stage 3 demonstrated domain-specific post-CI improvement, compared to 72.7% (n=40 of 55) of patients in pre-CI stages 1 or 2 (d=1.07[0.48-1.65]). Notably, no differences in improvement in CNC word (d=0.47[-0.1-1.02]) or AzBio sentence (d=0.26[-0.30-0.82]) scores were observed between functional-stage cohorts.

**Conclusion:** The CIQOL Functional Staging System provides an enhanced evidence-based understanding of the real-world functional abilities of adult CI users across multiple domains. The staging system helps monitor post-CI outcomes and may also be used to counsel patients regarding the likelihood of improvement in post-CI functional abilities. As an example, patients at higher pre-CI functional stages should be made aware of the risk of no further improvement following cochlear implantation.

**Primary Author/Presenter:** Theodore McRackan, MD, MSCR

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**Learner Objectives:**

Understand how functional staging systems can improve patient care

Understand the role that pre-CI functional stage may play in the degree of improvement observed in CI users


**Concurrent Session:** Concurrent Session 7-3 "Quality of Life and Patient-reported Outcome Measures"

**Abstract Number:** 311

**Abstract Title:** The Impacts of Cochlear Implantation on Subjective Music Perception in Adolescents

**Abstract Content:**

Introduction: Music forms a powerful contributor to quality of life due to its effect on interpersonal communication (e.g., shared experiences such as concerts) and individual well-being (e.g., mood, emotion, and behavior). Difficulties perceiving music may negatively influence these aspects of quality of life. For individuals with significant hearing loss, cochlear implants (CIs) afford access to sound via an electric signal with reduced intensity, temporal, and spectral resolution relative to typical hearing, but processing strategies and electrode designs primarily focus on enhancing speech perception rather than music perception. No studies to date simultaneously explore music engagement, music enjoyment, music perception, and speech perception in adolescent CI listeners. This study explores the effect of auditory status on music perception (pitch direction and timbre) and music appreciation in adolescents.

Methods: Participants include 42 adolescents (13-17 years), 17 using CIs (M\(</i>\)=14.9 years, 41% female) and 25 with typical hearing (M\(</i>\)=15.5 years, 44% female). Participants completed the Music-Related Quality of Life (MuRQoL) questionnaire to assess subjective music perception via self-rated musical ability and importance of musical experiences. A two-way analysis of variance examined effects of auditory status group and gender on self-rated MuRQoL score.

Results: Adolescents with CIs report significantly poorer musical ability than peers with typical hearing (CI: M\(</i>\)=65.2, TH: M\(</i>\)=74.2), \(p=0.01\), but no difference in importance of music (CI: M\(</i>\)=55.9, TH: M\(</i>\)=61.1), \(p=0.12\). More variance in musical importance scores was accounted for by musical ability scores in adolescents with typical hearing compared to adolescents with CIs. However, in both groups, self-reported ability was significantly related to self-reported importance of music.

Conclusion: Adolescents with typical hearing and adolescents with CIs differed significantly on perceived musical ability scores, converging with previous research, which likely reflects the limitations of CI technology to effectively code musical stimuli. However, the two groups rated musical importance similarly, suggesting that in CI listeners, the impact of music can transcend the limitations of CI technology. Practically, this study suggests that clinicians should evaluate both perceived musical ability and importance in adolescent CI listeners to accurately capture a crucial contributor to their quality of life.

**Primary Author/Presenter:** Kristin Kronenberger, BA

**Author Block:** Kristin Kronenberger, B.A., Andrea Warner-Czyz, PhD, Stephanie Fowler, AuD, PhD; Audiology, Univ. of Texas at Dallas, Richardson, TX.

**Learner Objectives:**

Describe differences in subjective music perception between adolescents with typical hearing and adolescents with cochlear implants.
Abstract Number: 320

Abstract Title: Spatial Attention Ability is Positively Correlated to Quality of Life in Cochlear Implant Users

Abstract Content:

Introduction: Quality of life (QoL) among cochlear implantation (CI) users is a key component in understanding the patient’s benefit from CI. QoL assessment is performed by various questionnaires using real life scenarios, to be subjectively filled by the patient. However, previous work has shown that there are very low correlations between clinical speech perception and QoL measures. Part of this apparent discrepancy may be due to the inability of the standard tests to capture everyday listening environments. In this study, we aimed to mimic a realistic listening environment by creating a selective spatial attention listening task (Spatial Digits in Noise Task). We hypothesize that such listening may represent what CI users face everyday and therefore would have high predictive value in QoL prediction.

Methods: A prospective study was conducted. Adult CI recipients performed a spatial hearing task based on triple digits. Participants were asked to repeat triple digits while distracting triple digits were presented at speakers +/- 45, 90, and 0 degrees azimuth. The distracting digits were either in the same voice as the target, or in a different voice. The threshold target to distractor ratio for 50% performance was determined by adaptive threshold estimation. In addition to the spatial digits in noise task, participants were administered standard QoL assessments including: "Speech, Spatial, and Qualities of Hearing Scale" (SSQ), "Nijmegen Cochlear Implant questionnaire" (NCIQ) and "Cochlear Implant Quality of Life-35 Profile" (CIQoL35P), followed by standard clinical tests including sentence in noise (AzBio hearing test), consonant-vowel nucleus-consonant (CNC). Spearman correlation coefficient (SCC) was used to calculate correlation between independent parameters.

Results: Forty patients were enrolled, age range (average) 19-63 (42). AzBio hearing test and consonant-vowel nucleus-consonant (CNC) were found not to correlate to any of the QoL assessments tested. Spatial digits in noise scores were significantly correlated to all QoL assessments, in both the 45 degrees same voice and right angle different voice configurations: SSQ (-0.5085 (p= 0.0157) and -0.5175 (p=0.0114), respectively), NCIQ (-0.3818 (p=0.0165) and -0.3411 (p=0.0312), respectively) and CIQoL35P (-0.3199 (p=0.0536 near significance) and -0.3284 (p=0.0441), respectively).

Conclusion: Unlike the AzBio and CNC hearing tests, the spatial digits in noise task showed significant correlations with QoL measures. These data suggest that selective attention abilities in CI users are related to QoL outcome.

Primary Author/Presenter: Omer Ungar, MD

Author Block: Omer J. Ungar, MD, Clinical Fellow , Joseph Chen, MD, FRCSC, Professor , Vincent Lin, MD, FRCSC, Professor , Trung Le, MD, FRCSC, Professor , Andrew Dimitrijevic, PhD, Professor ; Department of Otolaryngology, Head and Neck Surgery, Sunnybrook Hlth. Sci. Ctr., Toronto, Canada, Department of Otolaryngology, Head and Neck Surgery, Sunnybrook Hlth. Sci. Ctr., Cochlear implant program, Toronto, Canada.

Learner Objectives:

How does spatial attention relate to Quality of Life?
Abstract Number: 60

Abstract Title: Safety and early outcomes of cochlear implantation in infants: A multi-centre study

Abstract Content:

Introduction: The aim of this study was to determine whether previously off-label use of cochlear implants in children under 12 months is safe and effective. Prior to 2020, many countries provided approval for cochlear implantation in children as young as 12 months of age. Yet, evidence to support the importance of identifying hearing loss and providing access to sound in infants by 6 months of age has become increasingly clear. Several cochlear implant centres provided cochlear implants to infants below 12 months on this basis.

Methods: A multi-centre retrospective chart review of cochlear implantation provided to infants < 12 months of age was conducted. In Stage 1, outcome measures included surgical and recovery times and adverse events up to 6 months post-operatively in a group of 84 infants implanted at 9.00-11.99 months of age between January 1, 2012-December 31, 2017. These data have been reported previously. In Stage 2, data collection expanded to include adverse events over a longer period, up to 24 months post-operatively, in the original group (Cohort 1) and measures of post-operative hearing (audiograms, parental questionnaires of post-implant hearing and speech-language development). In addition, a new group of 51 infants implanted between January 1, 2018 and May 15, 2020 were recruited for review of the same outcome measures.

Results: Data were obtained from 5 different centres. Age at implantation for Cohort 2 was mean(SD)= 10.4 (0.9) months and 31% of all subjects (Cohort 1 & 2) were implanted prior to 10 months. Most of the surgeries were simultaneous bilateral procedures (92/134) and surgical outcomes were duration under anaesthesia, estimated blood loss, and duration in recovery. The rate of adverse events up to 6 months post-implant was slightly lower in Cohort 2 (19.6%) than Cohort 1 (26.5%), primarily due to reduced instances of thermoregulation in surgery. The most common post-operative issue was ear-related infections experienced by 12/134 infants up to 6 months post-implant and 4/134 infants from 6-24 months post-implant. Outcomes of cochlear implantation revealed aided access to conversational speech sounds (aided PTA mean(SD)=dB HL) and significant improvements in hearing and language development measured on the LittEars questionnaire (p<0.0001).

Conclusion: Stage 2 of this multi-centre study confirmed the safety of cochlear implantation in infants reported from Stage 1. Earlier surgical issues of thermoregulation appear to have been addressed in these centres. Ear infections, common to this age group, and other potential post-operative events should be monitored. Outcomes reveal early hearing and language development promoted by cochlear implant use.

Primary Author/Presenter: Karen Gordon

Author Block: Tal Honigman, MD, FRSCS , Blake Papsin, MD, FRSCS , Sharon Cushing, MD, FRSCS , Patricia Purcell, MD, FRSCS , Nicholas Deep, MD, FRSCS , Susan Waltzman, PhD , Jaina Negandhi, MSc , Karen Gordon, PhD, CCC-A, Reg. CASLPO ; The Hosp. for Sick Children, TORONTO, Canada, Otolaryngology-Head & Neck Surgery, University of Toronto, The Hosp. for Sick Children, TORONTO, Canada, ?, ?, ON, New York Univ., New York, NY.

Learner Objectives:

Explain why cochlear implants should be provided to children below 12 months of age.

Describe a hearing outcome of cochlear implantation in infants.
**Concurrent Session:** Concurrent Session 8-1 "Cochlear Implantation in the Very Young"

**Abstract Number:** 134

**Abstract Title:** Early Implantation In Children With Complex Medical Needs: A Multidisciplinary Approach

**Abstract Content:**

Introduction: Research suggests that earlier cochlear implantation in children with bilateral severe to profound hearing loss leads to better spoken language outcomes (Waltzman & Roland, 2005; Cuda et al., 2014). In 2020, the FDA approved implantation for children 9 months and older to facilitate improved outcomes.

At a major pediatric medical center, the patient population can be diverse with regards to medical diagnoses. Our patients are medically complex and benefit from multidisciplinary care. Children of all abilities can benefit from an earlier age at implantation, though outcomes and expectations for spoken communication may differ.

Methods: A review of electronic medical records was completed for cochlear implant recipients at Children's Hospital Colorado from 2018-2022. Inclusive criteria were infants who were diagnosed with severe to profound hearing loss by 3 months of age and had at least one other medical diagnosis. Of these patients, their cochlear implant trajectory was evaluated and compared to children who were also diagnosed by 3 months of age who did not have additional diagnoses. Information including age at implantation and outcomes (quality of life and speech perception) were collected and reviewed. All analyses were completed in SPSS.

Results: Preliminary results suggest that children who have medical diagnoses in addition to hearing loss take longer to progress through the cochlear implant evaluation process than children without additional medical diagnoses. This is due, in part, to the need for appointments with additional medical specialists (neurology, cardiology, etc.) as well as extended counseling with the cochlear implant team regarding appropriate expectations. While these children are often implanted at an older age when compared to their peers with hearing loss and no additional medical diagnosis, they are not precluded from "early implantation". Data collection and analysis is ongoing.

Conclusion: Complex medical needs should not preclude a child from being evaluated for early cochlear implantation. However, the number of medical appointments for the child's overall health and well-being may delay their age at cochlear implantation. Children with hearing loss are heterogeneous, however, children with complex medical needs have even greater heterogeneity. This highlights the importance of both following best practice and tailoring the evaluation process to each individual to optimize outcomes. Among the population we studied, the delays in implantation were caused by the following: 1. Additional appointments with other medical providers. 2. Increased counseling to support development of realistic expectations. Our multidisciplinary team approach is designed to support the whole child and empower the family when deciding on cochlear implantation. With appropriate counseling, families of children with complex medical needs can have realistic expectations and overall satisfaction with their child's unique cochlear implant journey. We will continue to evaluate the additional time to support each child and their family.

**Primary Author/Presenter:** Laura Greaver, AuD; Dani Stern, AuD

**Author Block:** Laura Greaver, AuD, Dani Stern, AuD; Children's Hosp. Colorado, Colorado Springs, CO.

**Learner Objectives:**

At the end of the session, participants will be able to explain the importance of early implantation in patients with medical complexities.
Introduction: Cochlear implantation was first approved by the Food and Drug Administration (FDA) in 1990 for children 2 years of age or older presenting with profound sensorineural hearing loss. Expanded criteria was granted by the FDA in 2000, and again more recently in 2020 for the Cochlear Nucleus device, effectively lowering the age of implantation to 9-months of age. However, successful implementation of Universal Newborn Hearing Screening programs has led to earlier identification of hearing loss. In response to this earlier identification and treatment, some implantation centres have provided cochlear implantation services off-label (per guidelines set by the FDA) to children under 9 months of age. The purpose of this study was to evaluate the safety and efficacy of cochlear implantation in children under 9 months of age.

Methods: A retrospective chart review of past medical history, surgical considerations, and adverse events collected up to 6-months post-operatively were reviewed for all children implanted under the age of 9-months.

Results: Between January 1, 2011 and December 31, 2021, 107 children under 9 months of age with bilateral profound sensorineural hearing loss were implanted at our institution. Age at implantation ranged between 5-8 months with a mean age of 6 months. Comorbidities, or significant medical history, included fluid in the lungs at birth, lactose intolerance, congenital heart defect, congenital encephalocele, Waardenburg syndrome, GERD, laryngomalacia, and Mondini malformation with enlarged vestibular aqueducts. All but 10 cases were bilateral simultaneous implantation and all had full insertion of the electrode array. There were no reported readmissions to the hospital within 30 days of surgery. Post-operative adverse events (out to 6 months) included reports of fever with or without infection, vomiting, irritation of the external ear, swelling at the implant site, mastoiditis and drainage from the implanted ear. There was no significant difference detected in complication rates for this patient population versus those above the age of 9 months. Perceptual and linguistic development outcomes were variable and depended on a number of factors.

Conclusion: This data demonstrates that cochlear implantation can be a safe and effective treatment option for children under 9-months of age. The decision to implant children under 9 months of age should be made by the parents and the physician taking all appropriate factors into consideration.

Primary Author/Presenter: Justin Cottrell, MD

Author Block: Justin Cottrell, MD, Emily Spitzer, AuD, Susan B. Waltzman, PhD, Thomas J. Roland, MD; NYU, new york, NY.

Learner Objectives:

Describe outcomes of cochlear implantation in children under 9 months of age.

Describe the safety profile of cochlear implantation in children under 9 months of age.
Concurrent Session: Concurrent Session 8-1 "Cochlear Implantation in the Very Young"

Abstract Number: 211

Abstract Title: Age of Cochlear Implantation within the Pediatric Population with Congenital Sensorineural Hearing Loss

Abstract Content:

Introduction: While cochlear implantation criteria for pediatric patients have expanded over recent years, data regarding implementation of these criteria is limited. The current study evaluates changes in the number of cochlear implant (CI) surgeries performed and the age of implantation among the pediatric population with congenital sensorineural hearing loss (SNHL) in the U.S.

Methods: Deidentified CI data were acquired 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. Children ≤36 months old were assumed to have bilateral congenital SNHL. Evaluated outcome measures included age at implantation, annual implantation rates and laterality of implantation (unilateral vs bilateral).

Results: A total of 4,311 children ≤36 months old received CIs between 2015 and 2019. The annual number of recipients increased from 787 in 2015 to 940 in 2019. The median age at implantation was 16 months (IQR 12-24), which did not change significantly during the 5-year study period (p=0.09). Age of implantation was not significantly associated with urban or rural residence (p=0.5) or distance traveled to CI center (p=0.05). Bilateral simultaneous implantation increased from 38% to 52% of CIs in 2015 and 2019, respectively (p<0.001). Children who received bilateral simultaneous implants were younger compared to those receiving unilateral or bilateral sequential implants (14 vs 18 months, p<0.001). Higher volume CI centers (>10 pediatric CIs per year) implanted children at a younger age compared to lower volume centers (15 vs 16 months, p=0.009), although this difference may not be clinically significant.

Conclusion: Though the number of pediatric CI recipients and the frequency of bilateral simultaneous implantation increased over the studied interval, age at time of implantation did not change and far exceeds current FDA (9 months) and AAOHNS position statement (6-12 months) guidelines. Timely implantation improves auditory and language outcomes and should be more prioritized in children with congenital SNHL.

Primary Author/Presenter: Ashley Nassiri, MD, MBA

Author Block: Ashley M. Nassiri, MD, MBA, John Marinelli, MD, Christine Lohse, MS, Matthew Carlson, MD; Otolaryngology, Univ. of Colorado, Denver, CO, Otolaryngology, Mayo Clinic, Rochester, MN, Mayo Clinic, Rochester, MN.

Learner Objectives:

Describe the rates of cochlear implantation and changes over time within the pediatric population with congenital sensorineural hearing loss.

Understand current practices and shortcomings of implementation of expanded cochlear implant criteria.
Abstract Number: 215
Abstract Title: Cochlear Implant Cases Below 9 Months

Abstract Content:
Introduction: Increasing evidence of improved outcome in younger age at cochlear implantation has led to continuous research on the safety of decreasing the age boundary below 9 months. Methods: This retrospective case series examined the prevalence of surgical, anesthetic, and device-related complications as well as audiological outcomes among the pediatric patients below 9 months who underwent CI from January 2019 till October 2022 in a tertiary academic referral center. Results: Two patients younger than 9 months (6 and 7 months, weight 7.97kg and 7.8kg) were implanted in the studied period. They were diagnosed with profound SNHL by sedated ABR at age of 4 and 5 months respectively and both were confirmed with visual reinforcement audiometry at age of 6 months. Etiologic diagnostic studies found genetic mutations of uncertain significance and congenital CMV respectively. Both were bilaterally implanted, with a total time under anesthesia of 5h and 4h, estimated blood loss of 20 and 5 cc, total duration in recovery of 1h20mn and 10mn, respectively. Both were admitted for one day with no intra or postoperative complications, no temperature regulation issues, no arrhythmia, no need for readmissions and no device malfunction. Both had full electrode insertion. First patient has a three months follow up with last soundfield testing showing speech awareness threshold 20dB, Tonal testing 25dB from 500-2000Hz. Second patient has a follow up of two years and last sound field testing shows a speech awareness threshold 25dB, tonal testing 25-45 dBHL from 500-8000 Hz. Conclusion: Two infants below 9 months were safely implanted with no surgical, anesthetic, and device related complications.

Primary Author/Presenter: Evana Francis, MD
Author Block: Evana Francis, MD, Nandini Govil, MD, MPH, Kristan P. Alfonso, MD; Pediatric Otolaryngology, Emory Univ. school of Med., Atlanta, GA.

Learner Objectives:
To describe the prevalence of surgical, anesthetic, and device-related complications among the pediatric patients below 9 months who underwent CI from January 2019 till October 2022 in a tertiary academic referral center.

To describe the audiometric outcomes among the pediatric patients below 9 months who underwent CI from January 2019 till October 2022 in a tertiary academic referral center.
Concurrent Session: Concurrent Session 8-2 "Cochlear Implantation in the Very Young"

Abstract Number: 184

Abstract Title: The presence of the profibrotic markers TGFB-1 and CTGF immunofluorescence in the implanted cochlea

Abstract Content:

Introduction: Cochlear implants (CI) provide highly successful auditory rehabilitation for patients with sensorineural hearing loss; however, implantation can lead to insertion trauma and foreign body reaction resulting in intracochlear new tissue formation. This can increase impedance as well as spiral ganglion neuron death. While the exact mechanism is unclear, better understanding of this process can provide an opportunity for early intervention. Transforming growth factor beta-1 (TGFβ-1) plays an important role in fibrosis as well as osteogenesis. Inhibition of TGFB attenuates ectopic bone formation in mice. TGFβ-1 stimulates the expression of connective tissue growth factor (CTGF) which is involved in various physiologic and pathologic processes including cell proliferation, tumorigenesis, and fibrosis. Treatment with CTGF anti-sense oligonucleotides significantly reduced fibrosis around breast implants in rats. Given the importance of TGFβ-1 and CTGF in fibrosis, the present study aims to characterize the expression of these proteins in the human implanted cochlea.

Methods: HTB samples acquired from 5 patients with prior CI (3 diagnosed with sensorineural hearing loss (SNHL) and 2 with otosclerosis) and 5 age-matched controls were serially sectioned after fixation and celloidin embedding. Histopathologic analysis of fibrosis and osteoneogenesis was conducted using H&E. Protein expression was characterized using immunofluorescence and co-localization studies were conducted using laser confocal microscopy.

Results: A fibrous sheath with adjacent osteoneogenesis was found to surround the electrode path. The capsule was more prominent and thicker towards the modiolus. Profibrotic markers, TGFβ-1 and CTGF, were upregulated in CI HTB samples independent of underlying pathology (otosclerosis, SNHL) while there was minimal expression in healthy age-matched controls. TGFβ-1 was expressed diffusely within the fibrous capsule while CTGF was primarily expressed in the thickened portion towards the modiolus. Intracellular expression of TGFβ-1 was also seen within the fibrosis. Finally, there was strong expression of both TGFβ-1 and CTGF at the junction between fibrosis and new bone formation.

Conclusion: Fibrosis and osteoneogenesis following CI placement can lead to implant malfunction and loss of residual hearing. Understanding the pathogenesis of this process is critical to developing effective intervention. To our knowledge, this is the first study to characterize the expression pattern of TGFβ-1 and CTGF in HTB with CI implantation. Expression of both profibrotic markers in the fibrotic capsule and at the fibrosis-osteogenesis junctions suggest their importance in new tissue formation following CI and candidacy for targeted therapy. Interestingly, dexamethasone inhibits the expression of TGFβ-1 in vitro and may partially explain the efficacy of dexamethasone-eluting electrodes in reducing post-implant damage. Lastly, asymmetric fibrosis and expression of TGFβ-1 and CTGF in conjunction with increasing bone maturation towards the modiolus also suggest electrical conduction may play a role and warrants further investigation.

Primary Author/Presenter: Adam Xiao, MD, PhD

Author Block: Adam Xiao, MD, PhD, Ivan A. Lopez, PhD, Gail Ishiyama, MD, Akira Ishiyama, MD; Head and Neck Surgery, UCLA, Los Angeles, CA, Neurology, UCLA, Los Angeles, CA.

Learner Objectives:

Describe the distribution of TGFB-1 and CTGF as it relates to new tissue formation following cochlear implant placement.
Concurrent Session: Concurrent Session 8-2 "Cochlear Implantation in the Very Young"

Abstract Number: 231

Abstract Title: Differences in neural correlates of auditory working memory between cochlear implant users and normal hearing controls

Abstract Content:

Differences in neural correlates of auditory working memory between cochlear implant users and normal hearing controls. Priyanka Prince, Joseph Chen, Trung Le, Vincent Lin, and Andrew Dimitrijevic. 1. Evaluative Clinical Sciences Platform, Sunnybrook Research Institute, Toronto, ON Canada. 2. Department of Physiology, University of Toronto, Toronto, ON, Canada. 3. Otolaryngology—Head and Neck Surgery, Sunnybrook Health Sciences Centre, Toronto, ON, Canada. 4. Faculty of Medicine, Otolaryngology—Head and Neck Surgery, University of Toronto, Toronto, ON, Canada.

A common concern for individuals with severe-to-profound hearing loss fitted with cochlear implants (CIs) is difficulty following conversations in noisy environments. Previous literature has alluded to cognitive resources related to attention and working memory as a factor explaining some of the variability associated with speech in noise perception. However, the neural basis for this relationship is not fully understood. In this study, we investigated behavioural and neural correlates of auditory working memory in 14 CI users and normal hearing (NH) controls using high-density electroencephalogram (EEG) while participants completed an N-back task consisting of two conditions, 0-back and 2-back. While 0-back measured speech perception ability, the 2-back measured cognitive ability through working memory and attention. The auditory stimuli presented for each condition and trial was ten double-digit numbers (DDN). Behavioural results suggest no differences between groups in both conditions but in both groups, participants performed better on the 0-back than the 2-back. Although no behavioural differences were found between groups, differences were observed in sensory and neural oscillatory activity. CI users, overall, showed decreased evoked responses (P1, N1, and P2) to digits compared to NH and showed differences in alpha/beta and beta activations throughout the encoding and retaining of digits into memory. Importantly, the degree of auditory evoked potentials and oscillatory power were significantly correlated to speech perception in noise in CI users and NH. These results show neural differences in both bottom-up (encoding) and top-down (attention and working memory) processes in CI users which may contribute to difficulties speech communication.

Primary Author/Presenter: Priyanka Prince Yogarajah, MSc

Author Block: Priyanka Prince, MD, Vincent Lin, MD, Andrew Dimitrijevic, PhD; Sunnybrook Res. Inst., Toronto, Canada.

Learner Objectives:

Differentiate neural correlates of auditory working memory between CI users and NH control.
Introduction: It is now well established that for children receiving cochlear implants, better outcomes are associated with earlier age of implantation. Children implanted younger than 12-18 months demonstrate superior communication outcomes compared to children receiving CI's at later ages. However, even with earlier implantation, CI children continue to display a range of delays or deficits in receptive and expressive language, and vocabulary, often reappearing after early gains in speech and language acquisition. Understanding the deficits and their reappearance in CI children is difficult because of a lack of data on the neural reorganization following hearing. Our recent work with older CI participants suggests that differences in cortical reorganization and neural connectivity are important predictors of the development of age-appropriate language and reading competence. Unfortunately, by the time any of the difficulties are identified through standardized testing or even sensitive behavioral methods, compensatory or adaptive changes in neural function are already well established. The challenge, then, is the early identification of neurophenotypic patterns that are associated with hearing deprivation and subsequent implantation that may be detrimental to later speech and language development. Identification of neural adaptations relative to non-implanted normal hearing peers, may have important diagnostic implication for the development of targeted interventions facilitating optimal speech and language development.

Using electrophysiological measures (electrical source imaging, effective connectivity, evoked potentials) we are probing the functional neural consequences of early implanted CI children to assess their cortical processing and organization as a means to better understand the implications of early hearing loss and hearing restoration.

Methods: High-density EEG recordings were obtained from children with normal hearing and children with CIs. All children were two- to three-years old at the time of assessment. The high-density EEG signals were recorded while the children were involved in auditory and visual tasks and also while at rest. Multiple-channel evoked potential analysis was completed to examine the functional neural activity present while the children were engaged in functional tasks and used to identify the neural generators of their functional activity. Connectivity/coherence analysis was completed to evaluate brain networks that were active during the resting state condition.

Results: Differences in functional and resting-state brain activity were observed between pre-school children with normal hearing and children with cochlear implants. Differences were also observed as a function of the language and speech recognition abilities of children with CIs as well as the number of hours they used their CIs on average each day. A description of specific results will be provided in the presentation.

Conclusion: The current data show functional differences in the neural networks of children who have CIs compared to their peers with normal hearing. An important observation is that early neural changes in processing and organization post implantation display a range of differences within the CI group suggesting that early detection of neural adaptations may provide important information on individual variation and subsequent CI success.

Primary Author/Presenter: Vincent Gracco, PhD

Author Block: Vincent Gracco, Ph.D., Jace Wolfe, Ph.D., Mickael Deroche, Ph.D., Nabin Koirala, Ph.D., Muthuraman Muthuraman, Ph.D., Sara Neumann, Au.D.; Haskins Lab. at Yale Univ., New Haven, CT, Hearts for Hearing, Oklahoma City, OK, Concordia Univ., Montreal, Canada, Univ. Med. Ctr. of the Johannes Gutenberg Univ. at Mainz, Mainz, Germany.
**CI2023 Dallas: Cochlear Implants in Children and Adults**

Describe differences in functional and resting-state brain activity of children with cochlear implants compared to their peers with normal hearing.

Describe the relationship between neural networks and connectivity and language outcomes.
Concurrent Session: Concurrent Session 8-2 "Cochlear Implantation in the Very Young"

Abstract Number: 266

Abstract Title: The Role of the Cortical Auditory Evoked Response in the Pediatric Cochlear Implant Clinic

Abstract Content:
Introduction: The cortical auditory evoked response (CAER) may be elicited by tone bursts and speech tokens and may be used to determine whether a sound is likely to be audible for an infant or child who is using hearing aids or cochlear implants. The CAER may be used one measure in a battery of tests to evaluate cochlear implant candidacy for infants and young children. The CAER may also be used to determine whether a synchronous auditory neural response is produced at the auditory cortex of children with auditory neuropathy spectrum disorder. Additionally, the CAER may be used to determine whether cochlear implant stimulation levels are sufficient to provide audibility for low-level speech signals. The objective of this presentation is to provide a description of how the CAER may be used to optimize management of infants and children who are undergoing cochlear implant candidacy assessment or who are using cochlear implants.

Methods: The CAER assessment was completed with over 330 infants and young children who are undergoing cochlear implant candidacy assessment or who have received cochlear implants. Specifically, the CAER was measured in response to speech tokens (e.g., /m/, /g/, /t/, /s/) presented at 55, 65, and/or 75 dB SPL. An automated statistical-based algorithm was used to detect the presence of the CAER. For children with hearing aids and cochlear implants, the CAER was measured in the aided condition, whereas it was measured in the unaided and aided condition for children with auditory neuropathy spectrum disorder.

Results: The presence of a measurable CAER varied based on etiology of hearing loss, degree of hearing loss, and aided condition. A description of specific results will be provided in the presentation. The CAER often proved to be a valuable tool in the management of infants and children with hearing loss who are being considered for cochlear implantation or who have undergone cochlear implantation.

Conclusion: The CAER assessment provides useful information for pediatric cochlear implant candidacy assessment and cochlear implant management.

Primary Author/Presenter: Stephanie Browning, Au.D.

Author Block: Elizabeth Grim, Au.D., Stephanie Browning, Au.D., Jace Wolfe, Ph.D.; Hearts for Hearing, Hearts for Hearing, Oklahoma City, OK.

Learner Objectives:

describe how cortical auditory evoked response assessment can be used in the cochlear implant candidacy test battery.
describe how cortical auditory response assessment may be used to guide cochlear implant programming.
Introduction: Brain-derived neurotrophic factor (BDNF) is an important factor in the development and neuroprotection of the afferent auditory pathways. In animal models, BDNF has been demonstrated to play a neuroprotective role for the spiral ganglion neurons (SGN). In this study, we investigated the expression of BDNF in the afferent auditory pathway following cochlear implantation. It is hypothesized that the electrical stimulation following cochlear implantation stimulates BDNF expression in the afferent auditory pathway.

Methods: Archival human temporal bones from seven patients (age ranging from 67 to 92 years) with a history of cochlear implantation and four patients with a history of otopathologies causing hearing loss without cochlear implantation (age ranging from 38 to 92 years) were studied. The temporal bone specimens were immunoreacted with mouse monoclonal antibodies against pan-neurofilaments and rabbit polyclonal BDNF. In cases of unilateral cochlear implantation, the contralateral unimplanted ear served as a control.

Results: Neurofilament immunoreactivity (IR) localized to the SGN nerve fibers in the implanted and unimplanted ear. The SGN somata were neurofilament non-IR. BDNF IR localized to the SGN somata and the surrounding satellite glial cell. The expression of BDNF in the SGN was significantly increased in the implanted ear compared with the contralateral unimplanted ear. Furthermore, the expression of BDNF was increased in cases of cochlear implantation compared with the other otopathologies such as Meniere’s disease and ototoxicity. In some cases, BDNF expression in the SGN somata and satellite cell demonstrated increased expression in cochlear implantation despite complete loss of the organ of Corti hair cells and supporting cells. In the two cases of cochlear implantation with a 6 mm first generation electrode, the BDNF expression was upregulated in the apical, mid-basal as well as basal cochlea, which suggests the critical role of electrical stimulation.

Conclusion: BDNF expression in the SGN somata and satellite cells appears to be upregulated by the electrical stimulation from cochlear implantation. BDNF expression is increased in the implanted ear compared with the unimplanted ear and compared with other otopathologies. This study provides evidence that the electrical stimulation from cochlear implantation stimulates BDNF upregulation which likely plays a neuroprotective role in the rehabilitation of hearing in the deafened ear.

Primary Author/Presenter: Emily Wong, MD

Author Block: Emily C. Wong, MD, Ivan A. Lopez, PhD, Akira Ishiyama, MD, Gail Ishiyama, MD; Head and Neck Surgery, UCLA, Los Angeles, CA.

Learner Objectives:

Describe the distribution of BDNF expression within the spiral ganglion neuron

Compare BDNF expression of the spiral ganglion neuron between patients who have undergone cochlear implantation compared with those who have not
Concurrent Session: Concurrent Session 9-1 "Optimizing Programming Measurements and Strategies"

Abstract Number: 129

Abstract Title: The trans-impedance matrix (TIM) as an intraoperative measure of array integrity in children with cochlear implants

Abstract Content:

Introduction: Thinner and more flexible cochlear implant (CI) electrode arrays are being designed to reduce insertion trauma and potentially preserve residual hearing as well as cochlear integrity. However, the increased flexibility, especially for arrays with modiolar-hugging electrodes, commonly implanted in children, augments the susceptibility of these arrays to electrode tip fold-over. The trans-impedance matrix (TIM) is an electric field measure that can be obtained intraoperatively following array implantation to indicate tip fold-over allowing the surgeon the immediate opportunity to adjust the electrode array. While the use of TIMs has been investigated in adults, the aim of this study was to assess the utility of TIMs in children receiving different types of implants.

Methods: TIMs were measured intraoperatively following implantation of 6 different CI arrays (Nucleus 24RE, 512, 532, 612, 622, 632) in a large cohort of children with bilateral CIs (n = 154 children, n = 286 devices). TIMs were measured by automated stimulation of one electrode with a biphasic square impulse and recording the potential evoked in response in each electrode along the array. This process was repeated for all electrodes and the results are automatically compiled as a map of the absolute intracochlear voltage as a function of intracochlear position.

Results: Consistent with previous studies in adult users, TIM profiles showed similarities for all 6 CI arrays. Global maxima occurred at the stimulating electrodes and trans-impedance reduced as the intracochlear distance between the stimulating and recording electrode increased and decreased from apical to basal stimulating electrodes. TIMs provided information about electrode dysfunction; some electrodes with trans-impedance values that did not vary as a function of intracochlear distance were disabled during CI programming and a tip fold-over was identified intraoperatively in 1 of 179 (0.6%) 632 arrays by local maximums in the mid-array in addition to the expected global maximum at the stimulating electrode. The tip fold-over was corrected immediately under the same anaesthetic and confirmed by TIMs with expected impedance patterns as well as skull radiograph.

Conclusion: Deviations from the typical homogenous TIM pattern may indicate electrodes with a poor electrode-nerve interface such as tip fold-over and have implications for the programming of MAP levels as well as cochlear scarring and ease of explant/replant in the future. TIMs may provide an effective measure of array insertion integrity in children intraoperatively. This work was funded by the Canadian Institutes of Health Research.

Primary Author/Presenter: Sharon L. Cushing, MD, MSc, FRCSC

Author Block: Carina J. Sabourin, B.Sc. , Sharon L. Cushing, MD, MSc, FRCSC , Blake C. Papsin, MD, M.Sc., FRCSC, FACS, FAAP , Stephen G. Lomber, Ph.D. , Karen A. Gordon, Ph.D. ; Biological and Biomedical Engineering, McGill Univ., Montreal, Canada, The Hosp. for Sick Children, Toronto, Canada, Univ. of Toronto, Toronto, Canada.

Learner Objectives:

Identify tip-fold over of the cochlear implant array as well as electrodes with a poor electrode-nerve interface from a trans-impedance matrix heatmap.

Explain the potential uses of trans-impedance matrices for inter-operative monitoring of array implantation as well as follow-up care in children implanted with cochlear implants.
CI2023 Dallas: Cochlear Implants in Children and Adults
Concurrent Session: Concurrent Session 9-1 "Optimizing Programming Measurements and Strategies"

Abstract Number: 132

Abstract Title: Optimizing upper stimulation level measurement and setting

Abstract Content:

Introduction: Accurately setting the upper range of stimulation for a cochlear implant (CI) is critical for providing a full range of sound and optimizing speech understanding. Audiologists commonly rely on behavioral measures to guide the setting of upper stimulation levels, but these measures, such as loudness scaling, can be prone to error. An objective alternative to behavioral measures is electrically-evoked stapedial reflex thresholds (eSRTs). The current study had two objectives: 1) compare outcomes between behavioral and eSRT based fittings, and 2) report the average difference between measured eSRTs and ultimate upper stimulation levels in a large clinic routinely using eSRTs to guide fitting.

Methods: For the first objective, an eSRT map and a behavioral map were systematically created for 20 adult CI recipients. The two maps were then compared using acute measures of speech recognition testing and sound quality; the participant and tester were blinded to which program the participant was using, a key element not previously completed in similar studies. For the second objective, eSRT (1-month post-activation) and upper stimulation level data (1- and 6-months post-activation) were collected from the medical record and CI programming software for 414 patients.

Results: For the first objective, the eSRT program yielded superior word (+8.0 percentage points, p<0.0002) and sentence in noise (+9.1 percentage points, p<0.0002) recognition scores on average. 16 of 20 participants preferred the eSRT program.

For the second objective, eSRTs were found to be relatively flat across the array. The average stimulation level associated with eSRT was 185.8 for Cochlear using a pulse width of 25 microseconds, 176.2 for Cochlear using a pulse width of 37 microseconds, 209.8 for Advanced Bionics, and 21.9 for MED-EL. On average, upper stimulation levels were set 15.9 clinical levels below eSRT for Cochlear using a pulse width of 25 microseconds, 13.7 clinical levels below eSRT for Cochlear using a pulse width of 37 microseconds, 10.7 clinical units below eSRT for Advanced Bionics, and 0.2 charge units below eSRT for MED-EL. On average, upper stimulation levels increased 2.8 clinical levels for Cochlear, 10.6 clinical units for Advanced Bionics, and 0.9 charge units for MED-EL between the 1-month and 6-month programming visits.

Conclusion: eSRTs should be used to optimize the setting of upper stimulation levels. Averages from a large clinical population with more than 10 years of eSRT experience provide guidance for where to set upper stimulation levels in relation to eSRT. Finally, if upper stimulation levels are set based on eSRTs obtained at 1-month, upper stimulation levels tend to remain stable through at least the 6-month post-activation timepoint.

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Learner Objectives:

Describe differences in outcomes between two methods of programming upper stimulation levels (eSRT and loudness scaling)

Define relationship between upper stimulation levels and electrically-evoked stapedial reflex thresholds (eSRTs) for each manufacturer.
Abstract Number: 189

Abstract Title: Effectiveness of a Mapping Technique to Reduce Tinnitus Severity for Adult Cochlear Implant Recipients

Abstract Content:

Introduction: Cochlear implantation has been shown to reduce tinnitus perception (Baguley 2007, Quaranta 2004) but for some, it remains bothersome (Tyler 1994). The aim of this study was to determine the effectiveness of a novel mapping method involving modifying electric threshold levels in the region of tinnitus pitch perception to further optimize tinnitus reduction.

Methods: The map settings of adult CI recipients who reported bothersome tinnitus with their CI were adjusted in attempt to reduce perceived tinnitus severity. Tinnitus severity was assessed with the Tinnitus Handicap Inventory (THI). The frequency region of the tinnitus was identified with a behavioral pitch comparison task. Tinnitus pitch match was obtained using a 2 choice pitch paradigm, either in the contralateral ear or within the mapping software, based on the degree of hearing loss in the contralateral ear and/or when they reported the bothersome tinnitus. The electric thresholds (T) for the channels in the frequency region of the tinnitus were increased above the behaviorally-measured T levels in attempt to mask the tinnitus. At the follow-up visit, the THI was administered and aided speech recognition was evaluated to evaluate whether the adjusted levels influenced performance. If a reduction in tinnitus severity was reported, the electric T levels were lowered to the behaviorally-measured levels as long as the tinnitus perception did not increase.

Results: Patients who underwent this procedure perceived a reduction in tinnitus severity acutely after the mapping change. At the follow-up visit, patients reported a continued suppression in tinnitus severity that did not result in poorer speech recognition with the CI. Most patients continued to perceive reduced tinnitus severity when the T levels were returned to the behaviorally-measured level, which may indicate training of tinnitus suppression.

Conclusion: The present data support the effectiveness of a mapping procedure aimed to reduce tinnitus severity for adult CI users. While tinnitus is a multi-faceted issue and there were varying degrees of reduction and speed of habituation, this appears to be a helpful tool for audiologists in assisting this patient population.

Primary Author/Presenter: Allison Young, AuD


Learner Objectives:

Identify additional ways to optimize mapping to reduce tinnitus perception in some patients
Concurrent Session: Concurrent Session 9-1 "Optimizing Programming Measurements and Strategies"

Abstract Number: 195

Abstract Title: Sensitivity and Cost-Effectiveness of Intraoperative TransImpedance Matrix Recordings vs Intraoperative X-Rays in Detecting Tip-Foldovers

Abstract Content:

Introduction: Our institute routinely implants perimodiolar electrode arrays due to the close proximity of the electrode contacts to the modiolus. In a small percentage of cases, a tip-foldover occurs in which the apical electrodes fold onto itself. We utilize x-rays to confirm device placement and ensure there is no tip-fold-over; if a fold-over is detected, the foldover is corrected before concluding surgery. While effective, imaging increases surgical costs, exposes patients to radiation (albeit a small amount), and adds to the surgery time. A tool that can verify electrode array positioning without the use of imaging would be advantageous from both a patient perspective and from a cost perspective. Electrophysiological measures of Spread of Excitation (SOE) and, more recently, TransImpedance Matrix (TIM), have been proposed as time-effective methods of detecting tip fold overs. The current study compares the time, cost-effectiveness, and sensitivity of x-rays, SOE, and TIM in detecting tip fold-overs.

Methods: All patients (children and adults) with normal cochlear anatomy and undergoing implantation with perimodiolar arrays were included in this study. Implantation proceeded under normal clinical intraoperative workflow. Once the electrode array was inserted, clinical cochlear implant software was used to measure SOE functions and a TransImpedance Matrix; an x-ray was also performed. If a tip-fold over was detected and confirmed via x-ray, the CI was reinserted and all three measures were repeated. The length of time for each of the three procedures was also recorded. For x-rays, the time was tracked from when the surgeon requested the x-ray to the time at which the x-ray was formally completed. For SOE and TIM recordings, the recording time from start to finish was tracked.

Results: Preliminary data from 80 cases revealed 3 tip fold-overs. Fold-overs were confirmed by both x-ray and TIM recordings. Upon reinsertion of the electrode array, placement was appropriate as verified by both x-ray and TIM recordings. SOE recordings were not sensitive to fold-overs, even in the 3 cases of confirmed tip fold-over. The average time for SOE, TIM, and x-ray recordings were 10.42 ± 2.8 minutes, 8.69 ± 2.99 minutes, and 16.70 ± 6.79 minutes. (Note that SOE and TIM recording procedures also include recording times for Electrically Evoked Compound Action Potentials). TIM recording procedures were completed significantly quicker than SOE recordings (p < 0.001), while x-ray times were significantly longer than either TIM or SOE recordings (p < 0.001 in both cases). The additional 7 minutes needed for x-ray is a significant cost increase when considering fees for OR and anesthesia tech time.

Conclusion: The results provide proof-of-concept regarding the utility of TransImpedance Matrix recordings (as embedded in commercial or research software) in evaluating cochlear implant placement. Given the low tip fold-over rate reported across the literature and within our institution for perimodiolar arrays, our data collection is ongoing. Large scale studies are needed to generate a sufficient patient sample size to verify the sensitivity and specificity of TransImpedance Matrix recordings in identifying tip fold-overs and compare these metrics to the sensitivity of intraoperative imaging. If the sensitivity and specificity of TIM can be reliably established, it can potentially replace the need for intraoperative x-ray, resulting in cost-savings without compromising patient care.

Primary Author/Presenter: Viral Tejani, AuD, PhD

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Learner Objectives:

Describe the utility of TransImpedance Matrix recordings in detecting tip foldovers.
Concurrent Session: Concurrent Session 9-1 "Optimizing Programming Measurements and Strategies"

Abstract Number: 309

Abstract Title: Ameliorating Tinnitus Exacerbated by Contralateral Cochlear Implant

Abstract Content:

Introduction: Cochlear implants are known to suppress tinnitus. Here we present a unique case, in which an adult implant user reported that her tinnitus in the right ear was exacerbated by a contralateral cochlear implant (CI512 Nucleus 7), so much that she could not use the implant in daily life. She was referred to us in search of a solution for her to use the implant without worsening the tinnitus. To our knowledge, tinnitus exacerbated by a contralateral implant is rare, and a solution to this problem has not been reported.

Methods: Computed tomography (CT) imaging was performed to visualize the electrode locations in the cochlea. To document the effect of the contralateral implant on tinnitus, the change in tinnitus loudness, rated on a 10-point scale (0 - inaudible, 10 - unbearably loud), which followed a 1-minute activation of the contralateral implant in conversational speech, was recorded every 30 seconds until the tinnitus recovered to the baseline loudness. To identify electrodes responsible for this exacerbated tinnitus, each of the 22 inner-cochlear electrodes was individually activated, and the tinnitus loudness was measured for each electrode as a function of evoked stimulation loudness (from 1 to 7 on the loudness scale). A new map was created accordingly to eliminate the electrodes that exacerbated the tinnitus. Functional evaluation was conducted, including pure-tone hearing thresholds and sentence recognition in quiet. To understand the underlying physiological mechanisms, evoked auditory brainstem responses and auditory cortical potentials would be recorded.

Results: The CT imaging showed proper insertion of electrodes in the cochlea. However, the one-minute activation of the implant caused an immediate increase in contralateral tinnitus loudness from the baseline (2 - soft) to a nearly unbearable level (i.e., 9 out of 10 on the loudness scale). This increased tinnitus did not recover to the baseline level until 10 minutes after the implant was turned off. Electrode tests found that 15 of the most basal 22 electrodes exacerbated the tinnitus. A new map using the remaining seven apical electrodes allowed the subject to use the implant with minimal exacerbation of the contralateral tinnitus. Compared with the old, unusable map, the new map produced 70% correct speech recognition in quiet (AzBio sentences without lip reading). The aided hearing threshold was below 40 dB HL across all octave frequencies between 250 and 8000 Hz.

Conclusion: Tinnitus can be exacerbated by selective contralateral electrodes in patients with cochlear implantation. The exacerbated tinnitus can be minimized by turning off these electrodes. A new map with the remaining seven electrodes produced appropriate hearing thresholds and good speech perception. The result of this case study highlighted the importance of personalized mapping in both cochlear implant performance and tinnitus management.

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Learner Objectives:

Describe a special case in which an adult whose tinnitus is exacerbated by the contralateral cochlear implant

Identify a new mapping strategy for tinnitus management
Introduction: The uptake of cochlear implants (CIs) is considered low, with an estimate of only 2% to 13% of qualifying adult candidates receiving CI care (Nassiri et al., 2021). Social and economic factors likely play a critical role in influencing CI access, utilization, and delivery, with racial and ethnic minorities experiencing even greater barriers to CI care (e.g., Schuh & Bush, 2021). Specifically, non-White candidates are about half as likely to pursue a CI compared to White Candidates (Tolisano et al., 2020). Reasons for poor access are thought to be related to medical mistrust, social stigma, financial cost, and lack of education on the device and related procedures (Sims et al., 2017). The underlying factors driving CI inequities are complex and evolving, making them difficult to measure and address. Barriers and motivators for pursuing CIs have been explored in the general U.S. population; however, little is understood about perceptions of CIs in Black communities. Our study is designed to systematically explore these factors within this underrepresented population.

Methods: The [Redacted] SOUND (Serving Our Underrepresented Neighbors who are Deaf/Hard of Hearing) Project is a community-engaged research project with the objective to understand the underutilization of CIs in marginalized populations. For this phase of the study, we are using a mixed methods approach to better understand the knowledge, attitudes, and beliefs of Black adults regarding CI in a medically underserved urban Southern U.S. community. Participants will be recruited from the [Redacted] Community and the [Redacted] CI Program to participate in focus groups divided into two cohorts: 1) individuals with CI, and their communication partners, and 2) individuals without CIs but have been told by a professional that they may benefit from a CI, and their communication partners. Each focus group meeting will be audio recorded and transcribed verbatim, and analyzed using a thematic iterative deductive/inductive analysis approach (Braun & Clark, 2012). Areas to explore include patient beliefs about hearing loss and CIs, perceived motivations and barriers for CI intervention, and experiences in the hearing healthcare system (Saunders et al., 2016). The transcripts will be coded with themes that emerge from the data. Recurring patterns in coding will be used to identify common themes. Subjective questionnaires on CI receptiveness, perceived communication difficulties, and patient demographics will also be collected, and descriptively analyzed.

Results: Data collection for this project is currently in progress and scheduled to be completed by March 2023. Data will be analyzed in Spring of 2023, with preliminary results being prepared for presentation by June 2023.

Conclusion: Conclusions are forthcoming.

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Learner Objectives:

1. Describe barriers to cochlear implantation among Black individuals with hearing loss.
2. Describe motivators for cochlear implantation among Black individuals with hearing loss.
Introduction: According to the Project HOPE study, cost estimates for individuals with severe to profound hearing loss is $297,000 over a person’s lifetime (Mohr et al., 2000). As the landscape of hearing healthcare continues to change with improvements in hearing technology and expanded criteria for cochlear implantation (CI), updated research is needed on the societal costs of hearing loss and long-term CI outcomes. The aims of the current study are 1) to estimate the lifetime costs of severe to profound hearing loss (SPHL) and 2) evaluate educational and quality of life outcomes in adolescents using CIs.

Methods: To estimate current lifetime costs of SPHL (medical, educational, etc.), we used the 2021 Medicare rates for CPT codes, IDEA estimate of twice the cost-per-pupil of public education supplemented by a written report for the California state legislature on these costs (Taylor, 2016), and the 2018 National Health Interview Survey (NHIS). To evaluate long term educational and quality of outcomes we utilized several data sources, including the Childhood Development after Cochlear Implantation (CDaCI), National Longitudinal Transition Study - 2 (NLTS-2), and published samples of non-implanted children (Meyer et al., 2013, Rachakonda et al., 2014, and Umansky et al., 2011). Adolescent outcomes were assessed using the Woodcock-Johnson III Tests of Achievement, Comprehensive Assessment of Spoken Language, Pediatric Quality of Life Inventory, and Youth Quality of Life Instrument - Deaf and Hard of Hearing.

Results: For the birth cohort 2020, the overall societal cost was estimated at $45.58 billion. This cost is broken down into educational costs, medical costs and earning losses. Individuals with SPHL earned less income with the largest income gap in individuals 30 - 45 years of age (SPHL: $30,127; No SPHL: $53,319). Additionally, individuals with SPHL had lower educational attainment compared to individuals without SPHL (33.42 vs 45.62% completed higher education). More importantly, children with CIs consistently had higher academic achievement scores, particularly in reading comprehension and writing compared to non-implanted samples. Adolescents with CIs also reported better QoL on the generic PedsQL measure across all subscales compared to the non-implanted comparison samples. The differences among the implanted CDaCI cohort and non-implanted samples were larger than the established minimally clinical important difference score for the PedsQL.

Conclusion: Overall, while the medical costs are higher for individuals who pursue cochlear implantation, they are ultimately offset by higher earning potential and higher education achievement compared to those with SPHL who do not pursue cochlear implants. Children with cochlear implants also outperform non-implanted children in educational outcomes and quality of life.

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Learner Objectives:

Describe the yearly costs of severe to profound sensorineural hearing loss.

Describe the long-term educational and quality of life outcomes for adolescents with CIs.
Introduction: Previous research demonstrates that women, racial minorities, and patients of low socioeconomic status are underrepresented in clinical research relative to their population frequency. These disparities likely influence the translational impact of the research findings for the patient population. An ongoing prospective study was designed to recruit and evaluate cochlear implant (CI) recipients at their routine post-operative visits in order to obtain a sample that would be reflective of the clinical patient population. The present review compared the demographic information of the clinical research participants with the demographic information of the CI recipients and the primary service population at the study site and CI center to evaluate the effectiveness of this approach.

Methods: Age, gender, race, ethnicity, and zip code were collected for adult CI recipients and for adult clinical research participants. Both groups underwent cochlear implantation between 2017 and 2022. US census data was used to collect median annual income for each recipient’s residential zip code. Demographic data of the clinical research participants was compared to the clinical population and to the hospital’s primary service population. Also, demographic information was compared between clinical research participants and CI recipients who were lost to follow-up to understand if those who withdraw from clinical research were similar to those who were lost to follow-up in the clinical population.

Results: Demographic information was collected from 81 clinical research participants and from 477 CI recipients. Compared to the clinical population, the clinical research population was significantly more likely to be Caucasian and of a higher socioeconomic status. The clinical research participants who were lost to follow-up were also significantly more likely to be Caucasian and of higher socioeconomic status compared to the clinical population who was lost to follow up. The demographics of the research sample and clinical population were not representative of the hospital’s primary service population.

Conclusion: The design of the clinical research study did not result in equal demographic representation with the clinical population, indicating more work is needed to improve representation in clinical research. Also, the clinical population was different than the primary service population, indicating the need for outreach efforts to improve access to cochlear implantation for underserved populations.

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Learner Objectives:

At the end of the session, participants will be able to measure the disparity in representation of racial minorities and patients of low socioeconomic status in cochlear implant research.
Abstract Content:
Introduction: A first step in eliminating hearing healthcare disparities and improving long-term outcomes among families with children who are DHH, is recognition of existing barriers to accessing clinical services as perceived by their families. Identifying the underlying causes for missed clinical appointments, particularly following a failed newborn hearing screening and/or confirmation of hearing loss during the first years of life, is essential when determining factors that place a child who is DHH at high risk for poor outcomes. Methods: The mixed-methods explanatory sequential study included two phases investigating factors that impact family attendance for scheduled appointments. Phase I was largely exploratory, implemented for the purpose of generating a REDCap survey instrument based on analysis of missed appointment types, parent input, and feedback from audiology providers. Researchers completed a retrospective chart review of child and family characteristics for children who missed >1,500 appointments during an 18-month period. Convenience sampling was used to select English-speaking and Spanish-speaking parents to participate in guided focus groups to obtain an in-depth understanding of issues surrounding cancellation and non-attendance. Audio and Zoom recordings were used to transcribe focus group responses. Thematic analysis of participant responses was conducted using NVivo software. Open-and closed-ended survey items were created to achieve balance, between data collection and data quality, minimizing respondent time. The survey was piloted with two additional focus groups, English-speaking and Spanish-speaking, parents of children who are DHH. Feedback provided by focus group participants was incorporated in the survey. The revised survey was piloted with audiology providers. Provider feedback was included in the final survey version. During Phase II of the project, the survey was distributed more broadly to families of children who are DHH who received audiology and speech therapy services. Results: In total, children < 6 years of age missed 394 scheduled hearing healthcare appointments during an 18-month period. Parents reported multiple challenges that decreased attendance at clinical appointments during the pandemic. Perceived barriers as expressed by parents of children who are DHH fell primarily into broad categories: 1) the family and their environment, 2) healthcare organizational factors, 3) providers, and 4) clinical encounter factors. Conclusion: The identification of patterns and influences impacting hearing healthcare services, along with parental perceptions of barriers to accessing hearing healthcare are central to child success. Implementing changes at the level of the individual, provider, and organization may improve attendance for pediatric audiology and speech-language therapy appointments, especially for children in the birth to 3-year age group.

Primary Author/Presenter: Debra Shrader, EdD

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Learner Objectives:
At the end of the learning session, participants will identify five barriers to access hearing healthcare as perceived by parents of infants and toddlers receiving healthcare in an urban community.

At the end of the learning session, participants will describe a range of issues at the clinical and organizational level that influence attendance at clinical appointments for infants and toddlers with hearing loss.
Abstract Number: 295

Abstract Title: Utilizing Community-Engaged Research to Understand Access to Cochlear Implants in Underserved Communities

Abstract Content:

Introduction: Multiple social, economic, and demographic factors influence the equity of cochlear implantation (CI) access, utilization, and outcomes (Schuh and Bush, 2021). Evidence suggests that racial and ethnic minorities experience these influences on a greater degree (Schuh & Bush, 2021). For example, one study found that Black individuals were underrepresented in their clinical population of those who sought pre-operative CI evaluations (Holder et al., 2018). Another study indicates that non-Whites are half as likely to pursue CI when compared to White populations (Tolisano et al., 2020). These data align with research in other hearing devices, as evidence suggests that only approximately 10% of minority and low-income older American use hearing aids which is a precursor to CI intervention (Dmitry et al., 2018). These inequities can be difficult to understand as they are complex in nature and difficult to measure (Sims et al., 2017). One approach to understanding and minimizing inequities in CI is Community-Engaged Research approaches. Rather than being fully investigator-driven, Community-Engaged research is conducted with assistance from the members of the population being explored (Marrone et al., 2022). Community Based Participatory Research (CPBR) has the highest degree of community involvement, and in this approach researchers and community members work together to address concerns that are most important to the community through shared power, resulting in improved understanding that has mutual benefit among all parties (Marrone et al., 2022). The purpose of this presentation is to provide information on how community-engaged research can be applied to understand barriers to CI.

Methods: In this presentation, information will be provided on how Community-Engaged Research, specifically CBPR, can be implemented to create an equitable and goal-oriented team to decrease current inequities in CI research. Principles and Frameworks of Community-Engaged Research will be provided. Community-engaged approach will be illustrated using examples from the authors’ experiences in building a community-engaged team to execute a research project with the aim of addressing CI access in an urban community.

Results: This is an informational session. There is no original data to present; however, experiences of our team will be shared at the time of the conference.

Conclusion: Community-engaged research is an approach that is currently underutilized in understanding inequities to CI access. Researchers in the area of CI should consider implementing this approach in an effort to decrease hearing health disparities.

Primary Author/Presenter: Gretchen N. Nibert, BA

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Abstract Number: 63

Abstract Title: How Much Is Enough? Building A Daily Usage Recommendation For Adult Cochlear Implant Users

Abstract Content:
Introduction: Many factors affect cochlear implant (CI) outcomes. Data regarding the relationship between early device datalogging and speech recognition outcomes in adults are limited.

Methods: A retrospective chart review included 337 patients implanted between 2015 and 2020 at a large CI center. Processor datalogging information and speech recognition data up to one year were recorded. We report outcomes based on early device usage and time to achieve ‘benchmark speech recognition performance’, defined as 80% of the median score for one year speech recognition outcomes at our institution.

Results: The one-month datalogging measure demonstrated a positive correlation to CNC and AzBio scores at one, three, six, and twelve-months post-activation. Datalogging was the largest predictive factor of benchmark achievement on multivariate analysis. Increased device usage (hours/day) at 1-month resulted in a higher likelihood of achieving benchmark CNC or AzBio scores within the first year (OR 1.21, p<0.001). Receiver operator characteristic (ROC) analysis demonstrates benefit beyond 10 hours/day daily usage time.

Conclusion: Early CI device usage as measured by 1-month datalogging predicts ultimate speech outcomes and benchmark speech recognition achievement in adults. Datalogging is the largest predictor of CI performance within the first-year post-implantation. Patients should utilize their devices a minimum of 10 hours/day, as potential benefit exists beyond this cut-off.

Primary Author/Presenter: Nathan R. Lindquist, MD


Learner Objectives:
Quantify and characterize the relationship between early daily device usage and speech recognition outcomes

Recognize early data logging as an inexpensive, easily accessible, and post-implantation intervention that requires minimal clinician bandwidth besides counseling and follow-up.
Concurrent Session: Concurrent Session 9-3 "Maximizing Cochlear Implant Daily Use"

Abstract Number: 79

Abstract Title: Cochlear Implant Patient Adherence To Post-Implant Care Recommendations

Abstract Content:
Introduction: Parents and patients are counseled preoperatively about the lifelong commitment of follow-ups after cochlear implantation. Following the initial year of adjustment, our center’s recommendation is for patients to follow-up at least annually to both their Otolaryngologist and Audiologist. Data regarding the adherence to this recommendation is not easily accessed in the literature. Identification of barriers to adherence as well as recommendations to improve return rates have not been widely available.

Methods: Retrospective chart review of cochlear implant patients followed at a large cochlear implant center. Data assessed included patient demographics, lost to follow-up rates and reasons.

Results: Of the 509 patients, 143 (28.1%) are current patients of both Otolaryngology and Audiology at this center, 125 (24.6%) are lost to follow-up for either Otolaryngology or Audiology, 117 (23.0%) patients moved, or their insurance changed causing them to seek care elsewhere, 76 (14.9%) are lost to both specialties at our facility, 29 (5.7%) with unknown status, and 19 (3.7%) are non-users or deceased.

Conclusion: 230 patients (45%) were lost to follow-up for at least one specialty, Otolaryngology or Audiology at our center, or have an unknown status. This highlights the importance of monitoring the attendance of cochlear implant patients and having a system for flagging no-shows. Protocols need to be in place to ensure that all patients continue to receive appropriate care, and that there is a system available to ensure a smooth transition of care to adult centers.

Primary Author/Presenter: Keri Colio, AuD


Learner Objectives:
At the end of the session, participants will be able to define desired follow-up for cochlear implant recipients, and list possible barriers to adherence.

At the end of the session, participants will be able to explain the importance of monitoring cochlear implant recipient adherence to recommended care.
Abstract Number: 172

Abstract Title: Decreased exposure to spoken communication in a large cohort of children with cochlear implants during early and later stages of the COVID-19 pandemic

Abstract Content:

Introduction: Study aims were to determine whether findings of significant decreases in exposure to spoken communication during the initial phase of the COVID-19 pandemic in children using cochlear implants (Gordon et al. 2021) are: a) confirmed in a larger cohort of children and b) sustained over the first years of the COVID-19 pandemic. Pandemic restrictions, including school closures, created delays in healthcare and increased social isolation. Children with hearing loss were at particular risk for developmental delays due to reduced language exposure. Methods: Cochlear implant datalogs were collected repeatedly from 343 children using cochlear implants. Only children who had pre-pandemic datalogs were included, leaving a sample of 2,746 datalogs in 262 children (175 bilateral CI users and 87 unilateral CI users) who were pre-school aged (<5 years, n=103) and school aged (>5 years, n=159) pre-pandemic. Daily hours of sound were captured by the implant datalogging system and categorized into 6 auditory scene categories (quiet, speech, speech-in-noise, music, noise, and other). Time exposed to speech was calculated as the sum of daily hours in speech + daily hours in speech-in-noise. Residual hearing in the non-implanted ears of unilateral CI users was measured by pure tone audiometry. Mixed-model regression analyses revealed main effects with post hoc adjustment of confidence intervals using the Satterthwaite method. Results: Daily CI use remained stable over the course of the pandemic in children using bilateral CIs but declined in children with unilateral CI, particularly in children with better residual hearing in the non-implanted ear. Prior to the pandemic, pre-school-aged and school-aged children were exposed to speech for 47-52% of their listening hours/day. School-age children in both groups experienced significantly decreased speech exposure in early and late pandemic periods (10-16% reductions compared to pre-pandemic baseline, p<0.0001). Conclusion: The findings indicate a sustained reduction in children’s access to spoken communication over the past two years of COVID-19 pandemic-related lockdowns and school closures. Reductions in device use in children with residual hearing in the unimplanted ear should be explored so that appropriate support can be provided.

Primary Author/Presenter: Karen Gordon, PhD

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Learner Objectives:

Explain which group of children using cochlear implants decreased their daily device use during the COVID-19 pandemic.

Describe the decrease in exposure to speech during the pandemic in school aged children.
Concurrent Session: Concurrent Session 9-3 "Maximizing Cochlear Implant Daily Use"

Abstract Number: 251

Abstract Title: Eyes Open, Ears On: Facilitating Cochlear Implant Wear Time for Infants and Children

Abstract Content:

Introduction: Research has shown cochlear implant wear time (i.e., average hours a day that a child uses her/his cochlear implants) influences the listening and spoken language outcomes children achieve after implantation (Park et al., 2019; Wolfe et al., 2021). Eyes Open, Ears On (EOEO) is an interdisciplinary program created to support families of children with hearing loss in the goal of achieving hearing technology use during all waking hours. The EOEO program contains five core components: 1. Setting wear time goals and assessing progress toward these goals, 2. Education of the benefits of full-time hearing technology use, 3. Solutions for full-time hearing technology retention and use, 4. Family coaching and support, 5. Continual assessment of a family’s needs and adjustment of services to meet those needs. This presentation will describe the EOEO program and its impact on cochlear implant wear time of infants and children.

Methods: Children were enrolled into the EOEO program from April 2021 to October of 2022. Listening and spoken language specialists used data logging to measure hearing technology wear time (average hours of use per day) on a periodic basis and provided family-centered support associated with each of the five core components of the EOEO program listed above. The impact of the EOEO program on average daily wear time of hearing technology was measured across time.

Results: The EOEO program positively impacted the average amount of time children used their cochlear implants per day. A description of specific results will be provided in this presentation. The EOEO components, factors, and solutions that influenced hearing technology wear time varied based on the needs of the families. Full-time use of hearing technology is most likely to occur when hearing healthcare professionals evaluate the specific needs of a family and customize intervention and services to meet those needs.

Conclusion: The EOEO program significantly increased cochlear implant wear time for infants and young children. Optimal cochlear implant wear time can be achieved with the provision of family-centered, interdisciplinary hearing healthcare that evaluates a family’s needs and customizes services and supports to meet those unique needs.

Primary Author/Presenter: Darcy Stowe, MS

Author Block: Darcy Stowe, M.S., Jace Wolfe, Ph.D.; Hearts for Hearing, Hearts for Hearing, Oklahoma City, OK.

Learner Objectives:

describe the five core components of the Eyes Open, Ears On program.

describe the effect of the Eyes Open, Ears On program on wear time of children with cochlear implants.
Introducción: COVID 19 has directly impacted the field of pediatric audiology affecting all aspects of patient care. Decreased access to hearing healthcare increases the risk for poor linguistic outcomes in children with hearing loss. Specific patient factors, including distance from clinic, severity of hearing loss, hearing device use, insurance type, digital literacy, and organizational factors disproportionately impacted access to hearing healthcare in urban areas during COVID 19. Clinical factors, including provider availability, appointment availability, and administrative support may adversely contribute to delays in access to care. Systemic factors, including the provision of authorizations, timely appointments, chronic health problems, and associated comorbidities, delay access to essential treatment for hearing loss. Since pediatric hearing healthcare is sought on an elective basis, models of service delivery during the global pandemic must address disparities. Improvement in adherence to prescribed treatment must eliminate barriers to care. Pediatric audiologists have a responsibility to advocate for change at the patient, provider, clinical, organizational, and systems level.

Methods: During 2020, pediatric audiologists examined clinical practices to increase the number of appointments available for pediatric patients. Analysis of organizational factors related to clinical scheduling practices led to an increase in available appointment times. Using InTouch telemedicine platform and Zoom technology, patients were offered appointments to include speech-language evaluations, speech-language therapy, aural habilitation services, hearing aid and cochlear implant troubleshooting support, and remote programming of hearing aids. Increased collaboration with the cochlear implant manufacturers led to changes in clinical and organizational workflow which in turn increased the number of clinical appointments available for pediatric patients. Clinical audiologists’ advocacy for systemic change at the state level led to policy change and increased reimbursement rates for clinical services.

Results: Coordination of care, access to services through telemedicine, utilization of remote programming, and intervention provided through tele-practice facilitated access to hearing healthcare for underserved individuals residing in an urban area. Maintenance of patient and community provider (educational audiologists) relationships proved essential to facilitating adherence to audiology appointments.

Conclusion: Delivery of hearing healthcare services in urban areas continues to be complicated. Within the context of the pandemic and access to hearing healthcare among underserved groups, understanding the multilevel contributions of various factors and organizational strategic actions to mitigate these delays in obtaining clinical services, and associated patient outcomes should be further examined.

Primary Author/Presenter: Debra Shrader, EdD

Author Block: Kristina Rousso, AUD, Debra K. Schrader, EdD ; Caruso Department of Otolaryngology Head & Neck Surgery, Univ. of Southern California Keck Sch. of Med., Los Angeles, CA.

Learner Objectives:
At the end of the learning session, participants will list three strategies for increasing provider appointment availability in pediatric hearing healthcare organizations.

At the end of the learning session, participants will be able to propose practical strategies to implement solutions in organizations that improve patient access to pediatric audiology services.
CI2023 Dallas: Cochlear Implants in Children and Adults
**Concurrent Session:** Concurrent Session 10-1 "Cochlear Implantation in the Older Adult"

**Abstract Number:** 70

**Abstract Title:** Cochlear implants in the young-old (65 to 74 years), the middle old (75 to 84 years), and the oldest old (≥85 years); A retrospective study on average cochlear implant performance across two university-based cochlear implant centers

**Abstract Content:**

Introduction: Estimates of cochlear implant uptake within individuals who meet criteria range from 2.1-12.7%. This poor uptake can be due to a variety of issues, including a patients age. With the average life expectancy increasing, older adults remaining more active, and the Centers for Medicare & Medicaid Services (CMS) expanding coverage for cochlear implants, hearing health care providers need to ensure all avenues to improve auditory access are considered. This study examines and compares the pre-operative speech performance to 6-months post-activation speech performance for individuals in the young-old (65 to 74 years), the middle-old (75 to 84 years), and the oldest-old (≥85 years).

Methods: A retrospective review was performed at two university-based hospital cochlear implant centers to identify patients who met the age criteria, were implanted between 2019-2022, and completed post-operative testing at 6 months. Demographic details, pre-operative scores on the minimum speech test battery (MSTB), and 6-month post-operative scores on the MSTB (CNC, AzBio-Quiet, AzBio +10 SNT) were collected as distinct data points.

Results: 23 patients met inclusion criteria for this study. There were 12 in the young-old (65 to 74 years) cohort, 6 in the middle-old (75 to 84 years) cohort, and 6 in the oldest-old (≥85 years) cohort. The young-old (65 to 74 years) cohort saw a 56% improvement for CNC phonemes, a 44% improvement for CNC words, a 74% improvement for AzBio in quiet, and a 57.3% improvement for AzBio at +10 SNR. The middle-old (75 to 84 years) cohort saw a 55% improvement for CNC phonemes, a 41% improvement for CNC words, a 74.5% improvement for AzBio in quiet, and a 46% improvement for AzBio at +10 SNR. The oldest-old (≥85 years) cohort saw a 51% improvement for CNC phonemes, a 52% improvement for AzBio in quiet, and a 42% improvement for AzBio at +10 SNR.

Conclusion: As hearing health care providers, we are responsible for ensuring every patient, regardless of age, is presented with all options to improve their hearing health quality of life and overall quality of life. Through this study it was demonstrated that patients even in the oldest-old category, demonstrated a clinically significant improvement in speech understanding after cochlear implantation. This study proves that while advanced age comes with its own risks, age in of itself should not be an automatic contraindication to referring for a candidacy evaluation or for recommending cochlear implantation. As hearing healthcare professionals, it is our professional responsibility to ensure all patients are provided with the opportunity to pursue the amplification option that is best for them.

**Primary Author/Presenter:** Stevana Sullivan, AuD

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**Learner Objectives:**

At the end of the session, participants will be able to contrast speech performance outcomes across the geriatric population.

At the end of the session, participants will be able to discuss the benefits of cochlear implants for the oldest old population.
Abstract Number: 155

Abstract Title: Quality of life after cochlear implantation in nonagenarians

Abstract Content:

Introduction: Cochlear implantation in octogenarians and nonagenarians has been shown to result in similar speech perception outcomes compared to younger adults. However, speech perception testing lacks information on important indirect domains of implantation such as social and emotional benefit. Quality of life data is limited in older adults, particularly those aged 90 years and older. The objectives of this study are to describe the quality of life of nonagenarians using the Cochlear Implant Quality of Life-35 instrument (CIQOL-35) and compare CIQOL-35 scores to a younger adult cohort.

Methods: This study is a retrospective chart review and cross-sectional survey study of cochlear implant (CI) recipients aged 70 years and older at a single institution from 2015-2021. Demographic, hearing, and CI information were collected, and patients were sent the CIQOL-35 survey simultaneously. Speech perception was evaluated using CNC and AzBio in quiet and +10 dB signal-to-noise ratio (SNR) scores assessed at preoperative and most recent postoperative testing appointments. Patients were categorized into age groups (70-89 years old vs. 90 years or older) based on their age at the time of survey completion. The CIQOL-35 is comprised of six domains (communication, emotional, entertainment, environment, listening effort, social) and a global score. Scores range from 0 to 100 with larger numbers indicating greater self-reported quality of life.

Results: 165 patients aged 70-89 years and 30 patients aged 90 years or older completed the CIQOL-35. The average time between CI activation and survey completion was 35 months. Age groups did not differ significantly in sex, race, ACE-27 comorbidity scores, Mini-Mental Status Exam scores, and hours per day of CI use. Both cohorts had mean device use >10 hours daily. Preoperative AzBio scores were generally higher for the younger cohort, but this was not statistically significant. Mean CIQOL-35 domain scores in the 90+ group ranged from 37.0 ± 13.9 (listening effort) to 63.6 ± 18.8 (social). Mean CIQOL-35 global scores were similar in the 70-89 age group (47.5 ± 11.0) and 90+ group (48.1 ± 10.). CIQOL-35 scores were not significantly different between age groups for the global score and across all six domains. In contrast, mean postoperative AzBio scores were significantly higher in the younger cohort than the 90+ cohort, particularly in the +10 dB SNR condition (54.7 ± 23.4 vs. 34.5 ± 19.2, p < 0.001). Pearson’s correlation coefficients between AzBio scores and CIQOL-35 global scores were r = 0.42 (95% CI, 0.25-0.56) in the quiet condition and r = 0.49 (95% CI, 0.33-0.62) in the +10 dB SNR condition for 70-89 year old patients. For 90+ year old patients, r = 0.26 (95% CI, -0.18-0.61) in quiet and r = 0.17 (95% CI, -0.34-0.60) in +10 dB SNR. Conclusion: Despite differences in some speech perception performance, nonagenarians achieve similar quality of life scores after implantation as compared to 70-89 year old patients. Bivariate analysis suggests that postoperative speech perception has a greater influence on patient-reported quality of life in 70-89 year old patients than in 90+ year old patients.

Primary Author/Presenter: James W. Bao, MSCI

Author Block: James W. Bao, MSCI , Kevin Y. Zhan, MD , Amit Walia, MD , Dorina Kallogjeri, MD, Matthew A. Shew, MD , Craig A. Buchman, MD , Cameron C. Wick, MD ; Univ. of Miami Miller Sch. of Med., Miami, FL, Otolaryngology - Head and Neck Surgery, Washington Univ. Sch. of Med., St. Louis, MO.

Learner Objectives:

Describe quality of life after cochlear implantation in patients aged 90 years and older

Compare quality of life of 90+ year old patients to a younger cohort
Introduction: Cochlear implant (CI) outcomes in the elderly remain a significant topic of interest, given known hearing benefit and recently expanded Medicare candidacy criteria. Our objective was to provide a contemporary review of CIs performed in very elderly patients and compare outcomes of those ages 80-89 vs. 90+. Methods: Elderly patients (ages ≥80) undergoing cochlear implantation between 2015-2021 with post-operative speech outcomes were reviewed. Separate cohorts of ages 80-89 vs. 90+ were created. Standard speech testing was performed at routine intervals post-operatively. Cognitive screening (MMSE & MoCA) and comorbidities (ACE-27 index) were gathered pre-operatively. Self-reported balance issues were recorded at routine follow-ups. All patients underwent pre-operative anesthesia evaluation and optimization. Results: A total of 235 implanted ears were analyzed, with N=19 (8.1%) being second-side implants for both age cohorts combined. 177 patients were ages 80-89 and 58 patients were ≥90 years old. The three most commonly used electrode arrays were CI 532/632 N=169, 72.5%; CI 624 N=22, 9.4%; and AB Mid-Scala N=21, 9%. Mean pre-operative scores were as follows: CNC 18% SD 17, AzBio Quiet 19% SD 18, AzBio +10SNR: 8% SD 10—and were similar between age cohorts. Mean one-year post-operative speech scores were as follows for ages 80-89 vs 90+, respectively: CNC 49% SD 22 vs 46% SD 20, AzBio Quiet 54% SD 26 vs 53% SD 25, AzBio +10SNR 28% SD 21 vs 20% SD 17. Speech outcomes did not significantly differ across the two age groups for any comparison. Duration of hearing loss, duration of severe-to-profound hearing loss, ACE-27 comorbidity score, ASA physical status class, and BMI were not correlated with speech outcomes and did not vary significantly across age cohorts aside from duration of hearing loss. Presence of impaired cognitive function pre-operatively was not predictive of speech outcomes. Datalogging was significantly correlated with %CNC words, but not sentence tasks. Age at implantation was correlated only with speech in noise testing. Post-operative self-reported vertigo or imbalance symptoms in the 80-89 age group vs 90+ were reported in 23.5% vs 18.5% of patients at CI activation (p=0.445), and decreased to 6.1% vs. 10% (p=0.416) at 12 months post-operatively. Conclusion: Both 80-89 and ≥90-year-old patients undergoing cochlear implantation experienced significant average improvement in all speech measures at one year, without significant speech outcomes differences between age cohorts. Longer device use duration was associated with improved word understanding. Age was inversely correlated with speech in noise testing. Preoperative comorbidity scores and impaired cognition did not affect speech outcomes. Self-reported balance issues were low at one-year post-operatively.

Primary Author/Presenter: Kevin Zhan, MD

Author Block: Kevin Y. Zhan, MD, Amit Walia, MD, James Bao, MSCI, Sabina Dang, MD, Jordan Varghese, MD, Craig A. Buchman, MD, Matthew A. Shew, MD, Jacques A. Herzog, MD, Otolaryngology - Head & Neck Surgery, Washington Univ. in St. Louis, St. Louis, MO.

Learner Objectives:

Learn about speech outcomes in the elderly with cochlear implants
Abstract Number: 306

Abstract Title: Cochlear Implant in Older Adults: The Role of Speech Comprehension and Self-Perceived Auditory Effort in Quality of Life.

Abstract Content:

Introduction: With the aging of the population comes several health problems, and among them is hearing loss. The comprehension difficulty caused by hearing loss is linked to several health issues, such as social isolation behaviors, depression, and chronic stress. However, early diagnosis and correct intervention can prevent some of these consequences. Although the benefits are clearly described in the literature, does the percentage hit of speech comprehension or type of CI adaptation related to the quality of life? The purpose of this cross-sectional study is: to evaluate the outcomes of older adult CI users, comparing the results of different hearing device adaptations, and the variables that contribute to a better quality of life

Methods: Participants were older adults over 60 years of age, with at least 6 months of activation. Data were collected from medical records and the subjects were evaluated with: a quality-of-life questionnaire (WHOQOL-OLD), and a speech perception test (HINT). Tests in silence were performed with speech signal at 65 dBHL, in Fixed Noise with noise at 55 dBNPS, S/N +10 dB, and in adaptive noise starting with an S/N of 0 dB. Participants reported the degree of subjective effort made at each step of the speech perception test, using the Visual Analog Scale (VAS).

Results: The study included a total of 22 subjects (15 female, 7 male) divided at bilateral CI (n=7), unilateral CI (n=8), and bimodal (n=7). They were aged between 60 and 78 years (mean 68). The mean CI auditory age was 3.39 years. SPEECH PERCEPTION: bimodal and bilateral subjects had a better performance than those with a unilateral adaptation in all situations (Silence, adaptive and fixed noise) However, there were no significant statistical differences between the different CI configurations. Subjective Auditory Effort: Considering the visual analogic scale and the degree of subjective auditory effort employed in the speech tests: HINT silence (mean 2.18), HINT fixed noise (m: 4.14) and HINT adaptive noise (m: 6.52). When correlated with other variables, HINT silence had a correlation with age (p-value 0.0026): The higher the percentage of the silent HINT test, the lower the age. The quality-of-life assessment with WHOQOL-OLD shows that, regarding the type of hearing adaptation, patients with bilateral CI had higher quality-of-life scores, but also with large variability (M:88.17 SD: 10.42). However, there was no difference between the average means. Analysis of results shows a statistically significant correlation between WHOQOL-OLD and VAS. QOL: The higher the quality-of-life scores, the lower the subjective effort reported in the adaptive noise test (p-value 0.0475). When we analyze the facets of WHOQOL-OLD, the lower score was sensorial function (mean:51.99). The mean quality of life, of the participant, was 65.96%. HINT fixed noise had a positive correlation with the Social Participation subdomain of WHOQOL-OLD (p-value 0.0365): the higher the percentage in the HINT fixed noise, the greater score of social participation.

Conclusion: Cochlear implants in older adults are a feasible option to restore audition regardless of the type of adaptation. Our study showed that lower age is related to better performance in silence. But a greater quality of life is related to speech comprehension in noise and also, with less self-perceived effort in noisy situations. This leads to better social performance, which is one of the principal components of a good quality of life for older adults.

Primary Author/Presenter: Fernanda Ferreira Caldas, Au, MSc, PhD

Learner Objectives:

Discuss the speech comprehension and auditory effort outcomes of older adults cochlear implant users in silence and in noise.

Identify the variables that affect the quality of life in older adults cochlear implant users.
**Concurrent Session:** Concurrent Session 10-1 "Cochlear Implantation in the Older Adult"

**Abstract Number:** 325

**Abstract Title:** Cochlear Implant Outcomes in the Very, Very Elderly

**Abstract Content:**

Introduction: Managing hearing health in older adults has become a public health imperative, and cochlear implantation is now the standard of care for aural rehabilitation when hearing aids no longer provide sufficient benefit. Prior research by this group compared the outcomes for two cohorts of elderly cochlear implant recipients; 65-79 year olds to an older group aged 80-96 years. Statistical analysis found there was a significant difference for average improvements of AzBio in quiet scores between groups with a medium effect size. However, when the very oldest patients (90+ years) were removed, that statistical differences between groups disappeared. The aim of this study was to specifically evaluate speech performance in cochlear implant patients <u>></u>90 years of age.

Methods: Data were collected from 18 patients >90 years of age who underwent cochlear implantation by the senior author between April 1, 2017 and June 31, 2022. The primary outcome measure compared preoperative AzBio Quiet scores to 6-month post-activation AzBio Quiet results. Other speech outcomes measures were included.

Results: The very, very elderly patients progress from an average AzBio Quiet score of 25% pre-operatively to a score of 44% in the implanted ear at 6-months post-activation. AzBio, +5 SNR scores improved from 5% to 15%, and CNC word scores improved from 21% to 40%.

Conclusion: There is a paucity of data available on cochlear implant recipients of advanced age. Prior research by this group and this specific study have demonstrated that even patients over age 90 years benefit from cochlear implantation. While their somewhat poorer performance compared to younger cohorts may be related to increased duration of deafness and central auditory processing disorders tied to advanced age, these patients still reported improved environmental sound awareness, improved communication, and more effective social interaction. Our clinic has developed alternative testing protocols for these Very, Very Elderly patients as they often need more support with equipment, monitoring magnet strength, and have difficulty completing comprehensive speech testing and mapping due to fatigue. The speech outcomes for the very, very elderly CI recipients in a single-surgeon, high-volume practice indicates that the very oldest patients derive both statistical and clinical benefit and should not be dismissed as potential cochlear implant candidates.

**Primary Author/Presenter:** Stephanie Bourn, AuD

**Author Block:** Stephanie S. Bourn, AuD, Mary Rose Goldstein, Au.D, Alissa Knickerbocker, Au.D, Abraham Jacob, MD; Ear & Hearing, Ctr. for Neurosciences, Tucson, AZ.

**Learner Objectives:**

Describe benefits of cochlear implantation in the very, very elderly population.

Describe unique aspects of management and following audiologic in the very, very elderly population.
Introduction: Hearing loss is increasingly recognized as a chronic disease that warrants treatment. Depression, social isolation, loneliness, and poorer cognitive performance have all been linked to untreated and undertreated adult-onset hearing loss. A significant subset of the hearing loss patient population is inadequately rehabilitated by hearing aids alone and may benefit from cochlear implantation. Yet, it is estimated that less than 10% of those who qualify have received implants to date.

Methods: A national survey was conducted online in November and December of 2021. Subjects were identified using Dynata<sup>TM</sup> panelists and river sampling. Enrollment occurred on a rolling basis. Upfront sample management techniques were used to control the distribution, balancing the respondent cohort to the 2018 United States Census on age, household income, sex, marital status, household size, race/ethnicity, and education.

Results: Among 15,138 adult respondents with a mean (SD) age of 51 (17) years (54% female), only 10% reported being very familiar with cochlear implants, and 31% of those with hearing difficulty reported that they have “never heard” of a cochlear implant. Females were statistically significantly more likely to report some degree of familiarity with cochlear implants than men (34% vs 26%; p<0.01). The greatest familiarity with cochlear implants was observed among those age 35-44 years (18% reporting “very familiar”), whereas only 9% of those aged 65-74, 10% aged 75-84, and 8% ≥85 reported being very familiar (p<0.01). Those identifying as White/Caucasian were statistically significantly more likely to report familiarity with cochlear implants than those identifying as Black/African American and Hispanic/Latino/Spanish (33% vs 56% vs 50% responding that they had “never heard” of cochlear implants; p<0.01). Among adults with hearing difficulty, nearly 80% report having never talked with a medical or hearing care professional about cochlear implants.

Conclusion: Limited cochlear implant awareness likely influences its widespread underutilization across the United States. Sex, age, and race disparities compound these issues among men, the Medicare-aged population, and those identifying as Black/African American and Hispanic/Latino/Spanish.
**Abstract Content:**

Introduction: Hearing health is a recognized public health priority with prevalence of hearing loss rising worldwide. Currently, there is a lack of awareness of and inconsistency in diagnosing and managing of hearing loss, especially severe to profound sensorineural hearing loss (SNHL). Guidelines with clearly defined care pathways for adult cochlear implantation would enable consistent and equitable access to hearing healthcare and treatment. Publication of the 2020 consensus statements on unilateral cochlear implants (CI) for severe to profound bilateral SNHL marked the first step towards a standard of care framework. Building on this, we will describe the orchestrated efforts of an International Task Force in the development of guidelines for adult cochlear implantation using a living evidence model.

Methods: Living guidelines is a new and emerging approach that drives evidence-based practice, incorporating the latest and best available scientific evidence for optimal disease management. This is the first time a group of adult CI users as well as an international group of experts has been brought together in the field of hearing health, to form a Task Force, in partnership with the Cochlear Implant International Community of Action (CIICA). The Task Force identified a total of nine research questions as a key focus for the living guidelines. These align with the journey of a CI user from screening of hearing loss, referral for CI, surgery, fitting, to rehabilitation and after care. A systematic literature review of these main themes was conducted, and 13,738 citations were identified to form the basis of the adult CI recommendations.

Results: Following the consultation phase, involving independent key hearing stakeholders, it is anticipated the recommendations will be finalized and published on an online platform in 2023. Timely and coordinated updates to the guidelines will be performed as future evidence emerges. The living practice guidelines can be adapted and adopted in individual countries to help optimize the care of adults indicated for a CI and facilitate more equitable access to hearing health.

Conclusion: The CI Living Guidelines aim to define and optimize access referral pathways and CI treatment. By streamlining the patient pathway and establishing best practice recommendations, these guidelines may help bridge gaps in CI access and patient care.

**Primary Author/Presenter:** Meredith A. Holcomb, AuD,

**Author Block:** Meredith A. Holcomb, AuD, CCC-A Department of Otolaryngology, Univ. of Miami, Miller Sch. of Med., Miami, FL.

**Learner Objectives:**

Understand the novel nature of the Living Guidelines for Adult Cochlear Implantation approach and methodology.

Gain a clear understanding of this new and emerging approach that drives evidence-based practice, incorporating the latest and best available scientific evidence for optimal disease management.
**Concurrent Session:** Concurrent Session 10-2 "Advancing Referral Guidelines and Access to Care"

**Abstract Number:** 91

**Abstract Title:** An Updated Approach to Predicting Cochlear Implant Candidacy

**Abstract Content:**

Introduction: Cochlear implants (CI) are under-utilized, partially due to misunderstanding of CI candidacy. Although candidacy is determined by evaluating speech recognition ability using appropriately programmed hearing aids in the soundfield, referring providers usually rely on unaided pure tone average (PTA) and suprathreshold word recognition (WRS) performance in quiet plus self-reported patient success with hearing aids when making the decision to refer. Yet, research suggests this approach may lead clinicians to overestimate patients’ ability and defer CI evaluation when CI may be appropriate. McRackan et al (2018) concluded CNC word scores obtained under earphones overestimate aided speech recognition ability. Gubbels et al (2016) reported patients with <40% monosyllabic WRS were more likely to meet CI candidacy, but restrictive Medicare criteria were used to determine candidacy. Most recently, Zwolan et al (2020) recommended the use of a 60/60 referral guideline (unaided PTA of 60 dB HL or worse and unaided monosyllabic WRS of <60%) to more consistently capture candidates for evaluation, again based on Medicare criteria. Those with SSD, residual hearing, and asymmetric hearing loss were not captured. The current study aimed to determine whether unaided audiometric evaluation can reliably predict CI candidacy when payer is considered and whether current recommendations for interpreting pure tone average and WRS as an indication of candidacy are too restrictive. Additionally, it considers an alternative measure of aided speech intelligibility index (SII) which has not previously been assessed as a screening measure for CI candidacy.

**Methods:** Retrospective chart review of approximately 200 adults who underwent CI evaluation. Data collected: unaided PTA, unaided WRS (NU-6), aided word (CNC words) and sentence (AzBio) recognition in quiet and noise, CI candidacy status, primary payer, and SII. Conducted chi-square tests (categorical variables), logistic regression (quantitative variables), calculated odds ratios for prediction of CI candidacy, and derived optimal first split of a classification tree to identify significant breakpoint in data that might indicate clinically relevant indicators of CI candidacy. All analyses were conducted as a function of insurance (Medicare Part B, Medicare Advantage, commercial).

**Results:** This study reflects an updated data set that expands upon results presented as a poster at ACI2021 which did not include patients with SSD or SII. Even excluding candidates with asymmetric hearing loss, the original data set suggested that the 60/60 guideline of <60% word recognition AND >60 dB PTA is too restrictive for contemporary candidates. Analysis of the new data set is in process and results are expected to further underscore the limitations of current approaches to candidate identification.

**Conclusion:** Current protocols for identifying CI candidates are potentially detrimental to achieving optimal outcomes and increased access to CI. Using unaided PTA and WRS to identify appropriate candidates when primary insurance is non-Medicare Part B or better ear is considered can be expected to underestimate aided performance and exclude appropriate candidates from consideration. Aided testing using AzBio sentences or CNC words is more predictive of CI candidacy for non-Medicare Part B patients and should potentially be included in audiologic evaluations before referral to CI center.

**Primary Author/Presenter:** Sarah Sydlowski, AuD, PhD, MBA

**Author Block:** Sarah Sydlowski, AuD, PhD, MBA, Radhika Duggal, BS, George Saieed, BS, Alex Belinsky, AuD, Regan Everiss Weaver, AuD; Cleveland Clinic, Cleveland, OH, Case Western Reserve Univ., Cleveland, OH.

**Learner Objectives:**
Describe the predictive relationship of unaided audiometric thresholds and PTA and speech intelligibility with cochlear implant candidacy

Explain the inherent limitations of current predictive models for identifying potential cochlear implant candidates
Changes in outcomes expectations during the cochlear implant evaluation process

Introduction: Patient expectations are a critical factor in determining CI candidacy. However, minimal data are available on modifications of patient expectations by healthcare providers and the resources patients use to inform their CI outcome expectations. This project aims to assess (1) the extent to which patients’ pre-CI outcome expectations can be modified, (2) the role of the CI evaluation (CIE) process on patients’ expectations, (3) the information patients use to inform their expectations, and (4) patients’ preferences for the discussion/display of potential CI outcomes.

Methods: Prospective mixed methods study of 32 adult CI patients undergoing CIEs. Outcome measures included: pre-CI CIQOL-35 Profile scores; pre-CIE/post-CIE/day of surgery CIQOL-Expectations scores; post-CIE/day of surgery Decisional Conflict Scale (DSC) scores; pre-CI aided, and post-CI CNC word and AzBio sentence scores. Qualitative thematic analyses of key informant interviews with 19 potential CI patients were also performed.

Results: Overall, CI CIQOL-Expectation domain scores remained essentially unchanged after discussions with the audiologist and surgeon during the CIE (d=0.01 to 0.17). However, expectations significantly decreased following the CIE for patients with higher pre-CIE expectations for all CIQOL domains except emotion and social (d=-0.27 to -0.77); in contrast, post-CIE expectations significantly increased for patients with lower pre-CIE expectations in all domains (d=0.21 to 0.50). Expectations remained essentially unchanged or continued to change in the same direction between the post-CIE and time of surgery evaluations, narrowing the gap between patients with higher and lower expectations. Overall, patients demonstrated low overall conflict related to their decision to proceed with cochlear implantation (mean DCS 11.4 post-CIE and 14.2 time of surgery out of 100) but DCS scores were higher for patients with lower pre-CIE expectations (d=0.71). Analysis of key informant interviews demonstrated that potential CI users placed high value in talking with other patients who had previously received a CI. They also preferred discussing CI functional abilities via clinical vignettes described in the CIQOL Functional Staging System rather than by discussing speech recognition or CIQOL-35 Profile scores.

Conclusion: Given that patients’ pre-CI expectations are modifiable, CI clinicians should identify patients during the CIE with unrealistically low or high expectations and provide personalized counselling to present a more accurate representation of likely CI outcomes. Discussions with current CI users may also provide valuable information to CI candidates to inform their expectations and communicating potential CI benefits using CIQOL functional stages may result in more realistic patient expectations and support shared decision-making related to CI surgery.

Primary Author/Presenter: Theodore McRackan, MD, MSCR

Author Block: Joshua E. Fabie, MD, Christian Shannon, BS, Shreya Chidarala, BS, Kara C. Leyzac, AuD, PhD, Elizabeth L. Camposeo, AuD, Judy R. Dubno, PhD, Theodore R. McRackan, MD, MSCR; Otolaryngology, Med. Univ. of South Carolina, Charleston, SC.

Learner Objectives:

understand the impact of discussions with ENT and audiology on expectations for prospective cochlear implant users

determine the sources of information patients find most meaningful to inform their expectations and understand their hearing performance relative to other CI users
Abstract Number: 218

Abstract Title: SII 40: A New Referral Guideline for Cochlear Implant Candidacy Evaluations

Abstract Content:

Introduction: The Speech Intelligibility Index (SII), which provides information regarding the proportion of speech information that is both audible and usable for a listener, has been recommended as a tool to determine candidacy for a hearing aid. It also holds promise as a tool for identifying patients who should be referred for cochlear implant candidacy evaluation (CICE). This study aimed to develop and evaluate an aided speech intelligibility index (SII)-based guideline for identifying adult patients who should be referred for CICE.

Methods: A retrospective review was completed of adults seen for CICE at a large tertiary care center from January 2016 to September 2022. Pre-operative aided SII values for soft and average speech inputs, unaided pure tone thresholds, and aided sentence recognition scores in quiet and at +10 dB signal-to-noise ratio (SNR) for the right, left, and bilateral aided conditions were reviewed. Subjects were considered to have met cochlear implant (CI) guidelines if their pure tone thresholds fell in the moderate to profound hearing loss range and their best aided score on AzBio sentences at +10 SNR was less than or equal to 60% correct. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and total accuracy (TA) were calculated for various SII cutoff values for soft and average speech inputs to evaluate each value’s ability to identify patients who meet traditional CI indications.

Results: Preliminary results for 272 adults who were seen for CICE from January 2016 to May 2020 and met inclusion guidelines for this study are available; additional data for approximately 140 subjects seen from June 2020-September 2022 will be included at the time of presentation. Of the 272 adults seen for evaluation, 141 met traditional CI candidacy guidelines and 131 adults did not meet traditional CI candidacy guidelines. The mean better ear aided SII for average speech inputs (65 dB SPL) was .25 for CI candidates, and .46 for non-candidates. Sensitivity, specificity, positive and negative predictive values, and total accuracy were calculated for various better ear aided SII values. Subjects whose better ear aided SII value was < .4 were likely to meet traditional CI candidacy guidelines (sensitivity: 91%, specificity: 69%, PPV: 76%, NPV: 88%, TA: 81%).

Conclusion: Preliminary results suggest that hearing professionals should consider referring patients for CICE when their aided SII for average speech inputs is .4 or less for the better hearing ear. We expect that most patients (91%) who could benefit from a CI will be referred for evaluation using this guideline. While some patients who are referred using this guideline will not meet traditional CI guidelines as defined in this study (31%), we expect that a portion of this group would still be considered non-traditional candidates for cochlear implantation at the time of referral or in the near future.

Primary Author/Presenter: Heidi Slager, AuD

Author Block: Heidi K. Slager, AuD, Gabrielle Watson, AuD, Teresa A. Zwolan, PhD; Otolaryngology - Head & Neck Surgery, Michigan Med., Ann Arbor, MI, Cochlear Americas, Lone Tree, CO.

Learner Objectives:

describe how to use aided speech intelligibility index values to determine when to refer for cochlear implant candidacy evaluation.

describe how to use sided speech intelligibility values to counsel patients regarding the likelihood of meeting traditional cochlear implant candidacy guidelines.
Concurrent Session: Concurrent Session 10-3 "Parent, Family, and Community Concerns"

Abstract Number: 16

Abstract Title: Evaluations of parental perspectives and concerns about pediatric cochlear implantation

Abstract Content:

Introduction: Parental decision-making for pediatric cochlear implantation (CI) surgery is a complex process that often involves feelings of responsibility and uncertainty. Online forums offer an opportunity to identify parental perspectives and concerns about pediatric CI that might not be apparent during clinical encounters. Methods: In this qualitative study, three highly frequented forums for parents of CI users were searched for posts about pediatric CI published by US-based parents from 2006-2021. Modified grounded theory was applied to classify posts by domain, theme, and subtheme. Posts were reviewed for thematic synthesis, and descriptive statistics were calculated for each theme by unique users. Posts were grouped by unique users and coded under various subthemes. Results: A total of 72 posts by 58 unique users were included. The following pre-CI themes were explored: factors influencing decision, pre-CI concerns, pre-CI resources, and pre-CI feelings. Lack of benefit from hearing aids was a common factor influencing CI decision (n=6 [10.3%]; “As soon as we discovered that [she] wasn’t getting much from aids it wasn’t very difficult to decide on CI”), and cost was the most frequently cited concern (n=5 [8.6%]; “doctor said do cochlear implant surgery but I don’t have money for that”). Multiple parents also expressed concern about making a decision for a minor (n=3, [5.2%], “I just felt that if she wanted an implant she could do it when she was grown. I felt like it was not my body so not my decision.”). Healthcare providers (n=13 [22.4%]) and social media (n=12 [20.7%]) were frequently mentioned as a resource. Indecision was the most commonly cited pre-CI feeling (n=9 [12.1%]; “It has been a really tough decision”). The following post-CI themes were explored: outcomes, post-CI concerns, and post-CI accommodations. Parents frequently reported having had a positive experience with surgery and/or recovery (n=11 [19.0%], “Everything went very well. She didn’t complain about pain or get really sick either.”) and overall satisfaction with CI (n=19 [32.8%]; “Cochlear implants are amazing and wonderful”). The most common concern was language and/or learning delay (n=9 [15.5%]; “[she] is SOOOOO far behind the other kids in language”), and many parents reported concerns about school accommodations (n=14 [24.1%]; “our school is not providing what my daughter NEEDS to get benefit from her limited window of language learning.”) Conclusion: Findings may inform physicians about parental thoughts before and after CI and guide parent-physician conversations during counseling and shared decision-making for pediatric CI.

Primary Author/Presenter: Emily Huang, BS

Author Block: Emily Y. Huang, BS, Tai K. Hairston, MD, Jonathan Walsh, MD, Emily F. Boss, MD, MPH, Carolyn M. Jenks, MD; Department of Otolaryngology – Head and Neck Surgery, Johns Hopkins Univ. Sch. of Med., Baltimore, MD, Department of Pediatrics, Johns Hopkins Univ. Sch. of Med., Baltimore, MD.

Learner Objectives:

Identify parental perspectives and concerns about pediatric cochlear implantation to guide shared decision-making for surgery.
Abstract Number: 38

Abstract Title: Coaching Practices Implementation in Family-Centered Listening and Spoken Language Intervention

Abstract Content:

Introduction: Auditory Verbal Therapy (AVT; sometimes broadly categorized as listening and spoken language, or LSLS, intervention) is a family-centered intervention method aimed at developing listening and spoken language skills for children with hearing loss (CWHL) (Rosenzweig, 2017). Auditory verbal practitioners hold the Listening and Spoken Language Specialist (LSLS) certification (AG Bell Academy for Listening and Spoken Language, n.d.). While the principles of LSLS practice emphasize parent/caregiver guidance and coaching, specific strategies are not explicated (AG Bell Academy for Listening and Spoken Language, 2007). This study investigated professionals’ use of evidence-based parent/caregiver coaching strategies in family-centered listening and spoken language intervention.

Methods: This quantitative survey collected information from over 120 audiologists, speech-language pathologists, teachers of the deaf, and others who provide family-centered listening and spoken language intervention. The study’s methodological grounding draws from the principles of implementation sciences and seeks to determine both the barriers to, and facilitators of, professionals’ implementation of evidence-based strategies in clinical practice. The Theoretical Domains Framework (Atkins et al., 2007) provides guiding questions to investigate behavior change, many of which were incorporated into the survey instrument designed for this study (e.g., “Use of coaching is supported by staff training in my practice setting”). Other questions aimed to assess professionals’ use (or nonuse) of Rush and Shelden’s (2020) specific coaching strategies. Previous studies have used a similar methodology to determine professionals’ rate of usage for other types of evidence-informed strategies (Rosenzweig & Smolen, 2021).

Results: Survey data indicated the following as significant barriers to the implementation of evidence-based coaching practices: lack of institutional support, lack of professional skill, lack of professional confidence.

Conclusion: Data can inform both individual and organizational decisions about facilitating professionals’ use of evidence-based caregiver coaching strategies. Education on coaching practices for pre-services and in-service professionals and increased administrative support for coaching were identified as key facilitators of coaching implementation.

Primary Author/Presenter: Elaine Smolen, PhD

Author Block: Elizabeth Rosenzweig, PhD CCC-SLP LSLS Cert. AVT, Elaine Smolen, PhD CED LSLS Cert. AVEd; Biobehavioral Sciences, Columbia Univ., New York, NY, Health and Behavior Studies, Columbia Univ., New York, NY.

Learner Objectives:

- List barriers to the implementation of evidence-based caregiver coaching practices in auditory verbal intervention
- Identify modifications to in-service and pre-service professional development that may facilitate increased adoption of evidence-based caregiver coaching strategies
Development of a Community Based Cochlear Implant Program to Increase Patient Access: Opportunities, Barriers and Hope

Introduction: It is estimated that only 2.1-12.7% of the 1.3 million adult cochlear implant candidates actually get implanted in the United States. (1) Frequency Data of Medicare indicate that only 3,396 claims were paid in 2020 for cochlear implantation nationally of the 62,840,267 Medicare enrolled participants. This data underscores the drastic access issues for potential cochlear implant candidates nationally. In our metropolitan area of Los Angeles county (LAC), there are 9,861,224 residents of which 1,436,518 (15%) are over 65 years of age. Excluding our center, there are 3 ACIA registered cochlear implant programs to serve this population with an estimated 400 cochlear implants placed annually. Pacific Neuroscience Institute (PNI) has launched a comprehensive brain health and wellness center of excellence (COE). Hearing care diagnosis and rehabilitation is a focus of the COE with integration of CI when indicated for cognitive and auditory rehabilitation. Due to the access barriers, a community-based CI program was launched. Based on the estimates, the penetration of cochlear implantation in LAC is lacking. Exploring the “Why” is one of the goals of the program.

Methods/Concurrent Results: The first step is to evaluate and define the access barriers of CI candidates that exist in Los Angeles county and then to create an enhanced pathway for patients to obtain cochlear implantation based on concurrent study and analysis of the following parameters that impact access:

1. Program Structure: start up, identification of financial and workforce infrastructure with focus on sustainability
2. CI Patient Workflow process enhancement—clinical and facility management
3. Community health provider grassroots education with focus on hearing care professionals and primary care providers under the banner of “Demystification of Cochlear Implantation”
4. Identifying barriers and engineer solutions to integrate CI technology into mainstream hearing care practices
5. Novel collaboration with the three CI manufacturers to refocus support resources
6. 3<sup>rd</sup> party payor member CI indications and constraints streamlining authorization process
7. Development of community philanthropic champions and other secondary funding mechanisms to support the CI program expansion

Conclusion: Our vision is to present the progress, successes, and barriers of this nascent program at this and each annual conference to collaborate nationally with other CI providers to ultimately improve CI access.


Primary Author/Presenter: Chester Griffiths, MD, FACS

Author Block: Chester F. Griffiths, MD, FACS, Courtney Voelker, MD, PhD, Rebecca Lewis, AuD, CCC-A; Pacific Head and Neck, Pacific Neuroscience Inst., Los Angeles, CA.

Learner Objectives:

Understand the barriers to access for cochlear implant candidates

Defining the barriers to access and creating solutions to overcome these barriers
**Abstract Content:**

Introduction: Despite the robust body of evidence that has demonstrated the effectiveness of cochlear implants (CI) in the treatment of sensorineural hearing loss, utilization remains low as the population of untreated audiological CI candidates is on the rise. Barriers to treatment have been investigated in adult CI users in the United States and point to the absence of chronic hearing loss as a public health issue, further complicated by a fragmented and uncoordinated healthcare delivery pathway for individuals with hearing loss. Of particular relevance are the subgroup of individuals who are both interested in and undergo audiological evaluation for cochlear implantation though ultimately decide to not proceed with the recommend treatment. Given the growing concerns for mental health, communication and overall quality of life associated with undertreated hearing loss, how can CI professionals better support our patients to elect CI? This presentation reviews data on patients who underwent a CI evaluation though did not proceed to surgery to better understand the reasoning and discuss opportunities to improve adoption of a well-proven treatment for significant sensorineural hearing loss.

Methods: A retrospective analysis was completed by way of electronic health record (EHR) review between two CI centers to identify the number of patients who did not proceed with first-ear cochlear implantation after identification. 122 patients evaluated between 07/01/21 and 06/29/22 met inclusionary criterion for analysis.

Results: Of the 122 patients who were evaluated, more than 40% did not proceed with first-ear cochlear implantation despite qualifying in at least one ear. Rationale for not pursuing implantation fell into several categories; however, fear or surgery or outcome was identified as the chief barrier within this group.

Conclusion: New care models are clearly needed to accelerate access to new CI patients and manage the existing recipient base. However, what can CI programs do to support those who qualify for treatment but ultimately decide not to proceed with implantation? CI audiologists often counsel with an “under-promise and over-deliver” model that may not work for all patients who come through their clinic doors. This, coupled with provider bias, or who CI audiologists think may or may not do well with cochlear implants, could be isolating groups of patients who both qualify for and could benefit from CI technology. Rather than managing existing recipients who have met expected outcomes, or a heavy first-year post-implantation follow-up schedule, CI audiologists may benefit from evaluating their current counseling methods and post-evaluation follow-up protocols. How effective are current processes in converting identified CI candidates into recipients? In place of providing the same type of informational counseling and follow-up collateral to all identified candidates, CI audiologists may consider pivoting counseling styles, leveraging existing CI volunteers/recipients, and/or developing nurture campaigns to meet the dynamic needs and overcome barriers to implantation of their patient base. Perhaps most importantly, however, the CI audiologist will want to ensure that they are not a barrier to patient uptake of CI technology.

**Primary Author/Presenter:** Arun Joshi, AuD

**Author Block:** Arun Joshi, Doctor of Audiology, Kristen Caron, Doctor of Audiology; Cochlear Hearing Ctr., Bellaire, TX.

**Learner Objectives:**

- explain reasons why identified CI candidates do not proceed to surgery
- discuss opportunities to improve adoption of a well-proven treatment for significant sensorineural hearing loss
**Concurrent Session:** Concurrent Session 10-3 "Parent, Family, and Community Concerns"

**Abstract Number:** 289

**Abstract Title:** Increasing Cochlear Implant Care Access in a Large and Growing Metropolitan Area

**Abstract Content:**

**Introduction:** Providing access to hearing health in the county of Los Angeles with nearly 9 million residents based on 2020 census, is complex. Of those that have hearing loss, we know that 134,000 of those residents meet cochlear implant candidacy criteria. In a very large metropolitan area, there’s only a handful of implanting centers and not enough cochlear implant trained audiologists. Our CI center has experienced delays in CI evaluation appointments greater than 3 months. Additionally, when a nearby pediatric CI center was closing their doors, the responsibility of delivering services increased dramatically. How do we provide support for our own patients and expected increase in pediatric workload from another center? We needed to evaluate current workflows in order to find a more efficient way to provide patient care while providing quality, efficiency and remaining financially secure.

**Methods:** In July of 2021, the CI team started a project to review our current processes to understand what tasks were being completed, who was completing them and in what time frame for each part of the patient CI journey. We identified several key areas to change to meet our goals which included the following: 1) reducing the overall number of appointments and time allocated for each appointment for Adult CI patients, 2) aligning on counseling and defining expectations based on clinical evidence to support consistency across the team 3) More efficient and seamless device registration process 4) review of current coding/billing practices 5) utilizing manufacturers tools and services such as the Recipient Solutions Manager (RSM), Engagement Manager, (EM) to assist with non-billable time on equipment, accessories, aural rehab, connectivity, device troubleshooting and also included mandatory touch points and Remote Care tools like Remote Check and Remote Assist and 6) Use of a CI Coordinator to assist with coordinating appointments to reduce patient travel time and visits.

**Results:** The number of clinical visits were reduced from 6 visits to average of 4 with the length of the appointment reduced from the average of 120 minutes to 90 minutes with the average total amount of time in the first year reduced from 720 minutes to 410 minutes. This along with the other changes discussed above has resulted in a decrease in evaluation wait times from 3 months to 1 month, with an increased number of pediatric patients from 30 to 55 and an overall growth of 25% in CI volume from 2021.

**Conclusion:** A systematic analysis of existing processes and assessing where improvements can be implemented have demonstrated to be successful when trying to advance our CI program. Expanded criteria that CMS has recently approved will once again challenge our current system since more patients are eligible for cochlear implantation. Re-evaluation of our CI program goals and processes along with the implementation of remote care will certainly be expected to be advantageous in providing CI services to more patients as the hearing healthcare landscape continues to evolve.

**Primary Author/Presenter:** Gina Gracia, AuD

**Author Block:** Gina Gracia, AuD, Carlen Kim, AuD; Ronald Reagan UCLA Med. Ctr., Los Angeles, CA.

**Learner Objectives:**

Learn how to look at their current CI appointment processes and identify the areas that may need improvement.

Identify at least 3 methods to implement to improve overall patient experience throughout their CI journey.
**Concurrent Session:** Concurrent Session Poster Highlight Session PH-1

**Abstract Number:** 14

**Abstract Title:** Comprehension of C Pronouns by Children with Cochlear Implant

**Abstract Content:**

Introduction: Cochlear implants (CIs) have proved to be very effective in permitting children with severe to profound hearing loss to acquire oral language with the support of intervention following implantation (Geers et al., 2003). In general, lexical, semantic, pragmatic, and phonological knowledge are not particularly vulnerable in children with CIs. Morphosyntax has been reported as the most challenging linguistic area since early stages of cochlear implantation research (Davies et al., 2020). One particular area of morphosyntax that has recently received attention in children with CIs is the use of clitic pronouns (Giustolisi et al., 2020). Clitic pronouns are present in most Romance languages and, unlike full pronouns in English, they are unstressed morphemes that must be attached to a verb. In general, perception and application of prosodic cues are more challenging for children with CIs since the transmission of spectro-temporal information is limited by their implant. The present study investigates how children with CIs who speak Brazilian Portuguese process sentences with clitics and how they benefit from sentence stress. We hypothesize that children with CIs who speak Brazilian Portuguese will show decreased accuracy in comprehending sentences with clitic pronouns when compared to matched NH peers. Additionally, we hypothesize that children with CIs will not benefit from suprasegmental cues of sentence stress in the same way as children with NH. Methods: Fifteen children with NH and 13 children with CIs and participated. All children (8;0-12;7 years) were monolingual speakers of Brazilian Portuguese and had normal vocabulary scores and nonverbal IQ. All children with CIs were prelingually deafened and were implanted before the age of four. The experiment consisted of a computerized sentence comprehension task. Sixteen sentences that contained a reflexive clitic like in (a) composed the target experimental sentences of study. a) A avó (<sub>N1</sub>) atrás da mãe (<sub>N2</sub>) está se olhando. The grandma (<sub>N1</sub>) behind the mom (<sub>N2</sub>) is looking at herself. Each sentence was recorded in two different prosodic forms varying stress placement on noun 1 (N1) dad or noun 2 (N2) grandpa, the two possible antecedent nouns to the clitic pronoun. Unstressed words were produced with shorter duration and lower frequency than stressed words. Results: A mixed effects generalized logistic linear regression model was applied to the binary data with random effects that account for the within-subject correlation (BIC=887.556). Children with NH were significantly more accurate than children with CI in comprehending sentences with clitics on both stress conditions. For children with NH, stress on the correct antecedent (N1) significantly increased sentence comprehension accuracy. For children with CI, there was no significant effect of stress on selecting the correct antecedent. No statistically significant correlations were observed between acoustic measures and comprehension of sentences with clitics, regardless of stress condition. Conclusion: Children with CIs have difficulties processing sentences with clitics. We discuss that the challenge seem to arise from a syntactic deficit and sentence stress does not benefit comprehension of such sentences for these children. These findings points to the need of more careful and language-specific analysis of syntactic, morphosyntactic, and prosodic skills in children with CIs in order to plan an effective treatment.

**Primary Author/Presenter:** Talita Fortunato-Tavares, PhD

**Author Block:** Talita Fortunato-Tavares, Ph.D., Miya Wilson, MA student; Speech, Language and Hearing Sciences, Lehman Coll. CUNY, Bronx, NY.
Learner Objectives:

Compare the comprehension of sentences with clitic pronouns by children with cochlear implants and children with normal hearing

Explain the role of prosodic information in supporting comprehension of sentences with clitics
Empowering Prelingually Deafened Cochlear Implant Recipients to Become Successful Audiologists

Abstract Content:

Introduction: There is a growing number of audiology students who use CIs. One of the authors received bilateral CIs sequentially when she was young, and she is currently studying in the audiology graduate school. Like the author, these students can provide exceptional patient care as they can relate to patients with empathy, build good rapport, and counsel patients and families with knowledges and experiences. However, these students confront inevitable challenges in graduate classrooms and clinics. The purpose of this study was to identify the challenges in classrooms, audiology clinics, and social life for audiology students who use CIs and to address solutions and strategies to overcome these challenges.

Methods: First, challenges for graduate students with CIs were identified and listed in academic and clinic settings based on the authors’ experiences, clinic educators’ feedback, and peer colleagues’ input. Strategies for each challenge were addressed through brainstorming and practice from authors, faculty, colleagues in the department, CI manufacturer audiologists, and engineers for audiologic equipment. These possible solutions were formulated shared with other audiology graduate students with CIs and clinic instructors outside the department clinic. A questionnaire was also created to obtain the patient and the family’s satisfaction working with the graduate student with CIs. Second, socioemotional aspects are further explored in addition to the academic and clinic areas. For this, we will create a questionnaire for students and adults who grew up with hearing loss. This questionnaire includes items to explore the effect of hearing loss especially on the socioemotional aspects, including their mental health, quality of life, self-image, relationships, and their coping methods. The questionnaire will be distributed via online and shared through various organizations, including Association for Audiologists with Hearing Loss, Hearing Loss Association of America Young Adults Group, etc.

Results: Two critical challenges for classroom learning were the poor quality of auditory input and lack of visual input. The use of the remote microphone and captioning at real time were most helpful to reduce the difficulties. Three critical challenges for audiology clinics were listening check of hearing aids, listening check of sound processors, and audiometric testing. The remote microphone technologies again were to be the most effective tool to carry out various clinical procedures successfully. Listening checks of hearing aids were done using Verifit 1 or Verifit 2 with a remote microphone. Listening checks of any sound processor were accomplished with a remote microphone and listening check devices provided for each CI manufacturer. To avoid communication breakdowns during audiometric testing and being unable to understand patients for speech perception testing, patients were informed that the clinician is a bilateral CI user, and the patient was instructed to wear the remote microphone. Self-advocacy skills were essential to be successful in classrooms as well as clinics as well.

Conclusion: While audiology programs have welcomed students with CIs, there are obstacles that students with CIs and educators come across in the training. This study demonstrated some challenges and solutions to prepare CI recipients to be successful clinicians. Social-emotional aspects and more strategies will be discussed at the conference.

Primary Author/Presenter: Priyanka Gupte, BS

Author Block: Priyanka Gupte, B.S., Eun Kyung Jeon, Au.D., Ph.D.; Communication Sciences and Disorders, Univ. of Iowa, Iowa City, IA.

Learner Objectives:
Describe how CI recipients can do the hearing aid and/or sound processor listening checks using remote microphones.

Discuss various advocacy skills that graduate students with CIs utilizes in classrooms and clinics to become successful audiologists.
Remote Programming of Cochlear Implants: A Feasibility Study

Introduction: The COVID-19 pandemic has revealed the need for increased accessibility and availability of remote services. Traditionally, patients are seen at their closest cochlear implant centre. However, in Ontario, Canada, there are only three adult centres to service the whole province. This means that at Sunnybrook Health Sciences Centre, we will see patients from great distances such as Thunder Bay (343 km/one way), Sault Ste. Marie (685 km), and North Bay (1,379 km). Some of these patients have great difficulty accessing care for multiple reasons. These may include poor weather conditions, needing to take time off work, COVID concerns, mobility issues, fear of coming into the hospital, lack of transportation/funds, or poor health, to name a few. These barriers can be potentially overcome by remote programming options.

Methods: We hope to overcome the barrier of distance by programming the patient's cochlear implant in their own home virtually. We will make adjustments to the cochlear implant processor via internet over video connection between the audiologist and the patient. It is a live appointment with the audiologist present from their office and running the appointment. The audiologist controls the software remotely while the patient is at home. The patient will need to have access to the cochlear implant software, which will be shipped to them on a password-protected laptop. This service would be offered to patients who have already completed one year of in-person appointments, which is their standard of care.

Results: • At this time, only 5 participants have completed the study so far. Recruitment is on-going. • Preliminary data shows 40% of participants preferred their in-person MAP, 40% preferred remote programming MAP, and 10% had no preference. • 100% of patients were satisfied with their remote programming appointments • 100% of patients would recommend remote programming to a friend and would use the service again. • The majority of patients were either fairly or very confident that they could do remote programming again.

Conclusion: Based on the data so far, all participants have indicated satisfaction on their remote programming experiences. Preliminary data suggests that remote programming is a feasible method for adjusting cochlear implant speech processors. As more data is accrued, we will look at the sustainability and the impact of other models of remote programming.

Primary Author/Presenter: Jessica Banh, MSc


Learner Objectives:

Describe the feasibility of remote programming of cochlear implant speech processor as a clinical procedure.
Comparing the effectiveness of programming cochlear implants remotely versus in-office (current standard of care).
**Abstract Content:**

Introduction: Over 740,000 people with moderate-to-profound sensorineural hearing loss worldwide live with a cochlear implant (CI), enabling them to hear sounds that they could not otherwise. Despite the ability of CIs to restore some hearing, many CI users still struggle to understand speech. Previous work has shown that hearing loss not only impacts speech understanding, but also decreases the range of emotional responses that an individual experiences while listening to sounds. Emotional responses to sound may be further compromised in CI users who rely on a spectrally degraded electric signal to perceive and process acoustic stimuli. Understanding how a spectrally degraded CI signal influences sound-induced emotion may facilitate the development of (re)habilitation strategies aimed at expanding the range of experienced emotion for CI users. In this study, we therefore seek to quantify the effects of CI processing on sound-induced emotional valence and arousal.

Methods: Thirty emotionally arousing nonspeech environmental sound stimuli from the International Affective Digitized Sounds database were filtered and processed through a vocoder to simulate electric hearing. To date, we have tested ten adults (age 15-47) with self-reported normal hearing. The stimuli were presented to the participants in random order in each of three conditions: 1) unprocessed, 2) 4-channel vocoded, and 3) 8-channel vocoded. Participants provided subjective ratings of the emotional valence and arousal of each stimulus using the standard 9-point Self-Assessment Manikin scale.

Results: Participants’ valence and arousal ratings were analyzed using repeated measures ANOVA. On average, vocoded stimuli were rated as more emotionally negative and less arousing than unprocessed stimuli. Moreover, 8-channel vocoded stimuli were rated as more emotionally positive and more arousing than 4-channel vocoded stimuli. The range of emotional valence responses was smaller for vocoded stimuli than for unprocessed stimuli, whereas the range of emotional arousal was larger for vocoded stimuli than for the unprocessed stimuli.

Conclusion: These preliminary results suggest that when environmental sounds are spectrally degraded in a manner that simulates electric hearing through a CI, they are perceived to be more negative and less arousing than natural, unprocessed stimuli. The range of sound-induced emotional arousal may therefore be altered in CI listeners. Subsequent analyses will investigate emotional responses to sound across a large cohort of listeners with normal hearing and in pediatric and adult CI users.

**Primary Author/Presenter:** Vaishnavi Moturi, Student

**Author Block:** Vaishnavi Moturi, High School Student, Karlee R. Doak, BS, Braden M. Wiegand-Shahani, BS, Kelly N. Jahn, AuD, PhD; Speech, Language, and Hearing, Univ. of Texas at Dallas, Richardson, TX.

**Learner Objectives:**

Describe the effects of spectral degradation on emotional reactions to sound.

Explain the relevance of experienced emotion to quality of life and aural (re)habilitation.
Abstract Number: 73

Abstract Title: Comparative effectiveness and cost-effectiveness of the Cochlear® Osia 2 and Cochlear® Baha Atract systems in patients with conductive or mixed hearing loss or single-sided deafness: trial-based analysis and probabilistic economic

Abstract Content:

Introduction: Bone conduction implant (BCI) devices are a well-established treatment option for patients with conductive or mixed hearing loss (CMHL), or single-sided deafness (SSD). The Cochlear® Osia 2 (Osia) System is an active transcutaneous osseointegrated BCI utilising piezoelectric transducer technology and a fitting range ≤55dB sensorineural hearing level. The Osia transducer technology differs from other transcutaneous BCI, including the Cochlear® Baha Atract system. There are no large scale randomised controlled trials (RCTs) comparing BCI systems. The Osia system has been studied using accepted methodology where patients serve as their own controls in two large, prospective, multicentre clinical studies (Mylanus 2020, Briggs 2022). These studies concluded Osia is more effective than both the unaided hearing situation and a non-implanted bone conduction system (Baha on Softband, with similar power level). Methods: A systematic literature search was conducted to confirm the absence of relevant RCTs and identify publications suitable to inform indirect treatment comparisons (ITC) of Osia with Baha Atract. In addition to the two pivotal Osia studies, one study with comparable design and endpoints investigating Baha Atract was identified (den Besten 2019, Kruyt 2020). Patient characteristics were similar across all studies. Data from the Osia studies were synthesised with a random effects inverse-variance weighted meta-analysis. ITCs were conducted for the objective audiological measures pure tone average (PTA), speech discrimination in quiet and noise, patient reported outcomes (PROs) and utility measures via unaided hearing as the common arm. A Markov economic model was developed to estimate the cost-utility of Osia compared to Baha Atract in the Australian private insurance setting. A 10-year time horizon and 5% annual discounting of costs and outcomes was applied. Results: A robust ITC comparing Osia with the Baha Atract system demonstrated: 1) Osia is more effective than Baha Atract: with statistically significant and clinically relevant improvements across all hearing outcomes; 2) Osia has at least an equivalent safety profile to Baha Atract, with advantages in reduced skin irritation and pain secondary to pressure from magnet retention; 3) Osia has advantages in PROs and a recognised clinically meaningful (Drummond 2001) incremental utility (HUI 3) gain of 0.03. The Markov model demonstrated that the Osia System is cost-effective compared to Baha Atract with a favourable incremental cost-effectiveness ratio within the Australian health care system. Conclusion: An ITC, utilising audiological, PRO and utility data from large clinical studies, demonstrated that the Osia System is more effective than Baha Atract, resulting in improved hearing outcomes for CMHL and SSD patients. Subsidy of the Osia System represents cost-effective use of private insurance funds as demonstrated in a cost-utility analysis versus Baha Atract.

Primary Author/Presenter: Dell Kingsford Smith, PhD

Author Block: Manjula Schou, PhD, Matthias Brunner, PhD, Robert J. Briggs, MD, Dell Kingsford Smith, PhD; Biostatistics, Cochlear Global Clinical, Cochlear Limited, Sydney, Australia, Health Economics, Cochlear Asia Pacific, Sydney, Australia, Department of Surgery, Otolaryngology, The Univ. of Melbourne, Melbourne, Australia, Medical Affairs and Market Access, Cochlear Limited, Sydney, Australia.

Learner Objectives:
CI2023 Dallas: Cochlear Implants in Children and Adults

At the end of the session, participants will be able to define the cost-effectiveness of active, transcutaneous bone conduction hearing systems in comparison to passive, transcutaneous systems.
Concurrent Session: Concurrent Session Poster Highlight Session PH-1

Abstract Number: 83

Abstract Title: Classifier-based Noise Management Technology Helps Children with Cochlear Implants Listen in Noise

Abstract Content:

Introduction: Historically, advanced sound-cleaning features have not been routinely activated in the pediatric population due to concerns of limiting access to sound. Recent evidence from studies involving children with hearing aids have suggested that the 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: Ten children (age 8-15 years) with bilateral CIs and ten age-matched, typically-hearing children were recruited for this study. Speech perception outcomes were 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 were also recorded to obtain subjective measures of benefit. Speech perception outcomes and subjective measures were 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: The application of classifier-based noise management algorithm improved speech perception in noise in all listening conditions. Group averages revealed a 22% improvement in speech perception when using the classifier-based noise management algorithm when compared with the omnidirectional program in the 0 dB SNR condition listening. 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.

Primary Author/Presenter: Ursula Findlen, PhD

Author Block: Ursula Findlen, PhD, Smita Agrawal, PhD; Clinical Therapies-Audiology Department, Nationwide Children’s Hosp., Columbus, OH, Advanced Bionics, LLC, Valencia, CA.

Learner Objectives:

Examine speech perception outcomes in noise of bilateral CI users as compared to their typically-hearing peers.

Describe a clinically-feasible method for evaluating both objective and subjective benefit from advanced noise management technology in the pediatric population.
Hearing Outcomes Following Reimplantation of Functional Legacy Cochlear Implants

Introduction: Recently, patients with certain legacy cochlear implants (CIs) have sought reimplantation to enjoy the benefits of newer processor technology, including the ability to stream to an electronic device, be exposed to water, afford greater battery life, and offer potential improvements in speech understanding in noise. This decision can, however, be difficult, particularly when the individual relies exclusively on the original device for communication and is scoring at the ceiling of performance metrics. To date, most outcome data are derived from reimplanting a non-functioning CI—a relatively easy decision. This study reports hearing outcomes following the reimplantation of legacy implants performed to improve processor technology. The intent of the study is to guide clinicians and patients in approaching this high-stakes clinical situation.

Methods: Following Institutional Review Board approval (IRB 00045048), a retrospective chart review identified three patients with Advanced Bionics Clarion C1 internal device reimplantation in whom the original device was functioning normally. All cases of reimplantation due to device failure were excluded. Demographic data and audiometric performance before and after reimplantation were recorded.

Results: The three cases included two males aged 25 and 81 and a female aged 20 at the time of presentation. Each patient had received their original cochlear implant at least 20 years before the discussion of reimplantation. All three reimplanted patients showed maintenance or improvement in their audiometric performance and expressed satisfaction with expanding technological capabilities, including improved battery life and device connectivity. There were no failed reimplantations, incomplete electrode insertions, or other adverse effects.

Conclusion: Reimplantation of legacy Advanced Bionics Clarion C1 devices can be accomplished with stability or improvement of speech understanding with the new device. As reimplantation continues, patients can experience improvement in their CI experience with updated processors, novel programming schemes, greater connectivity options, improved battery life, and accessories that can greatly expand access to sound. Given the present rate of technological advancement in cochlear implantation, these data will serve to support the inevitable reimplantation of current-generation devices as future devices emerge.
Concurrent Session: Concurrent Session Poster Highlight Session PH-1

Abstract Number: 93

Abstract Title: Exploring the Use of Listening and Spoken Language Strategies in Caregiver-Child Interactions

Abstract Content:

Introduction: The use of auditory verbal strategies and early intervention supports pre- and post-cochlear implantation are essential for language acquisition of deaf and hard of hearing children who use listening and spoken language as their primary mode of communication. Although there is evidence supporting the use of strategies between caregivers and their deaf and hard of hearing children for language development in listening and spoken language, there is limited research on the use of these strategies with linguistically diverse deaf and hard of hearing children. There is an increasing number of linguistically diverse families in the United States. Although specific listening and spoken language strategies have been developed to increase spoken language development in all deaf and hard of hearing children, it has not been determined if these strategies are equivalently used among families from linguistically diverse backgrounds. There is an increasing number of linguistically diverse households as well as explore if there was an association between home linguistic environment and the degree of the child’s hearing loss in addition to a group difference between number of listening and spoken language strategies used by caregivers from monolingual and bilingual households. Specifically, the use of these strategies was examined through coding a 15-minute recorded video interaction, via the ELAN coding program, between each caregiver and deaf and hard of hearing child in early intervention pre-cochlear implantation. The group difference between the use of these strategies in monolingual and bilingual households as well as the association between home linguistic environment and the degree of hearing loss for the child were assessed via SPSS.

Results: Results indicated that caregivers demonstrated greater selections of repetition, expectant look, and self-talk/parallel talk, which was most statistically significant. Although there was not a statistically significant difference between monolingual and bilingual groups, both strategies of auditory sandwich and expectant look approached significance at p values of .053 and .060, respectively, indicating a marginally significant difference between the two groups. Caregivers from monolingual households demonstrated greater selections of auditory closure, auditory sandwich, repetition, wait time, and whisper. On the contrary, caregivers from bilingual households demonstrated greater selections of expectant look and self-talk/parallel talk. Lastly, there was a marginally significant association between home linguistic environment for a caregiver/child dyad and the degree of hearing loss for the child.

Conclusion: The findings of this study have implications for practice and literature. This study extends the literature by investigating the types of strategies used naturally in linguistically diverse households and directly relates to the future suggestions of Bunta et al. (2016), which encourages home language use as well as providing treatment support in the home language to help with language development in spoken English and the home language. Overall, the results of this study inform early intervention providers what dual-language supports are needed, regarding strategies used by caregivers, to ultimately improve children’s language outcomes.

Primary Author/Presenter: Brynne Powell, MEd, MPH


Learner Objectives:
CI2023 Dallas: Cochlear Implants in Children and Adults

compare the use listening and spoken language strategies used in early intervention among diverse caregivers and their deaf and hard of hearing children.

modify individualized listening and spoken language early intervention support pre- and post-cochlear implantation to increase overall language outcomes in the deaf and hard of hearing population.
**Abstract Content:**

Introduction: The traditional cochlear implant activation process occurs anywhere from two to four weeks following surgery. During this time period, patients have reduced access to sound, and at times may have no functional access to sound until activation. Over the last few years, our clinic has introduced the option of activating the device as early as the same day as surgery. As a destination medical center, same-day or next-day activation can be beneficial logistically for patients that come from afar. Local patients can similarly share a benefit from early activation providing access to sound sooner. This study looks beyond the logistical benefits for the patient, aiming to compare outcomes and objective measures of same/next day activation compared to later activation dates. Objective measurements that were analyzed include magnet strength needs, speech perception scores, impedances, and charge levels among each group. We hypothesize that the time of cochlear implant activation post-surgery does not affect performance of speech perception, impedance measurements, magnet strengths or electrical stimulation levels.

**Methods:** This is a retrospective study looking at 152 patients with an average age of 61 years who underwent cochlear implantation in 2020. Four subgroups of activation time period were examined: same day/next day, within one week, between one and two weeks, and after two weeks. We looked at data taken from the pre-operative appointment, 1-, 3-, 6-, and 12-month post-operative appointment to determine the correlation between time of activation and five systemic variables (magnet strength, speech performance, charge levels, data logging and impedance measures).

**Results:** When looking at CNC and AzBio performance between same day/next day activation to each subgroup, there was not a significant difference at preoperative evaluation, 3-month evaluation, or 12-month evaluation. Comparison of magnet strength at initial activation, 1-month, 3-month, 6-month, and 12-month evaluations revealed no significant difference between same day/next day activation to the other subgroups. Analysis of impedance measures of each electrode at initial activation was lower for the same day/next day group compared to the other groups. We speculate that this increase in impedance for groups activating later is due to the possibility of tissue growth around electrodes. Following a period of stimulation, impedance levels reduced in devices that were activated at a later day, more so matching the same/next day group by one month post activation.

**Conclusion:** Early device activation does not elicit negative effects on clinical parameters of patient outcome. Non-audiological advantages of same day/next day activation can lead to an overall improved patient experience. Future evaluation of patient experience (e.g., potential time and cost savings, satisfaction) is necessary to further elucidate potential benefits or limitations of this strategy.

**Primary Author/Presenter:** Kayli Silverstein, AuD Student


**Learner Objectives:**

At the end of the session, participants will be able to compare hearing outcomes between cochlear implant patients who receive early device activation as compared to those with standard device activation.
Concurrent Session: Concurrent Session Poster Highlight Session PH-2

Abstract Number: 107

Abstract Title: Vestibular Weakness in Cochlear Implant Recipients

Abstract Content:
Introduction: Cochlear implantation (CI) is suspected to carry an increased risk for vestibular hypofunction. We aim to evaluate the prevalence of vestibular hypofunction in CI candidates with bilateral profound hearing loss as well as assess if CI increases the risk of vestibular weakness in these patients.

Methods: A retrospective chart review in adults aged 18 years and older from 2012 to 2022 was performed at a tertiary medical center. A videonystagmography (VNG) test with caloric evaluation was performed routinely in the CI candidate population, irrespective of symptoms. Patients subsequently underwent CI, with a single surgeon and manufacture via a cochleostomy approach.

Results: We retrospectively reviewed baseline rate of vestibular weakness in 180 patients with bilateral profound hearing loss who were determined to be cochlear implant candidates. A high rate of 39.4% vestibular hypofunction was identified. Of this percentage and prior to cochlear implantation, caloric evaluation revealed 26.8% had bilateral weakness, 60.5% had unilateral weakness ipsilateral to the scheduled implant ear and 12.7% had contralateral weakness. A subset of the population (21 patients) underwent an additional VNG prior to second side CI. Of these two patients had new vestibular weakness in the ear that was implanted. While nonsignificant due to limited sample size, our data comparing patients who had vestibular weakness after CI (n=2, 4 ears) to those who did not (n=19, 26 ears), did reveal some interesting patterns. The patients with vestibular weakness were women, with an average age of 60.5 years, compared to an average of age of 50.2 years in patients without identified vestibular weakness. The patients who had resultant new vestibular weakness had higher hearing thresholds especially in the low frequency; at 250 Hz (97.5 ± 9.6 vs. 62.3 ± 23.1), 500 Hz (98.8 ± 8.5 vs. 71 ± 20.8), 1000 Hz (97.5 ± 15.5 vs. 81 ± 17.3), 2000 Hz (90 ± 20 vs. 86 ± 16.5) with higher pure tone average as well (95.4 ± 14.4 vs. 79.3 ± 15.4).

Conclusions: CI candidates have a high prevalence of preoperative vestibular weakness both unilateral and bilateral. CI was found to increase the risk for further vestibular weakness. Taken together, CI recipients are at increased risk for clinically significant vestibular weakness. This increased risk should be considered prior to bilateral cochlear implantation especially for elderly women with worse hearing thresholds in the low tones that were found to have increased risk of vestibular hypofunction at baseline and after cochlear implantation. This increased risk for vestibular hypofunction, is important in counseling and medical decision making prior to considering a second side cochlear implantation.

Primary Author/Presenter: Hannah Dunn, BA

Author Block: Hannah Dunn, BA, Allison Reeder, MD, Rema Shah, BS, John F. Kveton, MD, Nofrat Schwartz, MD; Yale Hearing and Balance Ctr., New Haven, CT, Yale New Haven Hosp., New Haven, CT.

Learner Objectives:
Discuss the prevalence and baseline risk for vestibular hypofunction in cochlear implant candidates
**Abstract Number:** 157

**Abstract Title:** Evaluating the Synergistic Efficacy of Dexamethasone Eluting Electrode and a Novel Drug on Residual Hearing Preservation in a Preclinical Animal Model of Cochlear Implantation

**Abstract Content:**

Introduction: Pharmaceutical interventions hold a great potential for the preservation of residual hearing post-cochlear implantation. To achieve greater and consistent drug levels, intracochlear delivery is the key, but there are challenges in achieving high drug concentrations in all regions of the cochlea. The objective of this study was to evaluate the combined efficacy of a novel otoprotective drug (drug D) delivered through a cochlear catheter with a dexamethasone eluting electrode (Dexel) on residual hearing preservation in a preclinical rat model of cochlear implantation.

Methods: The animals were divided into 10 different groups: 1) Control; 2) animals implanted with a cochlear implant (CI); 3) animals implanted with a Dexel (Dexel); 4) Canula elution of artificial perilymph (Can + AP); 5) Canula elution of Ringer lactate (Can + Ringer); 6) Canula elution of Ringer lactate and implantation of animals (Can+ CI); 7) Canula elution of Ringer lactate solution and animals implanted with Dexel CI (Can + Dexel); 8) Canula elution of drug D at 5mM (Can D5); 9) Canula elution of drug D at 5mM and implantation of animals (Can D5+ CI); 10) Canula elution of drug D at 2mM and animals implanted with Dexel CI (Can D2+ Dexel). Hearing thresholds were determined in each group pre-operatively, day 7 and day 30 post-cochlear implantation, using auditory brainstem responses (ABRs). Animals were euthanized at day 30 post-cochlear implantation, and organ of Corti dissections were performed for each group. Immunostaining was performed to determine hair cell (HC) damage and oxidative stress markers.

Results: Hearing threshold shifts at day 7 and day 30 were significantly higher in all the implanted animals in all frequencies. Hearing threshold shifts of groups not treated with drug D (Can +AP Can +Ringer, Can + Dexel and Dexel) were lower than the standard CI group. HC viability was lower in the Can +AP/Ringer groups compared to control ears for basal outer hair cells (OHC). Dexel and Can + Dexel groups had OHC viability rates lower than control ear for basal basales and medial turns. HC viability was not statistically different to controls for Can D2+ Dexel and Can D5 groups. Oxidative stress presence was not statistically different to controls for Can D5, Can D5+CI and Can D2+ Dexel groups.

Conclusion: The cochlear catheter can be used efficiently for inner ear drug delivery during cochlear implantation for the preservation of residual hearing without having adverse effects on the cochlea. Drug D has a significant otoprotective effect, reaching the apical turns when delivered through the catheter. Canula delivery of drug D at 2mM and cochlear implantation with the dexamethasone eluting electrode have a synergistic effect allowing significant residual hearing preservation.

**Primary Author/Presenter:** Adrien Eshraghi, MD, MSC, FACS

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**Learner Objectives:**

At the end of the session, participants will be able to learn about a novel way of inner ear drug delivery.
Introduction: The consonant-nucleus-consonant (CNC) words test was developed in 1962, and to this day remains arguably the most consistently used test for measuring and monitoring the speech perception ability of adults with cochlear implants. Despite its common usage in cochlear implant centers across the country, the test itself does not report on where an individual patient’s strengths and weaknesses are in terms of their ability to hear. Knowing which frequencies are being misperceived would be useful for audiologists to know in order to target map manipulations that can help improve speech perception. In order to fill this gap, a new test called the “Strategic CNC Words” was developed by audiology staff at the hospital.

Methods: The Strategic CNC words are composed of the same consonant-nucleus-consonant morphology as the original CNC words but are also further classified into two categories: low frequency words and high frequency words. Low frequency words (eg. moon, ball) are comprised of voiced phonemes such as nasals, voiced stops and blends. Low frequency vowels are defined as having a second formant below 1500 Hz. High frequency words (eg. face, peach) are comprised of voiceless phonemes such as voiceless stops, fricatives, and blends. High frequency vowels are defined as having a second formant above 1500 Hz. Low frequency words are recorded by a male voice preceded by a carrier phrase “say the word” while high frequency words are similarly recorded by a female voice preceded by the same carrier phrase. The test is built into an app, which helps automatically calculate the patient’s score on the test. A trial of the 5 lists of the Strategic CNC Words was completed in a clinical setting. Various cochlear implants patients returning for follow up were tested in an office setting, and the results show some interesting patterns.

Results: Subjects tested so far consistently performed worse on low frequency phonemes compared to their high frequency counterparts, particularly vowels. It is posited that this may be a result of misperceiving frequencies encoded in the apical region of the cochlea. In one particular patient that was tested ten years post-activation with the Strategic CNC Words list, exploratory mapping was completed based on his individual results. Frequency allocations were modified accordingly for the apical channels, and significant acute improvement was observed.

Conclusion: Preliminary results suggest the tradition of using psychoacoustic loudness-based mapping may not necessarily be sufficient in optimizing outcomes for cochlear implant patients. The data obtained thus far appears to support the idea that a frequency allocation-based approach may improve outcomes in patients.

Primary Author/Presenter: Ricky Chow, MCISc


Learner Objectives:
At the end of the session, participants will be able to discuss the perceptual difference between high and low pitched words, and which type is more difficult for a cochlear implant user to recognize.
**Concurrent Session:** Concurrent Session Poster Highlight Session PH-2

**Abstract Number:** 170

**Abstract Title:** Real-time Intracochlear Electrocochleography Monitoring During and After Cochlear Implantation

**Abstract Content:**

Introduction: Intracochlear electrocochleography (ECochG) has emerged as a research area to investigate hearing preservation in cochlear implant (CI) users. The objective of the study was to describe intraoperative monitoring using ECochG and to compare the objective audiometry and behavioral audiometry in the first 90 postoperative days.

Methods: Prospective, longitudinal study of 10 adults with measurable low frequency hearing that were implanted with a slim straight electrode inserted by freehand technique. Preoperative evaluation involved tonal auditory thresholds as well as speech perception tests. During electrode insertion, intraoperative electrocochleography was conducted using active insertion monitoring system. Auditory stimuli were delivered through an insert earphone and consisted of 50 milliseconds tone burst with alternating starting phase and 2 milliseconds rise/fall or single cycle. The ECochG responses were assessed intraoperatively directly from the most apical electrode contact. The amplitude of the real-time ECochG curve was characterized in 4 different moments: (1) increase in amplitude at the beginning of insertion through the round window, (2) maximum amplitude, (3) final amplitude after full insertion and (4) drops or amplitude changes during round window seal with muscle fascia graft. Post-operative evaluation consisted on a longitudinal assessment of auditory thresholds as well as electrocochleography after 7, 14, 21, 30 and 90 days of the surger. The hearing preservation (S) was calculated based on formula proposed by Skarzynski et al.(2013).

Results: Of the total 10 patients, 7 patients showed ECochG responses during insertion. The average insertion time was 130 seconds. Postoperative audiological findings showed progressive improvement in air conduction hearing thresholds over the three months after surgery, possibly secondary to postoperative hemotympanum reduction. Residual hearing was fully or partially preserved in 9 of 10 subjects. Objective EcochG thresholds measured within the first 90 days postoperatively are higher than behavioral thresholds.

Conclusion: The use of ECochG measurement intraoperatively and in the early postoperative period of CI surgery allows real-time information of the electrode insertion process and it also provides more detailed assessment of hearing preservation.

**Primary Author/Presenter:** Natália Shigematsu, MD

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**Learner Objectives:**

To describe intraoperative monitoring using ECochG in adults with measurable low frequency hearing.

To compare the EcochG thresholds and the behavioral audiometry.
Concurrent Session: Concurrent Session Poster Highlight Session PH-2

Abstract Number: 199

Abstract Title: Identifying Auditory Emotion Bio-Markers in Cochlear Implant Users with Machine Learning

Abstract Content:
Introduction: Cochlear implants have had tremendous success restoring a sense of hearing in the deaf. However, for cochlear implant users, emotion perception can remain challenging. Even after months of intensive rehabilitation, many cochlear implant users struggle with appreciating emotive tones in speech and music despite overall good speech comprehension. Failure to perceive emotional expression can result in maladjusted social behaviour and, in turn, impair their capacity to express emotions adequately, leading to detrimental socio-economic consequences. Recent advances in data analysis and automated pattern identification offer a means of comparing neuroimaging data associated with emotional processing beyond conventional analysis and could bring empirical support to developing training programs for emotion rehabilitation in cochlear implant users.

Methods: Hence, we used a machine learning approach to identify emotion-processing bioarkers in high-density electroencephalograms collected from cochlear implant users (n = 22) and matched normal-hearing controls (n = 22). Participants’ brain responses elicited by short musical and vocal emotional (happy, sad, and neutral) stimuli were used to train a random forest classification algorithm to help identify, in each group, the pattern of brain responses that can best predict the presented emotion.

Results: Using this machine learning approach, we were able to confirm the presence of emotion-specific patterns of brain activity in cochlear implant users despite the cochlear implant user’s reported emotion perception deficit.

Conclusion: The identification of these patterns brings forward evidence for implementing a rehabilitation program for emotion perception for this population; if an algorithm can differentiate aurally presented emotions, perhaps cochlear implant users can learn to discriminate emotions.

Primary Author/Presenter: Samir Gouin, BS

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Learner Objectives:
Discuss the potential for implementing rehabilitation programs for emotion-specific deficits in cochlear implant users and applying machine learning approaches to health data.

Compare the emotion-specific patterns of brain activity between cochlear implant users and normally hearing individuals.
**Concurrent Session:** Concurrent Session Poster Highlight Session PH-2

**Abstract Number:** 207

**Abstract Title:** Auditory Skill Progression via the Pediatric Minimum Speech Test Battery by Children with Cochlear Implants

**Abstract Content:**

Introduction: The advancement of auditory skills in pediatric cochlear implant (CI) users varies widely, with factors such as earlier age at implantation, longer duration of device use, and absence of comorbid conditions corresponding to more advanced speech recognition abilities. However, research on this topic often uses an age-appropriate yet site-specific test batteries, which restricts direct comparison across studies. The Pediatric Minimum Speech Test Battery (PMSTB), a standardized pediatric audiological testing protocol, allows monitoring of a child’s auditory progress via speech discrimination, word and sentence recognition in quiet, and sentence recognition in noise (Uhler et al., 2017). No studies to date track progression of children with CIs through the PMSTB. This study uses retrospectively collected clinical data as a first attempt to assess the trajectory or auditory skill acquisition in children via the PMSTB in pediatric CI users.

Methods: Data collection is ongoing, but the sample currently includes 14 children who use CIs and have no comorbid conditions (e.g., syndromes). Most participants were identified as deaf/hard of hearing at birth, received hearing aids by a median age of 7 months (Range: 1-53 months), and had their first CI activated at a median age of 17 months (Range:11-58 months). Of the current sample, all use binaural devices (12 bilateral CIs, 2 bimodal with 1 CI + 1 contralateral hearing aid). Data collection across participants ranged in chronologic age from 2 to 71 months and ranged in CI device experience from 2 to 44 months. All participants completed at least one measure on the PMSTB, a hierarchical test battery with measures ranging from parent report (LitlEARS) to a speech discrimination task to speech recognition testing (i.e., word and sentence stimuli, quiet and competing signal conditions, and closed- and open-set tasks). The PMSTB recommends proceeding to the next testing level with scores ≥80% in 2 sessions.

Results: Eleven parents completed the LitlEARS for children with 0-24 months of CI experience. Five attained scores ≥80% with 2-7 months of CI experience. Five of seven children who attempted a closed-set speech recognition task had at least some word recognition with 24-30 months of CI experience. Eight children achieved open-set speech recognition by 44 months of CI experience. Conclusion: Preliminary results show vast variability in auditory skills and speech recognition outcomes in pediatric CI users. Earlier-implanted children tend to move through the PMSTB faster than later-implanted children. However, a larger, more diverse sample would help parse the influence of demographic factors on speech recognition outcomes in young CI recipients.

**Primary Author/Presenter:** Grace Phelps, BA

**Author Block:** Grace W. Phelps, B.A., Emily Kaplan, B.S., Sophia Heussner, B.S., Sarah Crow, B.S., Kim Fiorentino, Au.D., Shari Kwon, Au.D., Andrea Warner-Czyz, Ph.D.; Univ. of Texas at Dallas, Dallas, TX.

**Learner Objectives:**

Describe the components and tenets of the Pediatric Minimum Speech Test Battery.

Describe how pediatric cochlear implant users, on average, progress through the Pediatric Minimum Speech Test Battery after device activation.
Concurrent Session: Concurrent Session Poster Highlight Session PH-2

Abstract Number: 247

Abstract Title: Phonological Patterns Produced by Bilingual Children with Cochlear Implants and Their Bilingual Peers with Normal Hearing

Abstract Content:

Introduction: In this study, we analyze the phonological processes produced by 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 loss and the use of cochlear implants, language, and typicality of phonological patterns.

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), and phonological process type (typical versus atypical process). A repeated measures analysis of variance was conducted with hearing status as the between-subjects variable and language and typicality of processes as within-subjects variables. The dependent variable was percentage of occurrence of phonological processes.

Results: There was a statistically significant main effect of hearing status \[F(1, 38) = 61.73\] at \(p < 0.001\) with an effect size of partial \(\eta^2 = 0.62\). There was also a statistically significant main effect for typical versus atypical processes \(F(1, 38) = 131.01\) at \(p < 0.001\) with an effect size of partial \(\eta^2 = 0.78\). That is to say, there was a difference in the occurrence of phonological processes depending on whether they were typical or atypical. No main effect for language was found \[F(1, 38) = 0.35\] at \(p = 0.556\) with an effect size of partial \(\eta^2 = 0.09\). Typicality of processes did interact with hearing status in that children who use cochlear implants displayed a higher proportion of atypical phonological processes than their peers with normal hearing \(F(1, 38) = 52.29\) at \(p < 0.001\) with an effect size of partial \(\eta^2 = 0.58\). Conclusion: When it comes to the occurrence of phonological process in the productions of bilingual children with hearing loss who use cochlear implants, their patterns differ from those of their peers who are bilingual and have normal hearing. There is also a difference between the occurrence of typical versus atypical phonological processes in children who are bilingual who use cochlear implants in contrast with their peers with normal hearing. However, there does not appear to be a difference in the occurrence of phonological processes between the Spanish and English productions of bilingual children. Furthermore, the existence of an interaction effect between hearing status and typicality of phonological processes indicates that bilingual children with hearing loss who use cochlear implants display disproportionally more atypical processes than their bilingual peers with normal hearing. Our findings add to a growing body of work on the speech patterns of bilingual children with hearing loss by finding an interplay between spoken bilingualism and acquiring two languages with a diminished signal provided by cochlear implants.

Primary Author/Presenter: Ferenc Bunta, PhD

Author Block: Ferenc Bunta, PhD, Claudia Ramirez, Undergraduate Student, Ross Tonini, AuD; Communication Sciences and Disorders, Univ. of Houston, Manvel, TX, Communication Sciences and Disorders, Univ. of Houston, Houston, TX.

Learner Objectives:
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• After attending the presentation, participants will be able to describe how select speech and language patterns of bilingual children with hearing loss who use cochlear implants compare to those of their bilingual peers with normal hearing.

• Having attended the presentation, participants will be able to discuss issues involved with assessing speech and language patterns of young bilingual children with hearing loss who use cochlear implants pertaining to how learning two languages and having...
Abstract Number: 161
Abstract Title: Influence of map settings assigned with behavioral versus objective measures on the monaural and binaural hearing of adult cochlear implant users with asymmetric hearing loss

Abstract Content:

Introduction: Mapping of a cochlear implant (CI) includes defining the electric dynamic range for each active channel. Identifying the maximum comfortable loudness (MCL) for each channel can be completed with behavioral or objective measures. The behavioral measure involves the patient ranking the perceived loudness of electric stimulation from threshold to MCL. The electrically evoked stapedius reflex threshold (eSRT) is an objective measure that can be used to determine the MCL level for individual channels. While there is evidence of MCL levels determined with eSRT being highly correlated with MCL levels determined behaviorally, there are cases when these methods yield different results. This discrepancy is of particular interest for CI users with normal to near-normal hearing in the contralateral ear, known as asymmetric hearing loss (AHL). For CI users with AHL, it may be important to establish a balance in loudness between the ears to achieve a maximum binaural hearing benefit. The present study aimed to characterize the relationship between eSRT and behaviorally-measured MCL levels among adult CI users with AHL and assess the differences in monaural and binaural hearing between maps.

Methods: The map settings (i.e., MCL levels) were compared for adult CI users with AHL when assigned with an objective method (i.e., eSRT) versus with a behavioral method. For the behavioral method, recipients ranked the perceived loudness of stimulation, which was increased until reported as “loud but comfortable.” For the objective method, the tympanometry probe was placed in either the ipsilateral or contralateral ear and a probe tone of either 226Hz, 678Hz, or 1000 Hz was used. The stimulation level on individual channels was gradually increased until the eSRT was observed. Performance with each map was evaluated with CNC words in the CI-alone condition and with AzBio sentences in the best-aided condition (CI plus contralateral ear). For the best-aided condition, the target was presented from the front and the masker (10-talker babble) was either co-located with the target, or presented 90 degrees towards the CI-ear or contralateral ear.

Results: The behavioral measurement of MCL values were in varying agreement with objectively measured eSRT values, with the majority either in agreement with the eSRT values or the behavioral values as higher than the eSRT values. Preliminary data suggest for those with a difference in the assigned MCL values, better CNC scores were observed with the behavioral map and better best-aided scores were obtained with the eSRT map.

Conclusion: The individualized mapping of MCL levels may include behavioral and/or objective measures. In some cases, these methods result in different levels. There is a need to understand the optimal methods to individualize map settings to support each patient’s best outcome with a CI.

Primary Author/Presenter: Samantha Scharf, AuD


Learner Objectives:

Characterize the relationship between eSRT and behaviorally-measured MCL levels among adult CI users with asymmetric hearing loss.

Assess the differences in monaural and binaural hearing when mapped behaviorally versus eSRT.
Abstract Number: 203

Abstract Title: Parent Beliefs & Experiences with Genetic Testing for Children with Sensorineural Hearing Loss

Abstract Content:

Introduction: While the benefits of genetic testing have been documented; genetic testing has not become standard of care in otology/audiology practices. The reasons and barriers why remain largely unknown. The current study examined parents’ beliefs, knowledge, and experiences with genetic testing.

Methods: One hundred and forty-six parents were recruited from a comprehensive pediatric otology/audiology practice and social media groups for parents of children with hearing loss. The Parent Perception of Genetic Testing Questionnaire, which assesses parent perceptions, decisions, and satisfaction with genetic testing was completed electronically. The majority of parents were mothers (91.8%), between the ages of 30-49 years (49.3%), and identified as non-Hispanic (76.6%) and White (95.2%). Children had a mean age of 6.96 (SD=6.18) years and 45.5% were female. The majority of children had congenital hearing loss (63.1%). Most of the sample did not know etiology (47.3%), followed by probably genetic cause (40.4%), infectious diseases (5.5%), and other (6.8%). Twenty-five percent of the children wore cochlear implants, 66.4% hearing aids, 5.5% bone conduction device, and 6.8% were unaided.

Results: Approximately 47.6% of the children in our sample underwent genetic testing. For those that did not pursue testing, 20% were not aware and 40% were aware, but not interested. Barriers self-reported by families that did not pursue testing included trouble with insurance (40%), difficulty scheduling (10%), concerns with blood draw (10%), and mistrust in doctors (10%). For those who did pursue testing, 11.6% did not receive results. Less than half of families reported using the results to make decisions about family planning (39.7%), most shared results with relatives (90%), and were willing to share with their child (81.1%). Reasons for sharing results included: awareness, family concern, and family planning. Reasons for not sharing included test was inconclusive, lack of family interest, and privacy. In addition, over half reported they did not receive counseling before (55.1%) and only 41.7% reported receiving counseling after the testing. When receiving results, parents reported being confused (18.3% Very Confused; 28.3% Somewhat Confused; 20% A Little Confused). More importantly, less than half of parents (43.4%) remembered what they were told about the mode of inheritance and 40% reported a significant delay in obtaining results, describing less than optimal satisfaction with the care they received following testing.

Conclusion: Parents of children with hearing loss reported being open to genetic testing to aid in their decision making and treatment options. However, there continues to be significant barriers to obtaining genetic testing as well as counseling post-testing. Future research is warranted to help ameliorate these barriers and improve access to genetic testing and counseling for patients with hearing loss.

Primary Author/Presenter: Jennifer Coto, PhD

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Learner Objectives:

describe reasons parents did not pursue genetic testing.

contrast rates of counseling received before and after genetic testing process.
Abstract Title: Auditory Training Index for Cochlear Implant Professionals and Recipients

Abstract Content:

Introduction: The goal of this project was to create an online index of auditory training resources to ensure auditory training was accessible for CI professionals to recommend to patients. This project was two-folded: first, to compile smartphone and web-based applications and categorize them by features (e.g., environmental sounds, speech, music, cost, supported platform, etc.) Second, to create an online auditory training index where professionals “filter” the resources based on the features listed above for the patient’s individual training goals. This will assist CI professionals and patients in making the most appropriate selection for their training.

Methods: For the first part of this project, smartphone and web-based auditory training resources were collected from a review of public smartphone application stores, hearing aid and cochlear implant manufacturer websites and recommendations, and google searches. A total of 34 resources were compiled. Next, these resources were further analyzed and categorized by various features. These features include environmental sounds, speech (words, phonemes, sentences, discourse), with or without background noise, music (timbre, pitch contour, pitch matching), appropriate age (young children, adolescents/adult), platform available (Apple App Store, Google Play Store, website), cost (free, monthly subscription, or one-time payment), and monitoring feature availability. For the second and most critical part of this project, a user-friendly online index was created to assist professionals in their selection of these auditory training resources to recommend to patients. This will create a professional-guided auditory training plan for each patients’ individual goals and skill level. This online index allows professionals to “filter” through the resources based on the different features discussed above. Space for feedback from professionals will be available to ensure continued knowledge of new resources and specific resource reviews. The online index library of resources will be reviewed every three to six months to ensure only up-to-date resources are included and that new resources are added.

Results: The first part of the study has been completed: a full documentation of resources was created and can be accessed at https://bit.ly/aud_training_handout. The online index has been created and is being further improved. This allows professionals to filter through the large list of auditory training resources. An example is a recently implanted adult male having difficulty discriminating sounds in his environment. The professional can access the online index and click “adult,” “newly implanted,” “free,” “Apple App Store,” and “environmental sounds.” Based on the selection, a list of appropriate resources that match those features will populate automatically. This populated list allows a professionally-guided auditory training resource to the patient efficiently as well as monitoring of their auditory training.

Conclusion: This project compiled and analyzed auditory training resources and created a user-friendly online index to assist CI professionals when providing recommendations to patients. We hope that the online index can assist in making auditory training more accessible for the professionals and recipients, so that CI users can reach their full potential with their device.

Primary Author/Presenter: Olivia Adamson, BA

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Learner Objectives:
Identify and compare current app-, web-based, and online auditory training programs based on various features for both pediatric and adult cochlear implant recipients.

Utilize the created online index of auditory training resources so that they can make auditory training more accessible for both professionals and recipients.
Introduction: Estimates have shown that more than 700 million people will suffer with disabling hearing loss by 2050, and it can have significant impact on individuals' quality of life, professional occupation and social interactions. Aims: Assessing the impact of cochlear implants on quality of life, anxiety and depression improvement after surgery, based on validated questionnaires.

Methods: Thirty (30) adult, bilateral profound hearing loss carrier patients, recommended for Cochlear Implant surgery, were evaluated through the following questionnaires: World Health Organization - Quality of Life (WHOQOL-BREF) and Hospital Anxiety and Depression Scale (HADS), at four different moments, namely: pre-operative, 7 days, and 3 and 6 months after cochlear implant activation. Questionnaires ‘International Outcome Inventory Cochlear Implant (IOI-CI)’ and ‘Glasgow Benefit Inventory (GBI)’ were only applied 3 and 6 months after implant activation.

Results: Based on the anxiety and depression score analysis, there was decrease, either in anxiety or in depression values, throughout the 6-month follow-up in comparison to the pre-operative frame. This finding shows improvement in psychological disorders after the cochlear implant surgery; however, such data were not statistically significant. With respect to quality of life evaluated though WHOQOL-BREF, mean values recorded for the physical, psychological and social relationship domains did not present statistically significant changes throughout the follow-up period. Mean value recorded for domain ‘environment’ showed statistically significant increase at 6 months in comparison to the pre-operative frame. On the other hand, mean value recorded for quality-of-life self-assessment at 3 months has shown significant increase. Mean values observed for general health condition evaluation presented significant changes at 6-month follow-up. Regarding IOI-CI and GBI scores in our sample, they have shown that most patients were happy with the cochlear implant surgery.

Conclusion: Patients were happy with the cochlear implant surgery based on the IOI-CI and GBI questionnaires. Quality of life, anxiety and depression indices have improved after the cochlear implant surgery. Quality-of-life self-assessment, as well as the 'environment' and 'general' domains, recorded statistically significant improvement.

Primary Author/Presenter: Pauliana Lamounier, MD

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Learner Objectives:

Describe other benefits of cochlear implant surgery in addition to auditory rehabilitation, which are also involved in improving quality of life, such as improving depression and anxiety rates. At the end of the session, participants will be able to better understand those benefits.
Concurrent Session: Concurrent Session Poster Highlight Session PH-3

Abstract Number: 273

Abstract Title: Cochlear Implant And Tinnitus: A Prospective Cohort

Abstract Content:

Introduction: Approximately 1.5 billion people live with some degree of hearing loss worldwide; it is the major risk factor for tinnitus, a fact that can worsen quality of life and affect patients’ well-being and global health. Aims: objectively assessing cochlear implant (CI) influence on tinnitus perception before and after surgery based on validated questionnaires.Methods: 30 adult patients with bilateral profound hearing loss, who were candidates to Cochlear Implant surgery, complaining of tinnitus, were assessed. The following questionnaires were applied: Tinnitus Handicap Inventory (THI) and Visual Analog Scale (VAS), at 4 different moments: pre-operative, 7 days, 3 and 6 months after Cochlear Implant surgery. Speech recognition test was carried out 6 months after surgery to measure functional gain after Cochlear Implant surgery.

Results: Based on VAS, there was improved tinnitus perception 6 months after surgery, but such an improvement was not statistically significant. According to THI, there was improvement 3 months after surgery, but only the improvement recorded 6 months after surgery was statistically significant. It was not possible observing statistical correlation between hearing-loss time and hearing aids using time, and speech recognition test results. We also did not find correlation between THI and VAS change from pre-operative time to 6 months after surgery due to speech recognition test changes.

Conclusion: All aforementioned data prove the possibility of treating tinnitus through cochlear implant at different circumstances. Disarray in auditory pathway caused by hearing loss can be solved with auditory system reorganization based on a new input, such as cochlear implant. Tinnitus got better after Cochlear Implant surgery based on THI scores, but such improvement was only statistically significant 6 months after surgery.

Primary Author/Presenter: Pauliana Lamounier, MD

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Learner Objectives:

Evaluate the evolution of tinnitus and its influence on the quality of life of patients who underwent cochlear implant surgery. At the end of the session, participants will be able to note that we found that most patients have an improvement in tinnitus after surgery and that there is an improvement in the perception of their quality of life.
**Abstract Content:**

Introduction: Multichannel cochlear implants (CIs) capitalize on the natural tonotopic organization of the cochlea and the auditory nerve fibers to improve frequency resolution and speech recognition. The incoming frequency information is divided and presented by specific electrode contacts that are assumed to mimic the natural tonotopic organization. Some CI recipients are unable to discriminate pitch differences between adjacent contacts, resulting in poorer spectral resolution. Other CI recipients may experience pitch reversals, which are when a more basally positioned electrode contact generates a lower frequency pitch percept as compared to a more apically positioned electrode contact. Pitch reversals result in poorer sound quality and negatively influence speech recognition for CI users (Kenway et al., 2015). The present case study reviews how to identify pitch reversals in CI users and how modified filter frequencies can improve patient outcomes.

**Method:** A pitch ranking task was completed at the 3-month post-activation visit as part of a clinical research study. The participant responded to whether stimulation from adjacent electrode contacts were higher or lower in pitch. Filter frequencies were modified for the electrode contacts identified to have a pitch reversal. Speech recognition was evaluated with the implanted ear alone using CNC words in quiet and in the best-aided condition using AzBio sentences in a 10-talker masker at 0 dB SNR. Performance in the combined condition was assessed with the target from the front and the masker either colocated (SoNo) or 90 degrees towards the implanted ear (SoNeas).

**Results:** The participant listened with an electric-acoustic stimulation (EAS) device. At the 3-month post-activation visit, her CNC word score with EAS alone was 58%. Her performance in the combined condition was 46% for SoNo and 88% for SoNeas. The pitch ranking task identified pitch reversals between two electrode contact pairs (E10 and E11, and E11 and E12). The filter frequencies for these channels were modified in response to the pitch reversals. The participant returned 3 months later and reported an improvement in sound quality. Her CNC word score with EAS alone was 64%. Her performance in the combined condition was 47% for SoNo and 99% for SoNeas.

**Conclusion:** The pitch ranking task identified pitch reversals for a patient experiencing typical performance expected for an EAS user. Individualizing the filter frequencies in response to the pitch reversal resulted in improved sound quality and performance. These findings suggest the importance of test methods and mapping procedures aimed at helping individuals achieve their best outcomes with a cochlear implant.

**Primary Author/Presenter:** Jacqueline Eberhard, BS

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**Learner Objectives:**

At the end of this session, participants will be able to identify when pitch reversals have occurred and employ the pitch ranking task for clinical use.
Introduction: The cochlear implant (CI) evaluation process requires audiologists to decide which speech perception tests are most appropriate for determining CI candidacy. Fortunately, the Minimum Speech Test Battery (MSTB) was established over a decade ago and is commonly used by audiologists who are managing English speaking adults. The MSTB has allowed clinicians to practice similar to their colleagues at other CI programs and has reduced barriers to CI access for English speakers. Regrettably, speech perception test protocols are not readily available for assessment of non-English speakers in the United States (US). Audiologists in specific areas of the US manage diverse patient populations and routinely encounter difficulties when assessing non-English speakers for CI candidacy. Portuguese is the 9th most spoken language in the world, and the US houses approximately 693,000 Portuguese speakers. Portuguese speakers can be found throughout the US but most commonly reside in California, Massachusetts, Rhode Island, New Jersey and Florida. Portuguese is the second most spoken language in Massachusetts and the third most spoken language in Rhode Island and Florida. This presentation will discuss how one CI program developed a test protocol to utilize with Portuguese speakers during the pre and post operative CI process. Development and utilization of a CI test protocol for Portuguese speakers decreases health disparities for this population by improving access to hearing healthcare. Methods: A Portuguese speaking audiologist at a large academic institution developed a Portuguese speech perception test protocol by completing a literature review of existing test measures and consulting with CI clinics in Brazil. The proposed protocol will describe the available measures that exist for Portuguese speaking patients and will follow a step-by-step process to assist clinicians with identifying the appropriate test to use for CI candidacy and post-operative care. Results: Unaided test protocol includes recorded Auditec Portuguese bisyllable word test presented at UCL minus 5 dB HL. Aided test protocol includes Auditec recorded Portuguese bisyllable word test presented at 60 dB SPL, Portuguese HINT sentences presented in live voice at 60 dB SPL in quiet, and Portuguese HINT sentences presented in live voice at 60 dB SPL with recorded Az Bio English babble noise in the second channel. Signal to noise ratio can be altered for more difficult test conditions and to overcome ceiling effects of HINT. If there are no Portuguese-speaking audiologists at the CI clinic, an interpreter or family member should be used for monitored live voice presentation. As HINT sentences are known to be negatively impacted by ceiling effect, audiologists may need to focus on aided bisyllable Portuguese word score for CI candidacy determination in patients who speak Portuguese.Conclusion: The US houses the most diverse population of any country in the world, yet access to hearing healthcare for English and non-English speakers is disproportional. Non-English speakers, including those who speak Portuguese, need improved access to CI centers and hearing loss treatment. In an attempt to reduce barriers to care, one institution developed and implemented a CI test protocol for use with Portuguese speakers. Implementation of the protocol can help to decrease health disparities for this population.

Primary Author/Presenter: Thais Toledo, AuD

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Learner Objectives:

Describe the recommended protocol for pre and post operative assessment of Portuguese speakers