CI2019 Pediatric:

Podium Abstracts
Session: S1-1
Abstract ID: 313
Title: Family Engagement in Cochlear Implant Therapy and Education: Promoting Resilience for Children Experiencing Adversity
Presenting Author: Jenna Voss PhD, LSLS Cert AVEd
Author Block:
Susan Lenihan, PhD, Jenna Voss, PhD, LSLS Cert AVEd; Fontbonne Univ., Saint Louis, MO.
Abstract:
Introduction: The participant will: 1. Define and describe the impact of adversity on child development including the sources of trauma. 2. Identify restorative strategies using collaborative, interprofessional practice to promote family resilience. 3. Identify resources professionals use to empower caregivers to buffer the negative impact of adverse childhood experiences. 4. Explain the limitations in preparation programs which hinder professionals from using restorative practices with the children and families they serve. Children who use cochlear implants have many of the same experiences, both positive and negative, as their typically hearing peers. Childhood adversity has a tremendous impact on the development and educational achievement of children (Bartlett, Smith, Bringewatt, 2017; Harris, 2018). Sources of adversity such as poverty, violence and family instability create trauma for young children and prevent healthy development. Recent evidence from pediatric neuroscience suggests that trauma creates changes in brain development and puts children at risk for delays in social, emotional, behavioral and communicative development (Lipina & Posner, 2012; Noble, Houston, Kan & Sowell, 2012; Shonkoff, Boyce & McEwen; 2009). Children who use cochlear implants may also experience adversity and may be at even greater risk. Since the goal of implantation and early intervention services is to maximize child development, professionals who are knowledgeable about the impact of trauma on young children and their families will be able to support and facilitate relationships within families to mitigate the negative effect of adverse experiences.
Methods: Authors reviewed relevant research on adverse childhood experiences, trauma-informed care and effective practices in supporting children and families. The study included a survey of professionals providing services to children using cochlear implants to determine the professionals’ experience, knowledge and preparation to serve children and families who have experienced trauma.
Results: Research demonstrates the detrimental impact of adverse childhood experiences on child development and offers recommendations for health and education professionals. Responses to the survey show that professionals lack of knowledge and preparation in supporting families experiencing trauma.
Conclusion: A framework of effective practices can support professionals in maximizing communication and education outcomes for children using cochlear implants. This presentation will summarize current research on the sources and impact of trauma on child development and will provide a framework of effective practices and resources for professionals to increase successful interaction with families. Participants will identify evidence-based approaches and strategies, examine resources, and develop a plan to promote resilience for children and families they serve.
Session: S1-1  
Abstract ID: 196  
Title: Parents’ Engagement in a Cochlear Implant Orientation Program  
Presenting Author: Bruna Youssef Masters  
Author Block: Carla Olavarria Rigamonti, Masters 1, Bruna Youssef, Masters 2, Luciana Scarabeli, Masters 1; 1Mental Health, Instituto Escuta, São Paulo, Brazil, 2Language, Instituto Escuta, São Paulo, Brazil.  
Abstract:

Introduction: When the child is deaf, treating the whole means necessarily spending some time and effort with their parents. Even though there’s a universal public health system in our country, there’s a lack of access to information and orientation for low income families regarding their importance in the deaf child’s development. With the goal of filling this gap, we offer a weekly multidisciplinary program – formed by language and speech therapists, psychologist and social worker – with activities designed specifically for parents and children, both together and separate. The objective of this presentation is to show how the families’ engagement was and to explore reasons for attendance or the lack of it. Once families reach our organization we offer them the weekly program, but before that they go through an evaluation consisting in three to four visits where they will meet: speech and language therapist, psychologist and social worker. The contract of attendance and families/ organization responsibilities, as well as the amount of money the family can invest, is agreed on with the help of our social worker. After the evaluation, the family is ready to attend the weekly group with other families, where we offer orientation, support group and leisure activities for the parents and general and specific hearing, speech and language activities for children. The groups are closed and they’re annual, with approximate 30 weeks through the year. Also, all families were visited in their homes by the social worker during July, which is winter break in our country.

Method: Our method was to collect and analyze information about families’ attendance and evasion from February through December/ 2018

Results: All through the year of 2018 we received 27 families. Of those, 16 completed the evaluation process and 11 did not. Out of the families who completed the evaluation, 12 stayed until the end of the year, whilst only 2 of the families which did not complete the evaluation stayed. We ended the year with 14 families divided in three groups: for the first group the average attendance was 69,1%, for the second it was 75,8%, and for the third 79,9%. The attendance rate during the year was 74,9%.

Conclusion: Completing the evaluation process turned out to be a fundamental factor when it comes to families’ accession, considering that the vast majority of families that started attending the project without finishing the process evaded. We understand we must maintain and reinforce this welcoming strategy in order to be able to work with the families in the long term. Also, we have to highlight that about 50% of the families that reach us can’t actually keep up with the activities we offer, usually because of distance, money issues regarding transportation, and parents’ commitments of all kinds. On the other hand, for the 14 families that stayed through the year we considered we had a good engagement rate, considering the weekly attendance for two and a half hours and the requirement for parents’ participation. For families with lower income, we found out that the social worker home visit had a noticeable effect on accession because it showed our effort to understand their reality and taking it into consideration for our orientation.
**Session:** S1-1  
**Abstract ID:** 308  
**Title:** Getting the Word Out: Raising Awareness of Opportunities for Today’s Children With Hearing Loss  
**Presenting Author:** Teresa Caraway PhD  
**Author Block:**  
Teresa H. Caraway, PhD, Wendelyn DeMoss, MS, Marge Edwards, MS; Hearing First, Oklahoma City, OK.

**Abstract:**

**Introduction:** The general public and most families today remain unaware that advanced technologies such as hearing aids and cochlear implants and a Listening and Spoken Language (LSL) outcome are available for children who are deaf or hard of hearing. More than 90% of children born deaf or hard of hearing are born to two hearing parents (Mitchell & Karchmer 2004), and data suggest that spoken language outcomes are being embraced by the majority of parents of babies born deaf or hard of hearing (e.g., in the state of North Carolina, the percentage of parents in EI who have opted for spoken language over the last decade is 73-85% (Robbins & Caraway, 2010, Brown, 2005; K. Rhoades, personal communication, North Carolina Department of Health and Human Services, June 9, 2010). In addition, recent research (LOCHI, 2018) has provided evidence that child language outcomes are significantly improved with early appropriate hearing device fitting and early intervention. The LOCHI study has provided longitudinal evidence that outcomes are dramatically improved when children receive cochlear implants at 6 months combined with auditory based intervention for language. It is critical to increase public awareness about the availability of cochlear implant technology, the benefits of early implantation and the potential for optimal LSL outcomes for children. This session will explore the use of a digital strategy to expand awareness and provide accurate information about opportunities for children today.

**Methods:** A digital strategy was implemented using a digital ecosystem including websites, blogs, social media platforms, paid media, email marketing, search engine marketing and content production. An integrated content strategy was implemented starting in 2015 to maximize the message reach across the ecosystem. Monthly and quarterly metrics and key performance indicators were used to refine the digital strategy over time.

**Results:** As of August 2018, the Net Promoter Score (NPS), an index that quantifies the willingness of users on a website to recommend products, services or messages to others was +68. This survey finished at a ‘very strong’ level (Range = -100 to +100). Social platform follows include: Facebook = 41,188, Twitter = 4800, Instagram = 1034. Content for Facebook Ask Me Anything (AMA) Live Broadcasts in 2018 = +60,000 reach. Key components and metrics of the digital ecosystem model and will be shared to demonstrate the effectiveness of messaging in social spaces.

**Conclusion:** Unprecedented advances in digital technology provide the opportunity to advance awareness of cochlear implantation and LSL outcomes for children and families in new and different ways. Through the use of a digital strategy, the reach to parents, professionals and extended families has been successful. Families of children who are deaf or hard of hearing need to know what is possible today and how to achieve the outcomes they desire. A digital strategy allows for scalability as well as multiple avenues to reach families in the digital spaces where they communicate most.
Session: S1-1  
Abstract ID: 68  
**Title:** Cochlear Implants and Lack of Follow-Up: An Ethical Dilemma  
**Presenting Author:** Maria Leno AuD  
**Author Block:**  
Maria Leno, AuD, Laura Rickey, AuD, Anita Jeyakumar, MD, MS; Akron Children's Hosp., Akron, OH.  
**Abstract:**  
**Introduction:** A method of communication chosen by the families of children that have severe to profound sensorineural hearing loss is a very personal decision. It is well established that families should be given information on all communication options and that this information be provided in an unbiased manner. When families choose cochlear implantation with a listening and spoken language approach, parents need to be given realistic expectations regarding outcomes and understand the therapy/follow-up involved to achieve those outcomes. However, if parents do not follow-up after cochlear implantation, do we, as medical professionals, consider this lack of follow-through neglect? If lack of follow-up is leaving children without any form of language, do we, as medical professionals, involve other specialties such as social workers or county case workers?  
**Methods:** Anecdotal examination of typically developing pediatric patients whose families elected cochlear implantation with a listening and spoken language approach. In our review, we found patients who are noncompliant with device use and had significant lack of follow-up for therapy and programming appointments. This has led to poor, if any, language development, leaving the child without a true way to communicate. There are several factors that can contribute to lack of follow-up on the families’ behalf. These factors include, but are not limited to: lack of understanding the need for therapy, programming, and consistent use of device(s); local resources available to the families; and accessibility to follow-up (e.g., transportation, time off work, financial resources).  
**Results:** Part of the definition for neglect includes the failure of a parent or other person with responsibility for the child to provide medical care. Medical neglect specifically includes failure to heed obvious signs of serious illness or failure to follow a physician’s instruction once medical advice has been sought. Some factors considered for the diagnosis of medical neglect are that the recommended health care offers significant net benefit to the child and that it can be demonstrated that access to health care is available and not used. Based on this definition, noncompliance of device use/follow-up, which leaves a child without any form of language, would fall under the category of medical neglect. With little or no language, these children will fall behind their hearing peers in communication, cognition, reading, and social emotional development. This puts children at risk for lower educational and employment levels as they grow into adulthood. After contacting associates at several pediatric facilities, there are differences in how these patients and their families are handled, spanning from dismissal of care after two missed appointments to involving county children services.  
**Conclusion:** When families do not attend scheduled appointments and device use is minimal, it is a disservice to the child and their ability to develop a language for communication. A defined factor of medical neglect is that the recommended health care offers significant net benefit to the child. It seems as though a significant net benefit of a child would be the development of language. If all efforts to rectify the noncompliance have been attempted, and no changes have been witnessed, reporting medical neglect to social work or county children services may help to hold the family accountable or provide access to additional resources.
Session: S1-1
Abstract ID: 354
Title: Family Input to Program Development and Improvement
Presenting Author: Joni Alberg PhD
Author Block:
Joni Alberg, PhD 1, Daniel King, AuD 2, Kimberly Irby, CCC-SLP, MS 2, Debara Tucci, MD, MS, MBA 1, Howard Francis, MD, MBA 1; 1Division of Head and Neck Surgery, Duke Med. Ctr., Durham, NC, 2Speech Pathology and Audiology Clinic, Duke Med. Ctr., Durham, NC.

Abstract:
Introduction: Patient satisfaction surveys are commonly used by hospitals to obtain feedback. They have limited ability however to guide program improvement efforts. Patient advisory panels can provide concrete feedback to help clinicians and administrators improve patient experience and outcomes. We created a Parent Advisory Panel (PAP) that has provided meaningful input to strategic planning and program improvement, as we established a pediatric CI clinic as part of an integrated hearing program. We believed the experiences of these parents would provide us with specific information and direction as we established and continuously improve family-centered services and supports. We will share how our PAP was formed and how it has shaped our strategic planning and delivery of services that are truly family-centered.

Methods: Following preliminary needs assessment with stakeholders involved in early identification/intervention of childhood hearing loss across the state, specific goals of a PAP were developed. Panel participants were selected to include: parents of children diagnosed with hearing loss and receiving follow up care at our center; parents of children diagnosed at our center but who subsequently went elsewhere for follow up care; and parents of children diagnosed and receiving follow up elsewhere. Five parents were invited to participate. Prior to the first in-person meeting, parents completed a questionnaire about their experiences and satisfaction with our program. Their responses were used to set the agenda for the first face-to-face meeting. During the meeting, written responses were explored in-depth. Parents shared personal stories, gave specific examples that reflected their experiences and provided recommendations for how a difficult experience could have been made better.

Results: Parents were open and honest sharing their experiences, pointing out what was good/great or what was frustrating/disappointing. Sensitivity to the burden of grief experienced by parents following a new diagnosis emerged as an important determinant of family satisfaction and continuation of services at our center. Several administrative challenges emerged. Because some of the parents had experiences with programs other than ours, we now have access to a broad perspective in judging how our program is developing. The parents are providing us with recommendations for program improvement and contributing to the development of strategies and solutions. An important limitation of our PAP is the parents who are participating have the time and are able/willing to meet with us face-to-face. This is not the case for many of our parents. To ensure we are obtaining necessary input from parents of all backgrounds and means, we will from time to time conduct parent focus groups, scheduling and locating them at a time/place to ensure participation of parents of diverse backgrounds different from those of our PAP.

Conclusion: Ongoing program evaluation is necessary to ensure pediatric CI programs remain responsive to the needs of parents and children. Written patient satisfaction surveys alone cannot provide the in-depth information needed to improve program services, experiences and, ultimately, child outcomes. CI programs must seek opportunities to dig deeper in order to fully understand the experiences of patients and their families and learn from them. A PAP can provide the critical information and guidance essential to the creation of an excellent pediatric CI program.
Title: Exploring the Identities of Hearing Parents Who Chose Cochlear Implantation for their Children with Hearing Loss

Presenting Author: Brittan Barker PhD

Author Block:
Brittan A. Barker, PhD 1, Kristina M. Scharp, PhD 2, Kelsey L. Chandler, BS 1; 1Communicative Disorders & Deaf Education, Utah State Univ., Logan, UT, 2Communication Studies, Univ. Washington, Seattle, WA.

Abstract:
Introduction: We aimed to determine the types of identities hearing parents construct when telling realtime stories about their children with hearing loss (HL) who use cochlear implants (CIs).

Methods: We employed a qualitative design and interviewed 30 parents of children who use CIs. We used thematic narrative analysis (Braun & Clarke, 2006) to uncover recurring themes from these parents’ narratives. The themes then allowed us to assign different identities to the parents.

Results: Four identities emerged in the parents’ stories.

Conclusion: Identifying and understanding these parent identities is a first step toward improving theoretical and clinical insights into parents’ perspectives and experiences following their children’s diagnosis of HL. Such insights could ultimately improve audiologists’ abilities to look at the whole child and help families seek out, implement, and follow-through with family-centered hearing healthcare.
Session: S1-1  
Abstract ID: 20  
Presenting Author: Elizabeth Adams Costa PhD  
Author Block:  
Elizabeth Adams Costa, PhD 1, Nancy Mellon, MS 2, Meredith Oulette, MS 3, Colleen Caverly, PhD 1, Sharlene Ottley, PhD 4, Lori Day, PhD 5; 1Department of Psychology, The River Sch./RiverREACH Clinic, Washington, DC, 2Nancy Mellon, Washington, DC, 3Meredith Oulette, Washington, DC, 4The River Sch./RiverREACH Clinic, Washington, DC, 5Department of Psychology, Gallaudet Univ., Washington, DC.  
Abstract:  
Introduction: Parents generally serve as primary language models for their children, and when a child is identified as having a hearing loss, there is often a disruption in the dynamic parent-child language interaction (Young & Tattersall, 2007). Although families who pursue spoken language can serve as native language models, disparities in child outcomes suggest that parents need assistance in establishing an accessible, language-rich environment at home. Recent studies suggest that incorporating maternal sensitivity training into intervention programs may significantly improve child language outcomes. Quittner et al. (2013) found that maternal sensitivity predicted significant increases in language growth for children with cochlear implants, and that linguistic stimulation for the child was only related to language growth in the context of high maternal sensitivity. Notably, the effects of maternal sensitivity were similar to the effects found for age of implantation, which has long been considered one of the most powerful predictors of language outcomes. Other studies have documented the importance of emotional availability and maternal responsiveness on language learning and developmental play for children with hearing loss. Parent-Child Interaction Therapy (PCIT) is a parent interaction-training program and behavioral intervention in which a therapist works with parent-child dyads to promote child development. Parents are taught skills they can apply at home to promote child language, establish a nurturing and secure relationship, and increase prosocial behavior. The current study evaluated the effectiveness of PCIT as a psychosocial and behavioral intervention for families of children with hearing loss, examined its applicability as a language intervention, and assessed the impact on maternal sensitivity.  
Methods: PCIT was evaluated for parent participants who had children with hearing loss (N=17), examining both parent’s indirect language stimulation, and changes in child behavior as a result of treatment. For a subset of the treatment group (N=6), pre- and post-treatment child language samples were compared to matched controls that did not receive PCIT. Structured interactions were videotaped and coded on constructs of maternal sensitivity using the Parent-Child Interaction System (PARCHISY).  
Results: The frequency of optimal parental language input was significantly higher post-treatment (Mdn= 34) than pre-treatment (Mdn = 5), p < .01. Parent report of problematic behavior on a standardized measure was significantly lower post-treatment (Mdn = 85) than pre-treatment (Mdn = 121), p = .01. The change in Mean Length of Utterance from pre- to post-treatment for the PCIT group (Mdn = .96) was significantly different than the change for the matched control group (Mdn = .26), p < .05. In terms of maternal sensitivity, the treatment group demonstrated significant improvements in constructs related to maternal sensitivity (i.e., increased parent positive content, child responsiveness to parent, dyadic cooperation, parent positive affect, and decreased parent negative affect) as coded by the PARCHISY system, compared to controls.  
Conclusion: This study suggests that PCIT is a promising intervention to facilitate parent-child communication as it promotes optimal indirect language stimulation, improves parent-child interactions, increases maternal sensitivity, and ultimately increases spoken language skills for children.
Session: S1-2
Abstract ID: 1020
Title: A novel approach for electrical stimulation of the cochlear apex
Presenting Author: David Landsberger PhD
Author Block:
Abstract:
Invited Presentation
Session: S1-2
Abstract ID: 1021
Title: Auditory frequency mismatch in postlingually deaf patients: a gradual approach to facilitate adaptation
Presenting Author: Mario Svirsky PhD
Author Block:
Abstract:
Invited Presentation
Session: S1-2
Abstract ID: 1022
Title: Neuromodulation enhances plasticity in a rodent model of cochlear implant use
Presenting Author: Erin Glennon
Author Block:
Abstract:
Invited Presentation
Session: S1-2  
Abstract ID: 341  
**Title:** Central Auditory Processing Predicts Variance in Speech in Noise Performance: Importance of Preserving Low Frequency Acoustic Hearing  
**Presenting Author:** Bruce Gantz MD  
**Author Block:**  
Bruce J. Gantz, MD 1, Inyong Choi, PhD 2, Marlan Hansen, MD 1, Bob McMurray, PhD 3, Camille Dunn, PhD 1; 1Otolaryngology, Univ. of Iowa, Iowa City, IA, 2Communication Sciences and Disorders, Univ. of Iowa, Iowa City, IA, 3Psychology, Univ. of Iowa, Iowa City, IA.  
**Abstract:**  
Understanding speech in background noise is challenging especially for hearing-impaired listeners. The variance in the speech-in-noise (SnN) understanding ability is significant in cochlear implant (CI) users. Acoustic + Electric (A+E) processing has been shown to enhance word understanding in noise. Variations in the neural encoding of acoustic information, measured as early auditory-cortical evoked responses, is known to contribute to the behavioral variance, while its interaction with cognitive processing mediated by frontal cortex is unclear. Understanding the relative contributions of sensory encoding fidelity and cognitive factors can guide clinical interventions. Here, we explored relationships between the evoked responses from auditory cortex (AC), frontal cortex, and behavioral performance in SnN understanding. Previous electroencephalographic (EEG) studies showed increased inferior frontal gyrus (IFG) activity in the clean speech condition, whereas an fMRI study showed increased IFG activity associated with the increased listening effort. We hypothesized that stronger and faster AC responses predict better performance, and increased amplitude and latency of evoked responses from frontal cortex predict difficulty in SnN understanding. We tested evoked responses to words in multitalker babble background in 109 CI users (50 male, aged 53-75). We found that poor CI SnN performers exhibit stronger late response (later than around 600ms after the word onset) in the frontal area as well as weaker and delayed N1 response at the auditory cortex region. Good SnN A+E CI users, on the other hand, exhibited robust earlier frontal cortex responses (300ms). Our results suggest that frontal cortical activity can predict SnN understanding performance of CI users. Early auditory cortex responses were significantly weaker in those using electric processing only. These findings suggest that low frequency acoustic hearing provides more rapid lexical recognition and assists in separation of speech in noise. This research was sponsored in part by NIH grants DC 00242, DC 0037, RR00059, and Cochlear Limited.
Title: Assessment of Frequency-Place Mismatch by Flat-Panel CT and its Correlation with CI Performances.

Presenting Author: Diego Zanetti MD

Author Block:
Federica Di Berardino, MD 1, Diego Zanetti, MD 1, Giorgio Conte, MD 2, Clara Sina, MD 2, Sara Cavicchiolo, Speech Therapist 1, Fabio Triulzi, MD 2; 1Audiology Unit, Department of Clinical Sciences and Community Health; 2, Fondazione IRCCS Ca’Granda Ospedale Maggiore Policlinico, Univ. of Milan, Milano, Italy, 2Neuroradiology Unit, Fondazione IRCCS Ca’Granda Ospedale Maggiore Policlinico, Milano, Italy.

Abstract:
Introduction: To obtain an effective coding of sound, in all cochlear implant (CI) models a pre-determined frequency band is assigned to each electrode contact in a contiguous pattern resembling the tonotopic organization of the organ of Corti. However, the variability of surgical insertion or of cochlear shape and size inevitably lead to an unpredictable degree of frequency-to-place mismatch. Objective of the study was to evaluate the relation between the mismatch detected by flat-panel computerized tomography (FPCT) and the auditory performances in a selected group of adult CI recipients.

Methods: Seventeen adult subjects (11 females and 6 males, mean age 64 ±11, with homogeneous post-verbal SNHL, who had undergone a Medel Synchrony CI (with a standard 28 mm Flex electrode), were included. All subjects underwent a post-operative FPCT on the 1st post-operative day and measurements of the depth and angle of insertion for each electrode contact were obtained. The actual spiral ganglion frequency determined by FPCT was compared with the default center frequency assigned by the manufacturer to each corresponding electrode. The mismatch of the frequency-to-electrode allocation was then related to the CI performances in each subject. Speech perception tests were performed in quiet and noise using vocal-consonant-vocal (VCV), bysillabic words and sentences, with and without lip-reading. Data from a pitch discrimination test with phonemes, non-words and pseudosentences (ASSE test) and from the Montreal suprasegmental cues identification test were also collected.

Results: Electrode frequency-place mismatch resulted lower in patients with better outcomes. (p=0.019). While most of the subjects achieved predictable scores at the bysillabic and sentence test in quiet and in noise, the most interesting results were returned by the phonemes discrimination test, the VCV recognition score in noise and the suprasegmental cues identification interesting results. The outcomes will be discussed in relation with the observed allocation mismatch.

Conclusion: FPCT is a useful and effective means for detecting significant frequency allocation shifts after CI. The current findings might prelude to a more individualized mapping of CI recipients.
Session: S1-2  
Abstract ID: 266  
Title: Incorporating Electrode Angular Insertion Depth in Electric-Acoustic Stimulation Programming  
Presenting Author: Margaret Dillon AuD  
Author Block:  
Margaret Dillon, AuD, Brendan O'Connell, MD, Michael Canfarotta, MD, Harold Pillsbury, MD, Meredith Rooth, AuD, Emily Buss, PhD, Kevin Brown, MD, PhD; Otolaryngology/Head and Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC.  
Abstract:  
Introduction: Patients who listen with electric-acoustic stimulation (EAS) demonstrate improved speech perception as compared to a cochlear implant (CI) alone condition, likely due to better resolution of low-frequency cues provided acoustically. However, EAS users’ speech perception may be limited by discrepancies between the pitch-to-place association of acoustic transduction and electric stimulation. The discrepancies are driven, in part, by the frequency filter assignments for individual electrodes, which currently do not consider the place of stimulation. Electrode array angular insertion depth (AID) varies across CI recipients, and is dependent upon the cochlear anatomy, electrode array design, and surgical approach. The present report investigated whether adjusting the electric frequency filter assignments to match the associated place frequency improves speech perception with an EAS device.  
Methods: Subjects were evaluated with CNC words in quiet when listening with the default EAS map versus a place-based map. The clinical software determined the default map using each subject’s unaided thresholds in the implanted ear. For the place-based map, an algorithm using computed tomography scans estimated the AID and calculated the associated place frequency for each electrode. The electric low-frequency filters of apical electrodes were adjusted to match the place frequency. The comfort levels of electrodes with frequency content that overlapped with acoustic stimulation were reduced below detection.  
Results: Four subjects completed comparison testing between the place-based map and the default map at initial activation of the EAS processor. Subjects demonstrated a trend for better speech perception with the place-based map as compared to the default map, even with acute listening experience.  
Conclusion: Incorporating patient and device variables into mapping decision-making may improve initial speech perception with EAS devices. Critical evaluation of the variables that contribute to early speech perception performance is needed to support optimal outcomes in adults and children.
Session: S1-2  
Abstract ID: 392  
Title: Use of Intra-Cochlear Electro-Cochleography to Estimate Cochlear Implant Electrode Location within the Cochlea  
Presenting Author: Aniket Saoji PhD  
Author Block:  
Aniket A. Saoji, PhD 1, Colin L. W. Driscoll, MD 1, Matthew L. Carlson, MD 1, Scott B. Shapiro, MD 2, Adam M. Cassis, MD 2, Kanthaiah Koka, PhD 3; 1Mayo Clinic, Rochester, MN, 2West Virginia Univ., Morgantown, WV, 3Advanced Bionics, Santa Clarita, CA.  
Abstract:  
Introduction: Electrical stimulation delivered by cochlear implant electrodes located along the cochlear axis can result in a frequency-to-place mismatch that may adversely affect speech and music perception. In the present study, cochlear microphonic (CM) tuning curves were measured in cochlear implant recipients with significant post-operative residual hearing to estimate electrode location within the cochlea. Frequency specific acoustic pure tones can be used to generate CMs at different locations along the basilar membrane. CMs can be recorded as a function of the cochlear implant electrodes in separate locations to generate a tuning curve. Electrodes closer to the source of the CM will record higher amplitudes relative to the electrodes that are further from the CM source. Thus, CM tuning curves can be used to determine cochlear implant electrode location within the cochlea.  
Methods: Fifty millisecond acoustic tone bursts with two alternating polarities (condensation and rarefaction) were used to elicit CMs at 125, 250, 500, 750, 1000, 2000, and 3000 Hz, in separate conditions. Initially, the tone bursts were presented at 110 dB SPL. The presentation level was decreased in 5 dB steps until CMs were no longer measurable. For each stimulus frequency and presentation level, CMs were measured as a function of the cochlear implant electrodes. An extra-cochlear ring electrode was used as the ground electrode.  
Results: CM tuning curves elicited with different acoustic pure tones showed a tonotopic organization similar to that of the basilar membrane. CM tuning curves measured for low-frequency tone bursts showed larger amplitudes or tuning at recording electrodes closer to the apical end of the cochlea. Similarly, CM tuning curves measured for high-frequency tone bursts revealed tuning at electrodes that are located closer to the basal end of the cochlea.  
Conclusion: For patients with preserved residual hearing after cochlear implantation, intra-cochlear electro-cochleography can be used to measure CM tuning curves to estimate the location of individual cochlear implant electrodes along the cochlear axis. These CM tuning curves can be used to optimize the frequency-to-place mapping for cochlear implant patients.
Session: S1-3
Abstract ID: 50
Title: Adaptive Cochleostomy and Cochlear Implant Electrode Insertion Vectors
Presenting Author: Thomas Balkany MD
Author Block:
Thomas J. Balkany, MD, Otolaryngology, Univ. of Miami, Long Key, FL.
Abstract:
Adaptive Cochleostomy and Cochlear Implant Electrode Insertion Vectors Submitted for Oral Presentation

INTRODUCTION
Reduction of electrode insertion trauma during cochlear implantation has been associated with improved hearing and balance outcomes. We hypothesized that trauma can be minimized by adapting the cochleostomy and electrode insertion vectors to variables of electrode design and to surgical anatomy of the round window.

METHODS
Ninety human cadaver temporal bones underwent partial basal turn surface preparation to allow visualization of electrode insertion in respect to the osseous spiral lamina, basilar membrane, spiral ligament, and modiolus between April 20, 2015 and November 11, 2018 during a series of temporal bone workshops. Round window and bony cochleostomies were performed on each bone followed by insertion of a straight and a pre-curved electrode through each cochleostomy. In addition, superior segment and inferior segment (anterior to the hook portion) cochleostomies were performed in some cases to enable retrograde insertion and to adapt to a potential high jugular bulb respectively. Methods of anterior, inferior and medial vector control will be discussed. Two a priori surrogates for insertion trauma were selected: direct electrode tip “impact” on the modiolus adjacent to the cochleostomy resulting in electrode flexion; and scalar translocation. Contemporaneous observations were made by an experienced surgeon.

RESULTS
Cochleostomy: 1. Round window membrane cochleostomies with an apparent (surgeon’s view through facial recess) diameter of < 1 mm (corresponding to a parasagittal angulation of > 45°) were not feasible for insertion of straight or pre-curved electrodes and required cochleostomy extension. 2. Pre-curved electrodes had a higher likelihood of impacting the modiolus with resultant flexion when inserted through round window cochleostomies. 3. Pre-curved electrodes inserted through bony cochleostomies had fewer modiolar impacts than those inserted through round window cochleostomies.

Insertion vector: 1. Anterior-vector-only insertion led to electrode tip impact with the modiolus more often than when anterior and inferior vectors were used together, especially with round window membrane cochleostomies. 2. Greater inferior vector is necessary for round window insertion. 3. Adding a medial vector reduced scala vestibuli translocation more in pre-curved than in straight electrodes.

CONCLUSIONS
Cochleostomies may be seen as a variable continuum of possible scalar access points, as opposed to distinct categorical entities, and may be situated to accommodate both electrode and surgical anatomy. Electrode insertion vectors should be utilized to assure a trajectory consistent with that of the lumen of the proximal scala tympani in order to reduce insertion trauma. Further development of high-resolution computerized tomography algorithms may provide guidance to surgeons regarding applicable insertion vectors.
Session: S1-3
Abstract ID: 238
Title: Cellular and Molecular Biology of the Temporal Bones That Received Cochlea Implantation
Presenting Author: Akira Ishiyama MD
Author Block:
Akira Ishiyama, MD 1, Gail Ishiyama, MD 2, Ivan Lopez, Ph.D 1; 1Otolaryngology, UCLA Sch. of Med., Los Angeles, CA, 2Neurology, UCLA Sch. of Med., Los Angeles, CA.
Abstract:
Introduction: New cochlear implant prototypes designed for hearing preservation, and the implantation of CI as early as infancy, make it important to understand the fate of the remaining cellular components in the cochlea after implantation. We investigated the fate of the spiral ganglia neurons (SGN) and their supporting cells using the structural and functional proteins, acetylated tubulin and neurofilaments within the SGN and organ of Corti after CI. We also investigated the expression of the neurotrophic factor BDNF, and the distribution of inflammatory macrophages in the spiral ganglia. We also studied the ultrastructure of the remaining cells in the organ of Corti and SGN, and developed 3D reconstructions of the CI-implanted temporal bones to investigate the location of the CI.

Methods: Temporal bones from 10 patients that received CI and their contralateral side were used in the present study. Celloidin-embedded cochleas were immunoreacted with the antibodies against the following proteins: pan-neurofilaments (NF) and acetylated-tubulin (AT) (neuronal structural markers, brain derived neurotrophic factor (BDNF), CD68, and Iba1(macrophage markers). Detailed immunohistochemical analysis was performed in mid-modiolar sections using light and laser confocal immunofluorescence. Transmission electron microscopy analysis was made in selected celloidin sections. 3D reconstruction was made on hematoxylin and eosin celloidin serial sections from 16 CI temporal bones using AMIRA software.

Results: NF and AT were present in the SGNs of both implanted and non-implanted ears despite the loss of hair cells in the organ of Corti. NF and AT were detected in the cytoplasm of the SGNs and fibers. NF and AT distribution were similar throughout the basal, middle, and apical turns of the cochlea including the organ of Corti. In addition, AT allowed for the identification of remaining supporting cells in the organ of Corti. BDNF was expressed at a minimum basal level in the non-CI cochlea SGNs, but was strongly upregulated in SGNs and satellite cells of the CI cochlea. Laser confocal microscopic analysis of macrophages showed two types of macrophages in the cochleas: CD68 or Iba1 positive macrophages only, and CD68 and Iba1 colocalization in macrophages. Both markers were present in the stria vascularis, Rosenthal canal and mid-modiolus intermingled in the spiral ganglia neurons area. Positive Iba1 and CD68 macrophages were found in the CI and non-CI contralateral cochleas. Iba1 was seen in ramified/amoeboid cells, CD68 was seen in foamy, round macrophages. In CI cochlea, both types of macrophages were detected surrounding the CI path and fibrotic areas. Transmission electron microscopy verifies the presence of macrophages in the CI area and elsewhere. 3D reconstruction of CI temporal bones demonstrated differential preservation within the regional segments of Rosenthal’s canal, with 7 out of the 8 having better preservation in the middle and apical SGNs in subjects who had cochlear implants.

Conclusion: Overall our immunohistochemical staining, ultrastructural and 3D analysis on the CI temporal bones shows that the remaining structures are likely functional and benefit from the electrical stimulation, suggesting that CI electrodes with proper surgical techniques are beneficial to the preservation of hearing.
Session: S1-3
Abstract ID: 120
Title: Global Impact and Screening Strategy for Deafness Genes in CI Patients
Presenting Author: Xue Liu MD, PhD
Author Block:
Xue Z. Liu, MD, PhD
Otolaryngology, Univ. of Miami Miller Sch. of Med., Miami, FL.
Abstract:
Introduction: Hearing loss (HL) is the most common sensory disorder affecting more than 28 million Americans and 15-26% of the world’s population and is the most prevalent neurological disability among the elderly. Clinically significant HL is present in at least 1 per 500 infants at birth. Cochlear implants (CIs) have been used as a treatment option for children with HL for nearly three decades. It is well known that CI outcomes show substantial inter-patient variations. Factors accounting for these variations are not well understood, which makes it challenging to deliver precision medicine to individual CI users. Recent advances in the molecular genetics of deafness have vastly improved our ability to identify heritable HL and have had several important consequences including: 1. genetic testing has become the new standard of care to diagnose non syndromic HL (NSHL); 2. understanding the genetic basis for the development of novel gene-specific and even mutation-specific therapies to treat HL. Genetic etiology has been proposed as an important factor accounting for these variations. A better understanding of pathophysiological insult to the auditory system due to different gene mutations will enable us to better assess CI candidacy, implement optimal habilitation strategies for individual patients, and provide appropriate patient counseling for the prognosis of HL and predicted CI outcomes.
Methods: We have established an ethnic-based sequential screening strategy to identify the genetic cause of NSHL using a combination of population specific mutation arrays, copy number variations (CNVs) analysis and whole exome sequencing (WES) complemented with a hearing-centric database. The DNA microarray panel (Miami-CapitalBio) is applied as the initial screening to simultaneously detect the most common deafness-causative mutations, followed by the use of a custom capture/next-generation sequencing gene panel (MiamiOtoGenes) composed of 235 known deafness genes. Patients for whom the two panels do not provide a meaningful result, WES is performed to achieve a comprehensive interrogation of the full spectrum of variants to detect single-nucleotide variants (SNVs), insertion/deletions (Indels) and CNVs.
Results: Using high-throughput sequencing strategy, we identified causative variants in less than 40% of cases. The affected genes and their function and expression in the cochlea and along the entire auditory processing pathway are being studied. Genotype/phenotype correlations are also being catalogued.
Conclusion: Our screening strategy will allow a better understanding of the effects of different genetic mutations on auditory neural function and development of an effective, evidence-based clinical practice for delivering precision medicine to individual patients. The approach is an effective way to bring the sequencing data to clinical practice for the clinical diagnosis and management of deaf and hard-of-hearing families.
Session: S1-3
Abstract ID: 153
Title: The Effect of Gene Mutations on Neural Response of the Electrically-Stimulated Auditory Nerve in Children
Presenting Author: Shuman He MD, PhD
Author Block:
Shuman He, MD, PhD 1, Jianfen Luo, MD 2, Xiuhua Chao, MD 2, Lei Xu, MD 2, Angela Pellittieri, AuD 1; 1Otolaryngology - Head and Neck Surgery, The Ohio State Univ., Columbus, OH, 2Otolaryngology - Head and Neck Surgery, Shandong ENT Hosp., Jinan, China.
Abstract:
Title: The effect of gene mutations on neural response of the electrically-stimulated auditory nerve in children
Background: The goal of the present study was to investigate the effect of GJB2, SLC26A4 and MYO15A gene mutations on auditory nerve function in children with cochlear implants (CI). Their results were compared to those measured in children with idiopathic hearing loss.
Methods: There were 20 children with biallelic GJB2 mutations, 16 children with biallelic SLC26A4 mutations and 19 participants with idiopathic hearing loss participated in study one. All except for two study participants with SLC6A4 mutations had Mondini malformation and enlarged vestibul aqueduct (EVA). Up to date, there were two children with biallelic MYO15A mutations who were recruited and tested for study two. All participants were Cochlear® Nucleus™ CI users. For study one, the electrically-evoked compound action potential (eCAP) was recorded in each participant at three electrode locations across the electrode array using both anodic- and cathodic-leading biphasic pulses. The primary dependent variable (DV) of interest was the slope of the eCAP Input/Output (I/O) function and it was estimated using statistical modeling with a linear regression function. eCAP amplitude, measured at the maximum comfortable level of the anodic stimulus (the anodic C level) and eCAP threshold were also compared between pulse polarities and among study groups. Effects of study group, stimulus polarity and electrode location on each DV were evaluated using Generalized Linear effect Mixed Models. For study two, sensitivity of the auditory nerve to amplitude modulation (AM) was investigated by recording the eCAP evoked by individual pulses of an AM pulse train. In addition, eCAPs to single pulses were measured with the probe levels corresponding to the levels of selected pulses in the AM pulse train. The difference in the maximum and the minimum eCAP amplitudes measured for the AM pulse train (AMamp</sub>) and for the single pulse (NonAMamp</sub>) was calculated. The primary DV of interest was the modulated response amplitude ratio, which was defined as the ratio of AMamp to NonAMamp</sub>, which a greater ratio indicating better sensitivity to AM.
Results: Results of study one showed that the anodic stimulus resulted in steeper slopes of eCAP I/O functions, larger eCAP amplitudes at the anodic C level and lower eCAP thresholds in all subject groups and at all electrode locations. Children with GJB2 mutations showed steeper slopes and larger eCAP amplitude than children in both the SLC26A4 and idiopathic hearing loss group. In addition, these subjects also showed smaller effect size of pulse polarity on eCAP amplitude. These data indicate that children with GJB2 mutations have better neural survival of auditory nerve fibers than children with SLC26A4 who have concurrent Mondini malformation and EVA and children with idiopathic hearing loss. Preliminary results of study two indicate that the auditory nerve in children with MYO15A is sensitive to AM cues.
Conclusion: The results suggest that anodic stimuli are more effective in activating the auditory nerve fibers than cathodic stimuli in spite of GJB2 or SLC26A4 gene mutations. The results also provide evidence that children with hearing loss caused by the GJB2 gene mutation have better neural survival than those with the SLC26A4 mutations and concurrent Mondini malformation and EVA or idiopathic hearing loss.
Title: Delayed Pain in Cochlear Implant - A Tailored Treatment Plan According to An Etiology-Based Classification

Presenting Author: Yisgav Shapira MD

Abstract:

Introduction: Delayed pain over the receiver/stimulator (R/S), unrelated to use, is a serious consequence of cochlear implantation, and in some cases, those necessitating re-implantation or becoming non-users, should be considered a major complication. Management of these patients is empiric in many cases as the cause of pain in most is unknown.

Methods: A review of previously reported and new cases of unexplainable pain over the R/S, presenting through the years 2009-2018, with a follow-up of at least 6 months, was performed. At first all patients were treated according to an empirical regimen developed in our department, and previously published. With growing experience, we utilized an etiology-based classification of pain that included: Soft failure (SF), low grade infection (aka Bioflim-BF), Neuralgia (N) and foreign body reaction (aka Allergy-A). The characteristics, therapy regimen, and outcomes for each category were reviewed, and a suggested flow-chart was developed, accordingly.

Results: Fifty-four patients complained of sixty ears with pain over their R/S presenting months to years after implantation, amounting to 4% of primary implantations performed at our tertiary center as of 2018. The pain was unrelated to implant use in all categories, and without any local findings, apart from sensitivity in specific points around the R/S. Thirty-five ears (3 SF, 19 BF, 7 N, 5 A) were managed conservatively, although some required a few cycles of therapy. In twenty-three of these the pain resolved, ten suffer from occasional pain, but use their implant regularly and two are non-users. Twenty-five ears (14 SF, 5 BF, 5 N, 1 A) required explantation and either immediate or delayed revision surgery. At explantation no signs of infection or obvious device damage were found. Following re-implantation, the pain persisted in only 3 ears (1 SF, 2 N). All-in-all, in fifty ears (83%) the pain has declined or resolved, and the patients use their implant/s. Only one explanted implant was found faulty in the analysis performed by the manufacturers. The hearing performance at last follow-up did not significantly change compared to the performance at last evaluation before the presentation of pain.

Conclusion: Delayed pain over the R/S is not as uncommon as once thought. Thorough evaluation may enable categorizing the patient to the proper etiology group, thereby allowing a tailored therapy regimen.
Session: S1-3
Abstract ID: 344
Title: Clinical Trial of the Capacitive Component of Electrical Impedance in the Cochlea and the Effect of Topical Dexamethasone in Cochlear Implant Surgery
Presenting Author: Federico Di Lella MD
Author Block:
Federico A. Di Lella, MD, Matias Parreño, MD, Florencia Fernandez, MD, Carlos M. Boccio, MD PhD; ENT - Head & Neck surgery, Hosp. Italiano de Buenos Aires, CABA, Argentina.
Abstract:
Introduction: The electrical impedance is the opposition to the current flow between two electrodes. It is composed of two main elements: resistance and reactance. Impedances in a cochlear implant are not stable over time: values are minimal immediately after surgery and rises progressively due to inflammatory response and fibrosis. Impedance is typically used to assess CI integrity after implantation and calculate power consumption, but may be also used to explore the status of the electrode surroundings and effect of drugs in the inner ear, specially when considering the capacitive subcomponent. The objective of this study is to determine if topical dexamethasone during cochlear implant surgery alters the cochlear implant capacitive impedance.
Methods: A double-blinded randomized trial was carried out. Twenty patients with cochlear implant indication were included. The patients were randomly assigned to experimental or control group. Surgery was performed using soft surgery technique in all patients, the experimental group received a single dose of topical dexamethasone 20 mg/dl previous to the electrode insertion and control group received normal saline. A custom made impedance measuring software was developed, designed to be used by the patient. In the immediate postoperative period the patient was provided with a processor and calibration interphase and instructed to self perform measurements of impedance twice a day for 30 days before implant activation. Data is remotely transferred to the investigators in real time.
Results: All patients had full array insertion and self - completed the measurements as instructed. Total impedance, access resistance and capacitive impedance were recorded successfully and without adverse effects. In both control and experimental group total impedance and Access resistance values are minimum in the immediate postoperative period and rise rapidly in the first seven days. Afterwards the values continue increasing with slower pace. On the contrary Cp values have the opposite behaviour with high values at implantation time. There is a statistically significant difference between experimental and control group for total impedance, access resistance and capacitive impedance in the first ten postoperative days. Additionally Impedance differences are not stable in different cochlear regions. There are no statistically significant differences between the two groups after 30 days.
Conclusion: Topical dexamethasone reduces total impedance and access resistance and increases capacitance in the first 10 postoperative days after cochlear implant. The effect is not evident after 30 days. Different pharmacokinetic strategies should be addressed to extend the effect in time.
Abstract:

Introduction: Children born with significant hearing loss who receive a cochlear implant can learn to develop spoken language, often at levels rivaling those of their peers with normal hearing. It is well documented that early intervention and implantation for these children is closely associated with positive speech and language outcomes, and greatly increases the likelihood that the child will develop normal speech and language abilities. In the United States, the FDA guidelines for pediatric cochlear implantation are 12 months of age. However, there is reason to believe that children would benefit if the FDA criteria changed to allow for earlier ages of implantation. For example, multiple longitudinal studies suggest that children who receive cochlear implants or hearing aids by six months of age have improved outcomes relative to those who receive intervention at older ages. While these data provide key evidence in support of changing the FDA age guidelines for pediatric cochlear implantation, other crucial questions need to be addressed. Specifically, the safety of cochlear implant surgery for children under 12 months of age needs to be better established. While many centers are routinely implanting children under 12 months of age, there is a lack of uniformly gathered data related to surgical factors in this population. Thus, the purpose of this project was to examine the safety of cochlear implantation in children under 12 months of age.

Methods: We conducted a retrospective chart review from over 100 infants recently implanted at five centers across the US and Canada. In this review, we examined key variables relating to the safety of surgery for cochlear implantation. Examples of key variables examined here were the total time under anesthesia, the amount of blood loss, presence of exposed dura during drilling, the duration of recovery, the amount of pain medication administered after surgery, skin flap breakdown, and device malfunctions. Our goal was to quantify the incidence of complications related to the surgical procedure itself, and the incidence of device malfunction after surgery.

Results: Results obtained from more than 100 infants implanted under 12 months were analyzed against a database of reported occurrences for children implanted between 12-24 months of age. Safety profiles appear comparable between the two groups, and results will be described in detail in this presentation.

Conclusion: These results provide further evidence that cochlear implant surgery in children under 12 months of age is safe. The incidence of complications related to the surgical procedure in infants less than 12 months of age approximated the same low incidence observed for older children. These data, when considered in conjunction with data indicating that implanting children less than 12 months of age yields improved speech and language outcomes, suggests that the FDA guidelines for age of pediatric cochlear implantation could be reduced below 12 months of age when determined medically necessary/viable by the cochlear implant team.
Session: S1-3
Abstract ID: 1019
Title: Early Data from the Prospective Randomized Trial of intracochlear ECogh during Cochlear Implant Surgery
Presenting Author: Michael Harris MD
Author Block:
Abstract:
Invited Presentation
Session: S2-1
Abstract ID: 350
Title: Improved Speech Perception and Expression in Implanted Individuals having Dual Diagnosis of Hearing Loss and Autism Spectrum Disorder
Presenting Author: Adrien Eshraghi MD, MSc, FACS
Author Block: Adrien A. Eshraghi, MD, MSc, FACS, Emre Ocak, MD, Abdulrahman Aljohani, MD, MPh, Domitille F. Lochet, MS, CCC-SLP, LSLS Cert. AVT, Ronen Nazarian, MD, Chrisanda Sanchez, AuD, Diane Martinez, AuD, Ivette Cejas-Cruz, PhD, Sandra Velandia, AuD; Otolaryngology, Univ. of Miami Miller Sch. of Med., Miami, FL.
Abstract:
Introduction: Cochlear implantation (CI) has the potential to improve expressive and receptive language for hearing impaired children with autism spectrum disorder (ASD). CI is now being increasingly considered for individuals having dual diagnosis of ASD and hearing loss. However, very little information is available regarding speech development in ASD children with CI and their clinical outcome is not well known. The aim of this study was to assess receptive and expressive language skills in children with ASD post-implantation and surveying the parents in regard to the benefits of implantation.
Methods: This is a retrospective review comparing both pre- and post-implantation speech perception and expression scores in children with ASD and CIs to those of neurotypically developing children with CIs. All ASD patients in the current study were diagnosed under the DSM-IV criteria, and are reported as such. A novel scoring system for speech perception and speech expression was used to assess the functional language of ASD children before and after implantation. A survey, which asked about the effect of CI on behaviors closely associated to ASD as well as overall device satisfaction, was also administered to parents of children in the ASD group.
Results: 24 patients with history of ASD and cochlear implantation were analyzed and compared to 24 patients who received cochlear implant and have no other disability. Post-operatively after unilateral implantation, 57% of children with ASD significantly improved their speech perception skills and 60% significantly improved their speech expression skills while all patients in the control group showed significant improvement in both aspects. The improvement was further increased following bilateral implantation, with 73% showing improvement in speech perception and 71% improvement in their speech expression skills. The top three reported improvements after cochlear implantation were name recognition, response to verbal requests, and enjoyment of music. Of all behavioral aspects, the use of eye contact was the least improved. Survey results in regards to improvements in patient interaction were more subtle when compared to those related to sound and speech perception. The most improved aspects in the ASD patients’ lives after cochlear implantation appeared to be attending to other people’s requests and conforming to family routines. Of note, awareness of the child’s environment is the most highly ranked improvement attributed to the cochlear implant.
Conclusion: Our study suggests that CIs improve expressive and receptive language for hearing impaired children with ASD. Children with ASD and CIs have a bond with their device and benefit from it even if they do not develop language to the same extent as deaf children with no additional disability. The families are satisfied with the outcomes post-implantation. However, they should be counseled adequately on realistic expectations. If an implanted child does not develop language appropriately, an evaluation for comorbidities, such as ASD, should be recommended.
Session: S2-1
Abstract ID: 76
Title: Outcomes of Cochlear Implantation in Children with Developmental Disabilities
Presenting Author: Elizabeth Preston AuD
Author Block:
Xing Lu, PhD, Zhaobing Qin, PhD; The First Affiliated Hosp. of Zhengzhou Univ., Zhengzhou, China.
Abstract:
Introduction: Approximately 40% of children with permanent hearing loss have co-occurring conditions that may affect their development and their audiologic management. There is certainly not a consensus on whether or not children with developmental disabilities will benefit enough from cochlear implantation to warrant the risk and expense of the surgery. The policy at this center is to council families on realistic expectations for this population and pursue cochlear implantation in those who are healthy enough for surgery. The purpose of this presentation is to provide descriptive characteristics and outcomes of children with developmental delay and cochlear implants.
Methods: This retrospective study includes 103 children who received a cochlear implant and have a diagnosis of developmental delay. Examined factors included age at implant, auditory skills, inner ear malformation, characteristics of use, education, communication, and co-morbid conditions. We examined retrospective outcomes for 93 children who received cochlear implants at our center who have developmental disabilities. We wanted to look at what factors impacted the age of implantation for these children. Among the variables looked at are age of diagnosis of hearing loss, known developmental disabilities and inner ear anatomy. We also looked at how many of the children were still utilizing their cochlear implants and what their outcomes have been.
Results: Children with developmental delay present with a range of outcomes. While 28.16% have no demonstrated benefit, 32.04% have parental report of awareness and understanding despite not being behaviorally testable, 17.48% have closed set speech understanding, and 22.32% have open set understanding. Almost 7% of this population has become known non-users and 15.56% have been lost to follow-up. A promising 73% continue to use their devices. Age of implantation in this population is higher than typical, with a mean age of 3.3 years. The majority have a known etiology and several co-morbid conditions. Most have structurally normal inner ears. They use a range of communication modes including cued speech, augmentative communication, manual modes of communication, spoken language, and total communication. Educationally, their placements range from early intervention through high school graduates, with the majority receiving significant support in the form of self-contained programs.
Conclusion: Children with significant developmental delays can receive benefit from cochlear implants. Age of implantation is later than those with typical development and early implantation should be pursued whenever possible. Parental communication goals and expectations should be an important part of candidacy decisions and counseling. An expanded team approach is vital to enable these children to meet their communication potential. Looking at what factors drive our decisions on cochlear implantation and outcomes for children with developmental disabilities can help us improve how we serve this population.
Session: S2-1
Abstract ID: 171
Title: Long-Term Outcomes in Children with Congenital CMV Infection & Its Cochlear Implant
Presenting Author: Alessandra Murri MD
Author Block:
Alessandra Murri, MD 1, Letizia Guerzoni, PhD 2, Patrizia Frontera, PhD 1, Domenico Cuda, MD 1; 1Department of Otorhinolaryngology, “Guglielmo da Saliceto” Hosp., Piacenza, Italy, 2Department of Otorhinolaryngology, "Guglielmo da Saliceto" Hosp., Piacenza, Italy.
Abstract:
OBJECTIVE: To investigate the role of congenital cytomegalovirus (CMV) infection on the improvement of language understanding after cochlear implantation (CI).
STUDY DESIGN: The design of the study is a retrospective single-institutional chart review (2005-2017), performed in a tertiary academic referral center.
Methods: 15 children with typical signs of cCMV infection on cerebral magnetic resonance imaging (MRI) and bilateral severe-to-profound sensorineural hearing loss were retrospectively evaluated. Mean age at which patients underwent CI was 30 months. The mean follow-up period was 7.4 years. Hearing performance was assessed using the Categories of Auditory Performance (CAP), and speech development was assessed using Speech Intelligibility Rating (SIR).
Results: The outcomes showed great variation. The majority of children achieved moderate-to-good auditory and speech rehabilitation. Despite differences in the severity of CMV infection, the majority of affected children achieved CAP scores =4, representing discrimination of speech sounds and common phrases without lip reading. Regarding speech development, most of the children developed intelligible speech for a concentrated listener (SIR =3). The severity of brain lesions on its own did not directly correlate with the outcome of cochlear implantation.
Conclusion: Auditory performance and speech intelligibility after CI in children with cCMV infection are determined by multiple factors and do not only correlate with the severity of cerebral MRI lesions.
Introduction: CHARGE syndrome is a disorder that affects several areas of the body. Approximately 90-95% of children with CHARGE syndrome present with middle and inner ear abnormalities, which are often accompanied by significant hearing loss (CSF, 2018). Regarding the inner ear structures, CHARGE syndrome can be associated with Mondini cochlear malformations, cochlear nerve deficiency, and vestibular involvement, such as complete absence of the semicircular canals. Given the variability in type and severity of hearing loss, the audiological management of patients with CHARGE is considered highly variable and controversial. Often, these anatomical factors lead to hesitation when considering cochlear implantation. As such, these children with multi-sensory deficits present with many challenges which affect both their management and outcomes. This presentation will highlight a case review about a 2-year-old child with CHARGE syndrome and bilateral cochlear nerve deficiency. Audiological management, surgical intervention, clinical challenges, and current outcomes will be reviewed.

Methods: A retrospective chart review was conducted with the purpose of providing data and results on audiological and communication outcomes as the child journeys from one cochlear implant (CI) to becoming a bilateral CI recipient. A series of objective measures, including unaided and aided thresholds and subjective questionnaires were utilized to evaluate the progress post-CI.

Results: The child is an international patient who was diagnosed with CHARGE syndrome and severe to profound hearing loss. He is followed by multiple specialists including Neurotology, Audiology, and Auditory Verbal Therapy. MRI revealed bilateral cochlear nerve deficiency, with the right ear being worse than the left. Additionally, imaging confirmed absence of semicircular canals bilaterally. Despite unpredictable outcomes, family was motivated to pursue a CI and understood the limitations. Significant counseling was conducted with the family regarding realistic expectations. Patient underwent left cochlear implantation surgery at 14 months of age. Intraoperative electrically evoked compound action potentials (ECAP) were completed to measure responses from the auditory nerve; no measurable response could be obtained at the limits of 600 charge units. Throughout routine CI programming, ECAP recordings became both measurable and present over the course of 10 months. Currently, patient is responding in the expected range to all Ling 6 sounds and parents report a significant improvement in his overall quality of life. He continues to receive auditory verbal therapy via telehealth in addition to numerous other services. This presentation will discuss his overall audiological management and how we assisted the family in enrolling in additional programs and interventions. Given his positive outcomes, the team and family are now motivated to pursue bilateral implantation.

Conclusion: The management of children with CHARGE has been documented as both challenging and unpredictable. The importance of a multi-disciplinary approach is pivotal in the success of these patients. This case describes the need to evaluate the whole child and consider multiple factors beyond anatomy and auditory thresholds when discussing management options for children with CHARGE syndrome. Further, it highlights that with proper support, children with CHARGE can also benefit from cochlear implantation.
**Session:** S2-1  
**Abstract ID:** 1014  
**Title:** To What Extent Relaxation of Indication for CI Influences Clinical Practice  
**Presenting Author:** Michal Luntz MD  
**Author Block:**  
Michal Luntz 1,2,3, Ayman Makhul4, Riad Khniefes2,4, Caroline Peleg4, Noam Yehudai 2, 4, Talma Shpak4 1The Ear and Hearing Unit, ARM, the Center for Otolaryngology Head and Neck & Maxillofacial Surgery, Assuta Medical Center, Tel Aviv 2The Bruce Rappaport Faculty of Medicine, Technion- Israel Institute of Technology, Haifa; 3Department of Communication Disorders, Haifa University, Haifa; 4The Ear and Hearing Program, Department of Otolaryngology Head and Neck Surgery, Bnai-Zion MC Medical Center, Haifa;  
**Abstract:**  
**Background:** Since 2006 CI is fully reimburse in Israel for adults with up to 50% speech understanding and 70 dB or worse pure tone average (500, 1000 and 2000Hz). This age group includes also adolescents.  
**Objectives:** To evaluate to what extent relaxation of indication for CI influenced clinical practice.  
**Study participants and Methods:** The study includes individuals who underwent unilateral CI between 10.1998-10.2018 at Bnai Zion MC, and were 10 years or older at CI. Participants were divided into 4 groups according to period of implantation. Hearing thresholds at the time of implantation between the implantation periods were compared.  
**Results:** 400 of the implantations were within the inclusion criteria of the study, and 94 were in adolescents (10-21y CI). Amount of residual acoustic hearing at implantation increased during the study periods. In the non-implanted ear, during the last two periods (2014-2018, 2009-2013), 34% and 15% of the implantees respectively had a better than 70 dB threshold at 500 Hz, and in the implanted ear 20% and 9% respectively, with a significant difference between each of the last two periods and the earlier periods for both ears. In the adolescent group, 47% and 17% in the non-implanted ear, and 11% and 0% in the implanted ear.  
**Conclusions:** The relaxation of indication for CI in Israel in 2006 led to the expected change in clinical practice. It seems that adoption of wider audiologic indications for CI in adolescents was slower. Since high percentage of individuals are implanted while having very significant residual hearing in both the implanted and the non-implanted ears, procedures that can routinely guarantee long term hearing preservation should be developed as well as technologies for better communication between the implant and the HA on the contra-lateral ear. Such improvements might help clinicians and parents to implant adolescents earlier.
Session: S2-1
Abstract ID: 109
Title: Speech, Language, and Vocabulary Outcomes in Children with Dual Diagnoses: Hearing Loss and Autism
Presenting Author: Kathryn Marsh MA, MEd
Author Block:
Kathryn Marsh, MA, MEd 1, Tamala Bradham, PhD, DHA, CPPS, CPHQ, CCC-A 2, Christopher Fonnesbeck, PhD 3, Ivette Cejas, PhD 1; 1Univ. of Miami, Miami, FL, 2Vanderbilt Univ. Med. Ctr., Nashville, FL, 3Vanderbilt Univ. Med. Ctr., Nashville, TN.
Abstract:
Introduction: Autism Spectrum Disorder (ASD) is a developmental disability that can cause significant social, communication, and behavioral challenges and ranges in severity. In 2009-2010, the Annual Survey of Deaf and Hard of Hearing Children and Youth reported that one in 59 children with hearing loss also receive services for ASD. Despite these estimates, studies investigating the outcomes achieved by children with hearing loss and ASD have been underrepresented in the literature (Edwards, 2007). A few studies have provided some preliminary positive findings in speech and language outcomes in children with dual diagnoses of hearing loss and ASD (Meinzen-Derr, et al., 2014; Donaldson, Heavner, & Zwolan, 2004). The current study compares speech, language, and vocabulary outcomes of children with dual diagnoses and children with hearing loss only to determine whether there are significant performance gaps among the two groups and how these gaps impact intervention practices for children with hearing loss and ASD.
Methods: Children with hearing loss and ASD (n=75) and children with hearing loss only (n=4,135) were drawn from a population-cohort who participated in the Listening and Spoken Language Data Repository (LSL-DR, Bradham et al., 2018). All children were 3-5 years old, had a confirmed diagnosis of hearing loss by an audiologist, were fitted with amplification, and used spoken English as their primary language. Children who did not have the medical diagnosis of ASD or suspected to have ASD were not included in the dual diagnoses group. Demographic information (audiological, child- and family-related, and service provisions related variables) and assessment data measuring the five language learning domains (expressive and receptive language, expressive and receptive vocabulary, and articulation) were collected. Percentages for the population characteristics were calculated based on nonmissing values. Standard scores from assessments in each domain were “normalized” using the same protocol used in LSHSS (2018), in order to compare standard scores across different measures of language.
Results: Standard scores for each domain across age ranges were analyzed using a series of regression models that evaluate the impact of each factor on the standard score in a given domain. Due to similar distributions across the three age groups, standard scores were pooled for each language learning domain. Forest plots were used to graphically display the estimated results for each variable and its contribution to language learning outcomes. This study will discuss differences in speech, language, and vocabulary outcomes between the two groups and the demographic variables associated with these differences. Data is currently being cleaned and analyzed and will be ready for July conference.
Conclusion: Comparing outcomes for children with hearing loss and ASD and hearing loss only has helped increase awareness and understanding of how additional diagnoses relate to the development of listening and spoken language in children with hearing loss. Data from this study will be presented and discussed in terms of implications for hearing technologies and early intervention services.
Session: S2-1
Abstract ID: 323
Title: Auditory and Language Skills Development After Cochlear Implantation in Children with Multiple Disabilities
Presenting Author: Medhat Yousef MD, PhD
Author Block:
Medhat F. Yousef, MD, PhDAudiology unit, King Abdullah ear specialist center, King Saud Univ., Riyadh, Saudi Arabia.
Abstract:
Introduction: Cochlear implantation (CI) in children with additional disabilities can be a fundamental and supportive intervention. Although, there may be some positive impacts of CI on children with multiple disabilities such as better outcomes of communication skills, development, and quality of life, the families of those children complain from the post-implant habilitation efforts that considered as a burden.
Methods: The study sample comprised 25 hearing-impaired children with co-disability who received cochlear implantation. Age and gender-matched control group of 25 cochlear-implanted children without any other disability has been also included. The participants’ auditory skills and speech outcomes were assessed using MAIS and MUSS tests.
Results: There was a statistically significant difference in the different outcomes measure between the two groups. However, the outcomes of some multiple disabilities subgroups were comparable to the control group. Around 40% of the participants with co-disabilities experienced advancement in their methods of communication from behavior to oral mode.
Conclusion: Cochlear-implanted children with multiple disabilities showed variable degrees of auditory and speech outcomes. The degree of benefits depends on the type of co-disability. Long-term follow-up is recommended for those children.
Session: S2-2
Abstract ID: 9
Title: Utilization Of Round Window Membrane Surface Tension In Facilitating Slim Electrode Insertion In Cochlear Implant
Presenting Author: Ihab Nada MD
Author Block:
Ihab M. Nada, Jr., MDENT, Misr university for science and technology, Cairo, Egypt.
Abstract:
Introduction: Cochlear implantation (CI) is indicated for patients with severe to profound sensory neural hearing loss. Minimisation of the insertion cochlear trauma and preservation of residual hearing are major goals of modern CI surgery [1]. There is an increased interest in the round window membrane (RWM) access for atraumatic CI electrode insertion with increased probability of successful scala tympani placement, and hence, superior audiological results [2, 3]
Methods: This is a prospective randomized study. Patients with type I and type IIa RWM exposure (according to St. Thomas hospital classification) were included in this study (FigAn informed consent was obtained from all the patients. Study design: This is a prospective randomized study. The choice for either technique was randomized. Patients were randomly allocated to either study groups in a 3:2 ratio using a computer generated randomisation method. A total number of 75 patients were included in the first group who underwent slit incision of the RWM (with loss of follow-up data for 5 patients). While 50 patients were included in the second group who underwent cruciate incision of the RWM (with loss of follow-up data for two patients). So, a total number of (118) children were included in this study (118 implantations). Mean age was 36.72 months (range from 18 to 60 months). This study was conducted from January 2015 to September 2016 at a cochlear implant centre in a tertiary referral hospital. Slit incision in the anterosuperior border of the RWM was done in 70 cases. While RWM cruciate incision was done in 48 cases. Mean follow-up was 6 months
Results: Of the 48 patients who underwent RWM cruciate incision: 13 cases had no problem during electrode insertion, while in 35 cases we faced difficult insertion (nine of them showed kinking, in 16 cases we faced increased operative time due to flopping of the electrode, while in 10 cases multiple insertion trials have been done. For the (70) cases where slit incision of the RWM was done: 68 cases showed smooth insertion, while in 2 cases we faced increased operative time due to flopping of the electrode.
Conclusion: Tensile strength of the round window membrane after minimal penetration (slit incision of the RWM) offers support to slim electrodes during introduction, decreasing incidence of kinking and floppiness of the slim electrodes, hence shortening the maneuver time and minimizing the number of trials. This facilitates easy smooth slim electrodes introduction, decreasing intracochlear trauma. Moreover, slit incision of the RWM may offer better residual hearing preservations than cruciate incision of the RWM.
Session: S2-2
Abstract ID: 273
Title: Individualized Cochlear Implantation Using the Concept of Partial Insertion
Presenting Author: Thomas Lenarz Prof. Dr. med.
Author Block:
Thomas Lenarz, Prof. Dr. med., Rolf Salcher, Dr. med., Nils Prenzler, Dr. med., Andreas Büchner, Prof. Dr.; ENT Department, Med. Univ. of Hannover, Hannover, Germany.
Abstract:
Introduction: Individual 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 and an optimal cochlear coverage. Better hearing preservation results with shorter electrodes and best hearing performance results with longer electrodes in ES leads to a trade-off. Partial insertion of a longer electrode with the option for its adaption could overcome this trade-off.
Methods: N=18 patients were treated with a partial insertion and an individual selected insertion depth. Using statistical models the postoperative residual hearing and electrode location in the cochlea were individually predicted and supported the surgeon to select the best suitable electrode insertion depth. In n=5 cases a 24 mm long electrode was partially inserted with an average insertion depth of 20 mm and in n=12 case a 28 mm long electrode was partially inserted 21 mm in average. To document the patient outcomes pre- and postoperative hearing thresholds and speech perception in noise were determined.
Results: The median hearing loss at first activation was 19 dB (n=5) for a partially inserted electrode of 24 mm length and 17 dB (n=12) for a partially inserted electrode of 28 mm length. At 3 months, n=12 patients used their low-frequency hearing for a EAS and achieved in median 77% with the HSM sentence test in noise at 10 dB SNR.
Conclusion: Taking cochlear geometry and the prediction of postoperative residual hearing into account an optimal electrode insertion depth can be selected to achieve best individual outcomes. Patients treated with partial insertion can benefit from EAS. If hearing is progressive over time, partial insertion allows for further, patient specific adaptation of the insertion depth.
Session: S2-2
Abstract ID: 129
Title: Scalar Location and Hearing Preservation Outcomes in Precurved Electrode Arrays Inserted Using an External Sheath.
Presenting Author: Ashley Nassiri MD, MBA
Author Block:
Ashley M. Nassiri, MD, MBA, Robert J. Yawn, MD, Jourdan T. Holder, AuD, Marc L. Bennett, MD, Jack H. Noble, PhD, Robert F. Labadie, MD, PhD, Matthew R. O'Malley, MD, Rene H. Gifford, PhD, Robert Dwyer, Aud, Alejandro Rivas, MD; Vanderbilt Univ. Med. Ctr., Nashville, TN.
Abstract:
Introduction: The new precurved electrode array inserted using an external sheath has been designed to minimize average distance from electrode to modiolus ($d$), while minimizing translocation. Outcomes in the pediatric population have not yet reported. This study aims to 1) determine intracochlear electrode position, 2) determine the impact of slight over-insertion followed by pull-back upon final electrode position, and 3) determine hearing preservation outcomes for precurved electrode array inserted using an external sheath.
Methods: A retrospective review of cases from 2016-2018 identified 74 ears that were implanted with a precurved electrode array inserted using an external sheath. Thirty-eight ears (26 adult, 12 pediatric) underwent CI followed by computed tomography (CT) and were included for imaging analysis. Of the 74 ears, 22 adults were hearing preservation candidates (defined as <80dB threshold at 250Hz) and were included for hearing preservation outcomes analysis. Outcome measures included scalar location, average distance from electrode to modiolus ($d$), angular insertion depth, and audiologic measures (AzBio sentences, residual hearing thresholds).
Results: Electrode Location: One implant (2.6%) exhibited translocation at 124° with an angular insertion depth of 261°. The remaining 37 (97.4%) had all electrodes located entirely within scala tympani. One instance of tip fold-over using standard insertion technique was noted intraoperatively and resolved with repositioning. Overall ± standard deviation was 0.39±0.17mm with apical, middle, and basal electrode subgroups having of 0.2±0.12mm, 0.52±0.34mm, and 0.48±0.25mm, respectively. Slight over-insertion and pull-back, controlling for each performing surgeon, resulted in statistically significant lower (0.31mm) compared to those inserted using conventional technique (0.59mm, $p=0.001$) but was not associated with a significantly different angular insertion depth ($p=0.11$). Hearing Preservation: Preoperative hearing thresholds at 125Hz, 250Hz, and 500Hz were 52.1dB, 56.5dB, and 66.8dB, respectively; mean AzBio scores were 10%. Imaging revealed one translocation and no instances of tip fold-over. At activation, there was no statistically significant threshold shift at 125Hz (61.6dB, $p=0.13$), 250Hz (68.4dB, $p=0.6$), or 500Hz (79.8dB, $p=0.8$), while at 6 months, hearing thresholds were 67.8dB ($p=0.01$), 79.1dB ($p<0.01$), and 91.3dB ($p<0.01$), respectively. At 6 months, mean AzBio scores were 63%. Electrode proximity to the modiolus and angular insertion depth were not significantly correlated with AzBio scores at 6 months ($r=0.4$, $p=0.08$ and $r=0.005$, $p=0.8$, respectively).
Conclusions: A new precurved electrode inserted using an external sheath had very low rates of translocation or tip fold-over. Slight over-insertion and subsequent pull-back improved electrode proximity to the modiolus. A low rate of translocation allows a precurved electrode array inserted using an external sheath to maintain hearing preservation rates comparable to straight/lateral wall electrodes.
Session: S2-2
Abstract ID: 92
Title: Therapeutic Hypothermia to Preserve Residual Hearing in Cochlear Implantation
Presenting Author: Suhrud Rajguru PhD
Author Block:
Suhrud M. Rajguru, PhD, Rachele Sangaletti, PhD, Elizabeth Dugan, PhD, John Barrett, PhD, Fred F. Telischi, MD, W. Dalton Dietrich, PhD, Michael E. Hoffer, MD; Biomedical Engineering and Otolaryngology, Univ. of Miami, Coral Gables, FL.
Abstract:
Introduction: More than half a million patients, including children, have benefitted significantly from the remarkable technological breakthrough that are cochlear implants (CI). An increasing number of cochlear implant subjects have some level of residual hearing at the time of implantation and can benefit from bimodal electro-acoustic devices. Surviving hair cell activity and as a result a functioning organ of Corti and neural substrate are linked to speech perception outcomes. However, trauma to the sensitive inner ear structures during cochlear implantation leads to inflammation and oxidative stress that can exacerbate residual hearing loss or even lead to balance impairment. Unfortunately, therapeutic interventions to limit this injury have yet to be achieved. Localized mild to moderate therapeutic hypothermia has been widely studied for neuro-protection and in a preclinical model, we show that acute and localized application of mild hypothermia reduces trauma associated with cochlear implantation and preserves residual hearing.
Methods: The University of Miami Institutional Animal Care and Use Committee approved all procedures. Animals were implanted either in normothermic or hypothermic conditions and residual function was measured pre- and post-implant. Gene and protein level expression of selected factors in control, euthermic and hypothermia-treated conditions were analyzed to study the pathophysiology of the injury and mechanisms underlying therapeutic protection. Finally, cadaveric temporal bone and mathematical stimulations were developed to study translational potential of such approach.
Results: Functional measurements suggest strongly that mild hypothermia provided during cochlear implantation significantly reduced threshold shifts post trauma. Mild therapeutic hypothermia reduced inflammation and oxidative stress and increased activity of anti-apoptotic pathways, while increasing cell viability and reducing cell death. Moreover, flow cytometric analysis shows that hypothermia treatment significantly reduces the number of activated microglia, macrophages and lymphocytes/leukocytes recruited at the site of the injury.
Conclusion: Multiple cellular processes including inflammatory reactions, oxidative stress mechanisms, apoptosis and necroptosis mediate the death or survival of hair cells and neurons. Understanding the mechanisms underlying protective effects of hypothermia will guide its translational potential and lead to identification of potential targets for combinatorial therapeutic modalities. (Supported by NIH 1UL1TR000460, 1R01DC013798, and Cochlear grants to SMR.)
Title: Cochlear Implantation with a Slim, Modiolar Array

Presenting Author: Jonathan McJunkin MD

Author Block:
Jonathan McJunkin, MD, Nedim Durakovic, MD, Jacques Herzog, MD, Cameron Wick, MD, Craig Buchman, MD; Otolaryngology, Washington Univ. in St. Louis, St. Louis, MO.

Abstract:

Introduction: The purpose of this study is to describe the surgical findings associated with successful cochlear implant (CI) array insertion in a multi-center trial. The precurved array used in this study is placed with a sheath which allows for a slimmer profile than previous perimodiolar designs.

Methods: This study describes surgical outcomes from a prospective, multi-center (N=13), non-randomized clinical investigation using a slim, modiolar CI array which began in January 2017. 100 adult (≥18 yo) patients with bilateral postlingual sensorineural hearing loss meeting traditional CI candidacy received implants. Surgeons completed an operative questionnaire at the time of surgery. Intraoperative plain film X-rays were used to confirm there was no evidence of tip rollover. Postoperative CT scans were obtained and reconstructed to determine array location.

Results: 100 surgeries were completed by 25 surgeons. Surgical questionnaires were completed for all cases. 70 patients had radiographic data available. There were three tip rollovers (3%); one identified intraoperatively through x-ray and corrected via reinsertion and two detected on post-operative CT that underwent successful revision surgery. Cochlear access was described as extended round window in 70% of cases, followed by true round window and separate cochleostomy in 27% and 3%, respectively. 93% of the questionnaires reported an uneventful insertion while 7 cases required an electrode re-load into the sheath without incident. CT reconstructions revealed most electrodes (91%) were placed fully in the scala tympani (ST), 5 electrodes (7%) translocated from ST to scala vestibuli (SV) and 1 electrode was placed fully in the SV. The average wrap factor was 59.5% and average apical insertion depth was 400 degrees.

Conclusion: The slim, modiolar electrode array has a very consistent perimodiolar position and a low translocation rate. Surgeons used an extended round window approach most frequently to accomplish the sheath-dependent insertion technique. Intraoperative x-ray is needed to detect tip rollovers in the operating room.
Session: S2-2
Abstract ID: 58
Title: Controlled Modulation of Posture with a Vestibular Implant in Humans
Presenting Author: Raymond van de Berg MD, PhD
Author Block:
Raymond van de Berg, MD, PhD 1, Angelica Perez-Fornos, PhD 2, Stephane Armand, PhD 3, Maurizio Ranieri, Master 2, Celine Cretallaz, PhD 2, Herman Kingma, Prof. 1, Jean-Philippe Guyot, Prof. 2, Nils Guinand, MD, PhD 2; 1Maastricht Univ. Med. Ctr., Maastricht, Netherlands, 2Hôpitaux Universitaires de Genève, Geneve, Switzerland, 3Geneva Univ. Hosp., Geneve, Switzerland.

Abstract:
Introduction: Patients with bilateral vestibulopathy suffer from postural deficiencies. Often, the effect of physical therapy remains suboptimal. A vestibular implant might be another therapeutic strategy. Therefore, this study aimed to investigate the feasibility of evoking controlled postural responses using electrical stimulation delivered by a vestibular implant prototype (VI) in humans.

Methods: Three patients with bilateral vestibulopathy were fitted with a VI providing 1-3 electrode branches implanted in the ampullae of the semicircular canals, close to the ampullary branches of the vestibular nerve. Postural responses were evaluated during short (20 seconds) trials of the Unterberger test with and without electrical stimulation of the vestibular system. Electrical stimulation consisted of charge-balanced biphasic pulse trains (200µs/phase, 400 pulses-per-second) at different current intensities, up- and down-modulated around a constant baseline current. Whole-body postural responses were recorded using a 12-camera motion capture system (Oqus7+, Qualisys AB, Göteborg, Sweden).

Results: Without electrical stimulation, the angular rotation of the patients’ trunk was negligible. With electrical stimulation, a significant negative correlation between current intensity and trunk rotation was observed in two patients (subject 1 and subject 2). The results for subject 3 showed a slight, non-significant trend. Linear body motion (distance and direction) was variable and uncorrelated to electrical stimulation. Results for head motion were practically identical, demonstrating that the patients’ whole body moved “en-bloc”.

Conclusion: These results demonstrate that whole-body motion can be controlled and modulated using electrical stimulation delivered to the ampullary branches of the vestibular nerve in humans. These results are very promising, since they might imply that vestibular implants could potentially provide useful cues to address disabling postural deficiencies (e.g., imbalance), resulting in lower risks of falling.
Session: S2-2  
Abstract ID: 226  
Title: Post Meningitis Ossification and Neurologic Sequelae and its Effect on Speech Perception in Cochlear Implant Recipients  
Presenting Author: Amit Wolfovitz MD  
Author Block:  
Amit Wolfovitz, MD 1, Ricky Kaplan-Neeman, PhD 2, Yael Henkin, PhD 2, Chava Muchnik, PhD 2, Michael Wolf, MD 1, Yisgav Shapira, MD 1; 1Tolaryngology, Head and Neck Surgery, Chaim Sheba Med. Ctr., Ramat Gan, Israel, 2The Hearing, Speech, and Language Center, Chaim Sheba Medical Center, Dept. of Communication Disorders, Sackler Faculty of Med., Tel Aviv Univ., Ramat Gan, Israel.  
Abstract:  
Introduction: cochlear implantation (CI) is the preferred hearing rehabilitation method for patients who suffered profound hearing loss due to bacterial meningitis. Local factors (cochlear fibrosis and/or ossification) and general health factors (neurological sequelae) may influence speech understanding outcomes and stability of performance over time. Data in the literature is lacking regarding the long term hearing outcome stability. The objective of present study was to assess the influence of cochlear ossification and neurologic sequelae on speech perception outcomes of CI recipients post meningitis.  
Methods: Charts of patients who underwent CI post meningitis, at a tertiary care academic center, were retrospectively reviewed. Pre-operative imaging, intra-operative findings and neurologic sequelae and mono syllabic word identification scores post implantation were analyzed  
Results: Twenty six ears (16 patients) underwent CI post meningitis. The median age of implantation was 2.33 years (IQR 1.25). Four patients were males. Ten patients underwent bilateral CI (7 simultaneously). The median time from disease to implantation was 2.0 years (IQR 3.2). The median follow-up is 9.3 years (IQR 5.3). Preoperative cochlear ossification was identified in five ears. Intra-operative cochlear lumen obstruction was identified in nine ears. Three patients had pre-operative non-cognitive neurologic sequelae. Partial electrode insertion was achieved in three ears. A double electrode array was required in one ear. Twenty three ears (13 patients) had word identification in open-set condition. There was no difference in mean monosyllabic words identification scores between implanted ears with and without preoperative imaging findings of cochlear ossification, presence of neurologic sequelae, and intraoperative findings of cochlear fibrosis and/or ossification at first time point (≥8 months post implantation), and at second time point (≥3 years post implantation) of assessment. For the entire cohort, no difference was noted in mean monosyllabic words identification scores between the first and second time points of assessment (64.2±16.7% and 66.3±23.2% respectively; p=0.78).  
Conclusion: CI hearing performance following meningitis, in patients with word identification in open set conditions, coincide with the results reported for the general CI population, even with preoperative imaging demonstrating cochlear fibrosis and/or ossification, neurologic sequelae, and intraoperative cochlear lumen obstruction. In these patients, monosyllabic words identification scores appears stable over time.
Session: S2-3
Abstract ID: 349
Title: Reliability Of Cochlear Implants: Reporting In Compliance With International Standards By Cochlear Implant Manufacturers
Presenting Author: Brian Kaplan MD FACS
Author Block:
Brian Kaplan, MD FACS Otolaryngology, Greater Baltimore Med. Ctr. (GBMC), Baltimore, MD.
Abstract:
Introduction: Reliability of Cochlear Implants: Reporting in Compliance with International Standards by Cochlear Implant Manufacturers. The aim of this paper is to review reliability reporting requirements for cochlear implants, compare the methods used by manufacturers in their current reporting of device reliability per the existing international consensus, discuss the recently introduced ANSI/AAMI CI86:2017 standard (Cochlear implant systems: Requirements for safety, functional verification, labeling and reliability reporting) and assess the implications for patients and professionals.
Methods: Independent review of reliability reporting requirements of standards and compare the methods used by manufacturers in their current reporting of device reliability per the existing international consensus and recently introduced ANSI/AAMI CI86:2017 standard.
Results: The implementation of the international consensus for classifying and quantifying reliability data has improved the compliance of reliability reporting, however comparing the CSR of different implant models or manufacturers can still be challenging and reliant on the reporting approach of individual manufacturers.
Conclusion: Cochlear implant manufacturers report reliability data differently and many are non-compliant with key requirements of both the international consensus on reliability reporting and the recently introduced ANSI/AAMI CI86:2017 standard.
Session: S2-3
Abstract ID: 134
Title: The Long-Term Stability of the Electrical Stapedial Reflex Threshold; A Retrospective Chart Review
Presenting Author: Cache PITT AuD
Author Block:
Cache L. Pitt, AuD, Cache L. Pitt, AuD; Utah State Univ., Logan, UT.
Abstract:
Introduction: The purpose of this study was to investigate changes in the electrical stapedial reflex threshold within and across patients over time and to identify the relationship between the electrical stapedial reflex threshold levels and upper limit of loudness levels for the three cochlear implant manufacturers available in the United States.
Methods: The study was completed using a retrospective file review of cochlear implant recipients using devices from Advanced Bionics, Cochlear, and MedEl who were seen between January 2013 and December 2015. Demographic information along with any available electric stapedial reflex threshold and upper limits of loudness levels were recorded for 113 males and 93 female recipients (N = 206). Recipients ranged in age from 13 months to 86 years (mean = 18 years; standard deviation = 21).
Results: The mean difference in upper limits of loudness levels to the electric stapedial reflex threshold for Cochlear was 19 clinical units with a standard deviation of 11 units. For Advanced Bionics the mean difference was a decrease of 10% clinical units with a standard deviation of 39% and 3.4% with a standard deviation of 11% for MedEl. For each manufacturer the electric stapedial reflex threshold measurements were consistent over time during the timeframe of the study (2013-2015). MedEl had a 0.4 unit decrease per year (SD = 5.7) while Cochlear had a decrease of 1.4 units per year (SD = 8.3) and Advanced Bionics had a decrease of 3 units per year (SD = 45.6).
Conclusion: This study supports the clinical relationship between eSRT and behaviorally set upper limits of loudness for Cochlear, Advanced Bionics, and MedEl manufacturers. It also provides support that the electrical stapedial reflex threshold is consistent over time, eliciting confidence that little change will occur over extended periods of time.
Session: S2-3
Abstract ID: 358
Title: Evaluation of a Modern Remote Microphone Designed to Improve Performance in Small Group Settings with Multiple Talkers
Presenting Author: Sara Neumann AuD
Author Block:
Sara Neumann, AuD, Jace Wolfe, PhD, Elizabeth Musgrave, AuD; Audiology, Hearts for Hearing, Oklahoma City, OK.
Abstract:
Introduction: Cochlear implant (CI) recipients often experience difficulty understanding speech in noise, particularly when the recipient wishes to hear multiple talkers. Use of remote microphone (RM) technology has been shown to be the most effective method to improve speech recognition in noise. However, traditional RM systems only include one wireless microphone and are not an ideal solution in small group settings with multiple talkers. Recently, novel RM technologies have been developed with the intention of improving speech recognition in situations with multiple talkers. Some RM systems contain multiple microphones within one device to allow for adaptive beamforming (ABF) so that the axis of sensitivity may be steered toward the direction in which the speech signal is arriving (i.e., multi-beam technology). Alternatively, multiple talker networks (MTN) may be created in which several RM may be paired together and to a recipient’s sound processors. With a MTN, each talker in the small group may wear a RM within close proximity of his/her mouth to capture his/her speech and wirelessly deliver it to the recipient’s sound processors. The objective of this study was to evaluate the potential improvement in speech recognition in noise that CI recipients obtain with the use of ABF and MTN RM technologies.
Methods: Fifteen CI recipients, ages 7 and older, were tested in a simulated small group listening environment with multiple talkers. AzBio sentence recognition in noise was evaluated at multiple fixed signal-to-noise ratios (SNR) ranging from +2 to +10 dB. Target sentences were presented from each of three different loudspeakers surrounding a small table (at 0, 90, and 270 degrees azimuth) at which the participant was seated. The sentences randomly roved from each of the three loudspeakers to simulate a small group situation in which the talker of interest momentarily changed. Modulated noise was presented from four loudspeakers located in the corners of the room. At each of the five SNRs, performance was assessed in each of three technology conditions: 1) CI sound processor only, 2) CI sound processor with a RM equipped with ABF; the ABF RM was located in the center of the small group table (.7 meters from the participant and from each of the loudspeakers used to present the target sentences), and 3) a MTN with three RMs that were located 15 cm directly below the center of the each of loudspeakers used to present the target sentences.
Results: Repeated measures analysis of variance (RM-ANOVA) indicated significant main effects of SNR and of technology condition. A post-hoc analysis with the Tukey-Kramer Multiple-Comparisons Test indicated that use of the ABF RM provided significantly better speech recognition in noise than the CI sound processor only condition. Additionally, use of the MTN RM system provided significantly better speech recognition in noise than use of the ABF RM. In all technology conditions, sentence recognition in noise decreased significantly with decreases in the SNR.
Conclusion: Use of RM systems with ABF and MTN technology can provide significant improvement in speech recognition in noise in small group situations with multiple talkers. Optimal benefit was obtained with use of a RM system with an MTN that allowed for the speech signal of interest to be captured by a RM located within close proximity to the source of the speech.
Session: S2-3  
Abstract ID: 201  
Title: The Latest And Greatest From The Cochlear Implant Literature For The Clinical Audiologist  
Presenting Author: Jannine Larky AuD  
Author Block:  
Jannine Larky, AuD 1, Melissa Hall, AuD, CCC-A/SLP 2; 1Otolaryngology, Stanford Univ., Palo Alto, CA, 2Speech and Hearing Center, UF Health, Gainesville, FL.  
Abstract:  
Introduction: The goal of this presentation is to summarize current relevant literature related to pediatric cochlear implantation. Our goal is for attendees to obtain increased awareness of relevant research and specific findings which can positively influence clinical practice, service delivery and patient outcomes. Google Scholar identified more than 5000 articles published on cochlear implants since January 2018. Keeping current on literature is difficult. We will highlight and summarize articles that are particularly relevant in clinical practice with pediatric cochlear implant recipients and their families. A wide selection of articles will be chosen given the heterogeneity of the American pediatric cochlear implant population.  
Methods: We completed a literature review of clinically relevant research pertaining to pediatric cochlear implant articles published from January 2018 - May 2019. Presenters utilized Google Scholar to set up alerts for particular keywords to find relevant articles. Keywords utilized were “cochlear implants” and “cochlear implant.” The search function automatically forwarded articles to us with these keywords.  
Results: Approximately 20 articles will be reviewed (time permitting), to highlight the key clinically relevant points that can positively influence clinical practice.  
Conclusion: We will outline key points from each article chosen in the literature review in order to highlight information relevant for clinical implementation. Additionally, we will describe our methods for the benefit of clinicians not in academic institutions. We hope to encourage attendees to access and utilize current literature to inform best practices. Furthermore, we would like our session to feel accessible to the clinician new to cochlear implants.
Session: S2-3
Abstract ID: 418
Title: Longitudinal Results of Older Pediatric Sequential Cochlear Implant Recipients
Presenting Author: Allison Biever AuD
Author Block:
Allison Biever, AuDRocky Mountain Ear Ctr., Englewood, CO.
Abstract:
Introduction: Bilateral cochlear implants have been shown to provide many advantages to pediatric recipients including localization, the reduction of a head shadow and improved performance in difficult listening environments. While the benefits of bilateral cochlear implantation have been extensively reported in the literature, there is little research that has examined the long-term device use among pediatric implant recipients who were congenitally deafened and received their first implant early, but received their second implant at an older age. Are these children still using their sequential device? Do they demonstrate an ear preference? Are there variables that predict who will be a consistent device user, and who will become a non-user? This study examined the use of 39 pediatric implant recipients who received their first implant by the age of three, but their sequential device after the age of seven.
Methods: Thirty-eight children who received their first implant by three years of age, but their second implant at seven years of age or older were included in this study. The surgeries took place between 2005 and 2018 and were performed by the same surgeon. Although many of the sequentially implanted children and adolescents in this study are consistent users of both implants, almost a third of these pediatric recipients have been identified as inconsistent or non-users of their sequential implant. Not surprisingly, of the two thirds that are still utilizing their sequential device, almost all of these children showed a strong preference for the original implant.
Results: There did not appear to be any variable, (etiology, age at 1st implant, consistency or type of therapy) except age at time of the sequential implant that correlated with consistent device use of their sequential implant. In general, the younger the child was at the time of the second implant, the more likely the child was to be a consistent user of the technology in that ear.
Conclusion: Approximately a third of the children who received their second cochlear implant at an older age (seven years of age or older) have been identified as inconsistent or non-users of their sequential implants. Reasons for their inconsistent or non-use are reported in this presentation. While many centers might assume that their sequentially implanted pediatric recipients are consistent device wearers, continued monitoring of children who receive their second implant at an older age appears prudent. The advent of data logging has made it easier to determine who is a consistent user. Although two-thirds of the pediatric implant recipients who received the second implant at an older age are consistent users, it is recommended that the wide range of variability of device use among older children receiving a second implant be discussed during the counseling process.
Session: S2-3
Abstract ID: 113
Title: Towards a Consensus About Minimal Outcome Measurements in Paediatric Cochlear Implant Users
Presenting Author: Griet Mertens PhD Aud
Author Block:
Griet Mertens, PhD Aud, Anouk Hofkens, /, Paul Van de Heyning, MD, PhD, Vincent Van Rompaey, MD, PhD, An Boudewyns, MD, PhD, Vedat Topsakal, MD, PhD; Otorhinolaryngology, Head & Neck Surgery, Antwerp Univ. Hosp., Edegem, Belgium.
Abstract:
Introduction: While the benefits of cochlear implants (CI) in severely hearing impaired children is widely known and agreed upon, there exists no consensus about a set of minimal outcome measurements (MOM) to determine the outcomes in this paediatric CI population. Therefore, the authors aimed to agree upon a consensus about a MOM test battery in paediatric CI recipients to facilitate international multi-center research and collaboration.
Methods: The final set of the paediatric MOM has been developed, discussed, and eventually agreed upon by all HEARRING members. The HEARRING network is a group of 30 expert clinics in the field of hearing implants, including surgeons, audiologists, rehabilitationists, and other skilled professionals. The collection of a useful MOM test battery in paediatric CI recipients is based upon literature research, focusing on outcome measurements applied in clinical trials in hearing implant children. Thereafter, HEARRING experts were asked to provide information on potential paediatric MOM. To reach consensus the suggestions and comments were discussed during the HEARRING meeting in Perth, Australia, in November 2017.
Results: The HEARRING members agreed that the final set of paediatric MOM for children should be defined for chronological age categories: six weeks - five months; six months- two years; two years- six years and older than six years. The suggested test intervals are prior to implantation; three, six and twelve months after CI activation and yearly thereafter, which is in line with clinical practice. The defined set of paediatric MOM includes objective measurements, (un)aided audiometry, speech perception tests in quiet and in noise, subjective assessments, assessment of language, mental and motor development, and quality of life.
Conclusion: The project presents a consensus about a set of MOM in paediatric CI recipients, which is agreed-upon by all HEARRING members. This consensus will allow international multi-center research to extend evidence that will guide future clinical practice and research efforts in paediatric CI populations.
Session: S2-3
Abstract ID: 385
Title: Effects of Speech Processing Strategy on Cochlear Implant Performance
Presenting Author: Meredith Holcomb AuD
Author Block:
Meredith A. Holcomb, AuDMed. Univ. of South Carolina, Charleston, SC.
Abstract:
Introduction: While cochlear implants are the standard of care for moderate to profound sensorineural hearing loss, programming of the cochlear implant (CI) can vary from one clinician to another. CI companies often offer programming recommendations to CI audiologists but will not strongly recommend one processing strategy over due to defaults preloaded into CI software. However, a change in speech processing strategy can increase speech perception scores and improve the overall quality of life for a CI patient. Programming changes for adults that provide substantial speech perception improvement should be applied to the pediatric population for optimal performance. This study investigated the performance of Advanced Bionics (AB) CI users in Optima S vs Optima P strategy.
Methods: A retrospective review of post-lingual CI recipients was conducted from the period of January 2012 to December 2018. Data was collected for age at time of implantation and pre- and post-CI speech perception scores at various test intervals using two separate speech processing strategies.
Results: Preliminary analyses showed improvement for all patients when programmed from Optima P to Optima S speech processing strategy. Further, 100% of patients elected to forego their Optima P program and keep their Optima S program.
Conclusion: While a paired stimulation strategy is default for AB software, a sequential stimulation strategy is proven to be more appropriate for most patients. Formal speech perception test results and subjective preference reveal a pronounced difference between the two strategies. Clinicians should strongly consider using Optima S as a default strategy for adults and children.
Session: S2-3
Abstract ID: 312
Title: How Accurate is Cochlear Implant Scene Classification?
Presenting Author: Hillary Ganek PhD

Author Block:
Hillary Ganek, PhD, Deja Forde-Dixon, BS, Sharon Cushing, MD, Blake Papsin, MD, Karen Gordon, PhD; The Hosp. for Sick Children, Toronto, Canada.

Abstract:
Introduction: The main objective of this study is to determine if the cochlear implant processor can capture information about the child’s natural auditory environment. Cochlear implant scene classification software calculates how much time the user spent in ‘Quiet,’ ‘Noise,’ ‘Speech-in-Noise,’ ‘Speech,’ ‘Music,’ and ‘Wind.’ Audiologists can use these data to provide suggestions about changes to the environment that may help to improve auditory outcomes. The accuracy of the labels has been validated in a lab setting, however, they have never been tested in the ‘real world,’ where the device is meant to be used. Additionally, the software’s criteria for scene classification may not reflect the clinician’s interpretation of the term, bringing into question the functionality of datalogging as a patient counselling tool.

Methods: Ten children with cochlear implants wore a Language ENvironment Analysis (LENA) System digital language processor for one day. The audio recording was uploaded to LENA software and extracted as a .wav file. Each audio recording was then hand coded by the researcher and a research assistant for the same auditory scenes that the processor uses while also clarifying if the sound was quiet or loud and whether it was produced by a human or an electronic device like a television or stereo. Inter-rater reliability was calculated to confirm the accuracy of the human coders. Datalogs were extracted from the cochlear implant processor worn only on the day of LENA recording and results were compared to those of the human coder using an interclass correlation.

Results: To date, data has been collected from six children. Initial interrater reliability testing indicates strong agreement between the two human coders (ICC=.91, CI=[-.03,.99], F(4,4)=9.42, p=.03). Results support the accuracy of the human coding protocol.

Conclusion: We predict that human coding will provide details regarding environmental sounds that the datalogging scene classifier cannot distinguish. Further, these additional scenes may be important to note given potential influences on speech and language development.
Session: S3-1
Abstract ID: 205
Title: Diffusion Tensor Imaging Measures are Associated with Speech Perception Ability in Young Cochlear Implant Candidates
Presenting Author: Nancy Young MD
Author Block:
Nancy Young, MD 1, Xiujuan Geng, PhD 2, Gyangyi Feng, PhD 3, Maura Ryan, MD 4, Patrick Cm Wong, PhD 3; 1Otolaryngology, Ann & Robert H Lurie Children's Hosp. of Chicago, Chicago, IL, 2Brain and Mind Institute, Chinese Univ. of Hong Kong, Shatin, Hong Kong, 3Mind and Brain Institute, Chinese Univ. of Hong Kong, Shatin, Hong Kong, 4Medical Imagign, Ann & Robert H Lurie Children's Hosp. of Chicago, Chicago, IL.
Abstract:
Introduction: A method to accurately predict spoken language after cochlear implantation would be an important tool that could lead to customized therapeutic habilitation for children at risk for poor spoken language development. Our research group has created predictive models of language development with machine learning approach and neuroanatomy measures. Our models had superior predictive ability of high versus low spoken language improvement compared to traditional predictors such as age at implant. We report the first phase of our diffusion tensor imaging (DTI) study in which DTI measures are correlated with pre-implant speech perception performance. DTI takes advantage of differential diffusion of water molecules along tissues. It is used primarily to study axonal tracts because diffusion occurs more readily and is directionally-dependent (anisotropic) along axons. We hypothesize that neural connections measurable by DTI may be affected by hearing deprivation and that these differences may be predictive of speech perception ability.
Methods: This study included 35 cochlear implant (CI) candidates (16.74±9.44 months, 17 female); and 35 age and gender-matched normal hearing children (17.55±9.53 m, 18 female) drawn from an NIH database. The primary speech perception measure was the Speech Recognition Index in quiet (SRI-Q). Fractional anisotropy (FA) maps were estimated for each subject and warped into a children-specific brain atlas. The multi-voxel pattern similarity was computed over the entire FA map for each subject. Whole-brain tractography was conducted and the FA values along the tracts connecting any pairs of the predefined nodes were extracted to construct a connectivity matrix for each subject. Statistical Analyses. Between- and within-group multi-voxel pattern similarity measures in the normal hearing group were compared for local features (local white fiber integrity). Between- and within-group similarities of the whole brain connectivity matrices were compared for global features. The between-group similarities of local and global measures in the CI group were correlated with speech perception.
Results: Regions primarily located in left superior longitudinal fasciculus show significant group differences in multi-voxel pattern similarity between hearing and CI groups. The global similarities of connectivity matrices were also different between hearing and CI groups (P < 0.001). And the similarities of connectivity matrices between hearing and CI groups are significantly correlated with SRI-Q at baseline (P =0.003).
Conclusion: DTI demonstrates abnormalities of local and global structural connectivity of CI candidate brains. The global but not local connectivity patterns are associated with speech perception ability: the more similar the patterns of axonal connectivity of the CI candidates to normal hearing children, the higher their speech perception ability. The DTI-derived neural connectivity measures may be useful neural makers for predicting language development. If so, our models may aid in understanding the dose and type of therapy needed to maximize each child’s spoken language, the long term goal of our research.
Session: S3-1
Abstract ID: 246
Title: Cochlear Implants and Magnetic Resonance Imaging: Experience with Over 100 Studies Performed with Magnets in Place
Presenting Author: Neil Patel MD
Author Block:
Neil S. Patel, MD, Matthew L. Carlson, MD, Brian A. Neff, MD, Robert E. Watson, MD, John I. Lane, MD, Colin L. W. Driscoll, MD; Otorhinolaryngology, Mayo Clinic, Rochester, MN.
Abstract:
Introduction: There is an ever-increasing number of cochlear implant (CI) recipients who require diagnostic magnetic resonance imaging (MRI). Particularly relevant is the neurofibromatosis type II population, which represents patients who encounter hearing loss and a need for lifelong MRI surveillance at an early age. At the authors’ institution, a protocol has been in place since 2012 to safely perform MR studies with CI and ABI magnets in place by using a tight head wrap to secure the magnet. Initial results demonstrated only two instances of magnet displacement, with three instances of magnet tilting outside of the pocket within the receiver-stimulator package that required manual repositioning. Herein we present our experience with this protocol, associated adverse events, and future directions.
Methods: Retrospective review of imaging and clinical data to capture all patients who underwent MRI from 2012 to present. Data points included age, implant laterality, implant type, type of MR study performed, and complications. As of June 2018, placement of head wraps was transitioned to the radiology team from the otolaryngology service.
Results: A total of 122 MR studies in 79 patients were performed during the study period. Sixty-one patients (77%) had unilateral devices. Four patients (5%) underwent MRI with ABI magnets in place. Sixteen patients (20%) had MRI-compatible devices that did not require a head wrap. There were no instances of device stimulation, device malfunction, or excessive heating of the receiver-stimulator package. Magnet tilt requiring manual repositioning occurred during 8 studies (7%) and was the most common adverse event. Magnet displacement requiring operative intervention occurred during 5 studies (4%). Pain was reported by patients during 4 imaging episodes (3%), and in 3 instances, imaging had to be discontinued. No adverse events were noted among patients who underwent MRI with an MRI-compatible magnet. The most common study performed was brain MRI (n=55, 45%), however imaging of multiple other areas of the body, including MR angiography, was performed commonly.
Conclusion: Performing MRI with CI or ABI magnets in place carries a low likelihood of complications. Many partial magnet displacements can be corrected with firm manual pressure. Devices with MRI-compatible magnets were not associated with any adverse events and do not require head wraps to immobilize the magnet during the scan. These may be valuable in patients with known or anticipated need for MRI.
Session: S3-1  
Abstract ID: 397  
Title: Cochlear Morphologic Factors Associated with Electrode Contact Position with the New Slim Modiolar Electrode  
Presenting Author: Nedim Durakovic MD  
Author Block:  
Nedim Durakovic, MD, Jonathan L. McJunkin, MD, Cameron C. Wick, MD, Craig A. Buchman, MD, Jacques Herzog, MD; Otolaryngology, Washington Univ. in St. Louis, St. Louis, MO.  
Abstract:  
Introduction: Modifications to cochlear implant design have attempted to improve electrode contact localization within scala tympani. Partial or over insertions, tip folds, and translocations from scala tympani to scala vestibuli still occur even with newer electrode designs. The purpose of this study is to determine the radiographic factors that impact electrode contact position with the new slim modiolar electrode.  
Methods: Subjects undergoing cochlear implantation at a single institution with the slim modiolar electrode were evaluated. All subjects had post-operative CT reconstructions analyzing electrode contact position within the cochlea. Individual contacts were localized to scala tympani, media, or vestibuli. Cochlear diameter measurements were made from the round window membrane to the lateral cochlear wall. Intra-operative plain film x-rays were used to identify cases of tip folds.  
Results: There were 84 slim modiolar CI insertions completed with post-operative CT reconstructions. 5 (6%) cases resulted in a tip fold while 5 (6%) cases had a translocation from scala tympani to scala vestibuli. The median cochlear diameter was 9.2mm (range 8.5mm to 10.4mm). There was no difference in cochlear diameter for full scala tympani insertions (9.2mm; range 8.5 to 10.4) compared with translocations (9.4mm; range 9.1 to 9.5) (P=0.34). Larger cochlear diameter was associated with cases of tip folds (9.8mm; range 9.1 to 10.3) compared with reference insertions (9.2mm; range 8.5 to 10.4) (P=0.05).  
Conclusion: Newer electrode designs have improved electrode localization within scala tympani. Variability in cochlear size may impact probability of tip fold.
Session: S3-1
Abstract ID: 339
Title: Comparison of Intrascalar Location of Straight vs Perimodiolar Electrode Array by Flat-Panel Computerized Tomography
Presenting Author: Diego Zanetti MD
Author Block:
Diego Zanetti, MD 1, Giorgio Conte, MD 2, Elisa Scola, MD 2, Federica Di Berardino, MD 3, Anna Gasbarre, Audiologist 4, Sara Cavicchiolo, Speech Therapist 3, Luca Caschera, MD 2, Fabio Triulzi, MD 2; 1Audiology Unit, Department of Clinical Sciences and Community Health; 2Univ. of Milan, Milano, Italy, 2Dept. of Neuroradiology, Univ. of Milano, Fondazione IRCCS Cà Granda, Ospedale Maggiore Policlinico, Milano, Italy, 3Audiology Unit, Dept of Clinical Sciences and Community Health, Univ. of Milano, Fondazione IRCCS Cà Granda, Ospedale Maggiore Policlinico, Milano, Italy, 4Audiology Unit, Dept of Clinical Sciences and Community Health, Fondazione IRCCS Cà Granda, Ospedale Maggiore Policlinico, Milano, Italy.
Abstract:
Introduction: One of the fields of technological advancement in cochlear implants (CI) pursued by all manufacturers is the development of less traumatic electrodes that can conform to the anatomy of the cochlea, and possibly enhance the outcomes. Recently, a slim precurved perimodiolar electrode with an insertion guidance sleeve has been designed in order to facilitate the insertion and to avoid the inter-scalar dislodgement that frequently occurs at the first basal turn. Aim of this study was to evaluate the intracochlear position of different Nucleus electrode arrays in adult and pediatric CI recipients by means of flat-panel volume computerized tomography (FPCT).
Methods: Fifty-six CI recipients (37 females, 19 males), 1 to 80 years of age, operated by the same surgeon with the same technique, were included. All underwent FPCT with a C-arm angiographic system including a digital flat panel detector 30 x 40 cm, with a source-to-image-receptor distance of 120cm. The imaging assessment was performed the day after surgery in all cases. Sequential and simultaneous CI were included and a total of 68 ears have been analyzed. The primary objective was to identify the scalar location of the array (completely in scala tympani vs. partially dislodged in scala vestibuli) and the site of dislocation. Secondarily, we measured the medial-lateral position within the scala, the insertion depth (mm and angles). The FPCT findings were also contrasted with the type of cochleostomy (round window (RW), extended RW, promontorial) and with the residual hearing preservation.
Results: Fifty-nine ears were implanted with a perimodiolar electrode, either Nucleus CI532 (n=45) or a CI412 / CI512 Contour Advance (n=14), while 9 received a straight one (Nucleus CI422/CI522). A RW approach was performed more frequently (41 out of 45 = 91.1 %) with CI532 than with the other arrays (10 out of 23 = 43.5%). Inferior and/or anterior cochleostomy were never performed. The CI532 showed the most consistent and reliable intrascalar position, close to the modiolus and in the scala tympani. Scala vestibuli dislodgement was observed in (14.3%) of the Contour Advance electrodes and in (6.7%) of the CI532. Pre-operative residual hearing was preserved within 10 dB HL in 62% of the cases.
Conclusion: the CI532 electrode array achieved the most consistent and reliable perimodiolar location by FPCT; in our small series it appeared to be dislodged in the scala tympani in the minority of cases.
Session: S3-1
Abstract ID: 249
Title: Prediction of the cochlear implant electrode insertion depth
Presenting Author: Vedat Topsakal Professor
Author Block:

Vedat Topsakal, Professor Universitair Ziekenhuis Antwerpen, Antwerp, Belgium.

Abstract:

Introduction: Although the spiral anatomy of the human cochlea seems evident, measuring the highly inter-variable true dimensions is still challenging. Today, only a few three-dimensional reconstruction models of the inner ear are available. Therefore, spiral equations were previously applied to two-dimensional computed tomography images to predict the electrode insertion depth prior to cochlear implantation.

Methods: The study aimed to compare the clinical use of two analytical cochlear models to predict the insertion depth of the electrode array of 46 cochlear implant recipients. One was based upon the Escudé formula, which relies only on the basal turn diameter, and another based upon the Elliptic-Circular Approximation (ECA), using the diameter and width. Each case was measured twice by two ENT surgeons.

Results: The intra- and inter-observer agreement was significantly better when the ECA was applied, compared to the Escudé formula (p < 0.01). As a reference, the predicted insertion depth was compared to the actual insertion depth measured on post-operative images. The mean absolute error was 2.54 (1.48)mm in case of the Escudé approach and 1.38 (1.36)mm in case of the ECA. Integrating the diameter and width of the basal turn into the analytical cochlear model, resulted in the best predictions of the insertion depths.

Conclusion: we were able to integrate the planning software as part of the clinical routine for preoperative CI planning. Optimal cochlear views were obtained to predict preoperatively the insertion depth of a given electrode array, independently from the radiology department. The guided three-dimensional handling helped toward a consistent observer agreement during preoperative predictions using the new planning software.
Session: S3-2  
Abstract ID: 156  
Title: Executive Functioning in Children Using Cochlear Implants: Longitudinal Trajectories Over 3 Years  
Presenting Author: Alexandra Quittner PhD 

Author Block:  
Alexandra Quittner, PhD 1, Thomas Taylor, PhD 1, Ivette Cejas, PhD 2; 1Research Institute, Nicklaus Children's Hosp., Miami, FL, 2Department of Otolaryngology, Univ. of Miami, Miami, FL. 

Abstract:  
Introduction: Executive functioning is critically important in the development of language, behavioral control, academic performance, and social skills. It includes attention, inhibitory control, working memory, emotional regulation and planning, and problem-solving. Studies of children with cochlear implants have shown that although they have average intellectual functioning (Cejas et al., 2018), they exhibit difficulties with attention and other areas of executive function (Beer et al., 2014; Kronenberger et al., 2013; Quittner et al., 2007). The purpose of our study was to examine executive functioning in the largest, nationally representative cohort of children who received cochlear implants (CIs) in early childhood. We tested executive function in children in the CDaCI study using two different measures at three time points, and hypothesized that there would be deficits among this sample. 

Methods: Data were drawn from the Childhood Development after Cochlear Implantation (CDaCI; NIDCD R01 DC004797) study, which is a multi-center, national cohort investigation of the effectiveness of CIs in deaf children in relation to their hearing peers (Fink et al., 2007). Participants were recruited from 6 CI centers and 2 preschools that enrolled hearing children. Inclusion criteria for deaf children were: 1) age under 5 years, 2) severe to profound sensorineural hearing loss, and 3) a commitment to raise the child using spoken English. Mean age at implantation was 2.2 years. For this study, data were drawn from the follow-up assessment points at 108, 120 and 132 months post-implantation. We administered the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 1996) and the computerized Wisconsin Card Sorting Test (Grant et al., 2018). The BRIEF was completed by parents and teachers. 

Results: Overall, scores on the parent BRIEF indicated that children performed similarly to the normative data. Average scores for the Global Executive Composite were: 108 months post-implant, M = 50.45, SD 10.74; 120 months post-implant M = 52.14, SD = 11.89, and at 132 months post, M = 50.94, SD, 11.37. Similarly, Behavioral Regulation and Meta-Cognition Indices were also within the average ranges. Note that teachers reported worse performance across all subscales and indices. In addition, an examination of the percentage of children who fall above the clinical cut-off at any of the three timepoints indicated that a substantial proportion of these children are having difficulty in the following areas: Inhibit (26%), Shift (38%), Emotional Control (28%), Initiate (39%), Working Memory (42%), Plan/Organize (33%), Organization of Materials (24%), Monitor (32%). Future analyses will examine changes in executive function over time and will compare the parent and teacher report data on the BRIEF to an objective assessment of executive functioning (i.e., Wisconsin Card Sorting Task). 

Conclusion: Executive function appears to be an area in which children with CI’s continue to have difficulties. Although their average scores were within normal limits, approximately one-third of these children have deficits in critical areas, such as working memory, planning and organization. A better understanding of these cognitive processes is crucial as executive functioning predicts academic performance, self-control, and coping with stress and frustration during adolescence.
Session: S3-2  
Abstract ID: 41  
Title: Principles of Executive Function Interventions for Children with Cochlear Implants  
Presenting Author: Amy McConkey Robbins LSLS Cert AVT  
Author Block:  
Amy McConkey Robbins, LSLS Cert AVT1, William G. Kronenberger, Ph.D.2; 1Communication Consulting Services, Indianapolis, IN, 2Riley Child and Adolescent Psychiatry Clinic, Dept. of Psychiatry, Indiana Univ. Sch. of Med., Indianapolis, IN.  
Abstract:  
Introduction: Executive Functions (EF) are a set of neurocognitive processes responsible for the active management and control of cognitive resources, emotions, and behaviors in order to achieve a goal. These functions are important within all of the developmental areas required to be successful in life, and include such components as Self-Regulation, Attention, Planning/prioritization, Response Inhibition, and Working Memory. In several core domains of EF, children with cochlear implants (CIs) have been found to be at 2 to 5 times greater risk of having clinically-significant deficits compared to children with normal hearing (NH), although at least half of children with CIs do not have EF delays. Furthermore, the association between language and EF differs for children with CIs and children with NH. Therefore, effective EF interventions for children with CIs must be tailored to specific factors in speech, language, and EF development that are unique to children with CIs. Recent reports suggest that CI users may benefit from therapies that target EF, although the characteristics of those therapies have not been well delineated. In this presentation, we highlight principles to guide the development of EF interventions for children with CIs, based upon research findings and extensive clinical experience.  
Methods: This paper describes a collaboration between speech-language pathology (SLP) and cognitive science aimed at identifying guidelines for EF intervention tailored for children with CIs. Research findings from EF studies of children with CIs provide guidance for EF targets and techniques that can be implemented clinically, as demonstrated by the first author in her Auditory-verbal practice. These findings from the research and clinical spheres suggest some guiding principles for EF therapy in children wearing CIs, including: 1. Document a child’s EF using available tools to customize interventions based on a child’s strengths and weaknesses; 2. Integrate EF goals and strategies into therapies and education the child is already receiving in order to maximize benefit; 3. Utilize specific language that reinforces age-appropriate EF; 4. Embed the processes of time management, planning and predicting into sessions using such techniques as auditory-visual schedules, a surprise table, and tell-and-show game; 5. Address organizational skills with templates such as “Thinking In Threes”; 6. Foster impulse control with games such as “Mother, May I?” and by using a plus/zero chart to give immediate visual feedback; 7. Provide support and education to parents so that the child is embedded in a family environment that models EF.  
Results: Using a case study methodology, we will describe the encouraging trends seen in children with CIs who are engaged in this integrated therapy, and will highlight specific cases with video clips.  
Conclusion: Research about EF in children with CIs is sufficiently well-developed that translation into clinical interventions is a logical next step. Development of these interventions should be guided by principles from research findings and clinical experience. Collaboration between psychologists and SLPs may encourage the development of unique interventions that integrate EF goals into auditory and spoken language therapies for CI users.
Session: S3-2  
Abstract ID: 282  
Title: Comparisons of Listening Effort, Speech Perception in Noise, and Working Memory in High-performing School-aged Cochlear Implant Users and their Normal Hearing Peers  
Presenting Author: Eun Kyung Jeon PhD, AuD  
Author Block:  
Eun Kyung Jeon, PhD, AuD, Sherry Liao, BS, Alisa McKay, BS, Kyle Whittle, AuD; Communication Sciences and Disorders, Univ. of Utah, Salt Lake City, UT.  
Abstract:  
Introduction: A noisy learning environment in school is challenging for any child. However, children with cochlear implants (CIs) may require more effort to understand speech in adverse listening conditions than their normal hearing (NH) peers do. The objective of this study is to compare listening effort, speech perception, and short-term memory between high-performing school-aged CI users and their NH peers.  
Methods: A total of twenty children between the ages of 7 and 14 will be recruited: ten CI recipients and ten NH peers. All ten children with CIs are reported as good-performing users by their audiologists and parents. So far, four children with CIs (mean = 9 years, SD = 2.16) and six NH peers (13 years, SD = 2.50) have participated the study. We measured listening effort both objectively using reaction time and subjectively using rating scales. Reaction time was measured when the subject was engaged with a sound discrimination task using a three-alternative-forced choice paradigm. This sound discrimination task was designed using easy-to-distinguish sounds, so that we could compare reaction time when both groups do well on the task. We also asked subjects to rate their listening effort between 0 (no effort) and 100 (extreme effort) when speech perception in noise testing was conducted. For this, AzBio pediatric sentences were presented at three different levels (10, 5, and 0 dB SNRs). Two 20-sentence lists were presented for each noisy condition in a random order. Upon completion of each list, a subject marked their perceived effort on the scale. Working memory was tested using a digit span test, which was presented with audio and visual cues.  
Results: The preliminary data showed that while both CI and NH child groups achieved good performances in the sound discrimination task (NH group: mean = 96 % correct, SD = 4.43, and CI group: mean = 93 % correct, SD = 13.33), the reaction time was longer in CI children (mean = 5.65 seconds, SD = 5.09) than that in NH children (mean = 3.83 seconds, SD = 1.90). NH children performed well in all three listening conditions (mean = 98 %, 96 %, and 97 % correct at 10, 5, and 0 dB SNRs) and their subjective listening effort score was 20.6 (SD = 8.82) out of 100 maximum scale for the three conditions. Children with CIs obtained good scores in speech perception but deteriorated with different background noise levels (mean = 97 %, 88 %, and 66 % correct at 10, 5, and 0 dB SNRs). Interestingly, their subjective listening effort score was 14.9 (SD = 3.96), which was smaller (i.e., reported less effort) than NH peers. For working memory, both NH and CI groups obtained a mean of 8.7 and 6.9, respectively.  
Conclusion: Preliminary results of our objective measures of listening effort, i.e., reaction time, suggest that even high-performing CI children may require more listening effort. Initial results on our subjective measures, however, indicate that young school-aged CI children report less listening effort than NH peers even when their speech perception in noise scores were lower than NH peers. We will discuss how to implement these findings to counsel parents of CI children.
Session: S3-2
Abstract ID: 381
Title: Reading, Phonological Processing and Writing Outcomes for Adolescents Who Received Their First Cochlear Implant Younger than Two Years and Who are Now Aged 11 to 19 Years
Presenting Author: Shani Dettman PhD, MEd, Speech Pathology
Author Block:
Shani Dettman, PhD, MEd, Speech Pathology 1, Wendy Arnott, PhD 2, Robert Cowan, PhD 3; 1Dept Audiology and Speech Pathology, The Univ. of Melbourne, Parkville, Australia, 2The Hear and Say Ctr., Ashgrove, QLD, Australia, 3The HEARing CRC & HearWorks, Carlton, Australia.
Abstract:
Introduction: Children who received their first cochlear implants younger than two years of age during the late 1990s and early 2000s are now adolescents, and it is timely to assess their literacy skills, specifically reading, phonological processing and spontaneous narrative writing.
Methods: Adolescents (currently aged 11 to 19 years) who received their first CI when younger than two years were identified using records from early intervention centres and their research collaborative partners around Australia. Invitations to participate were sent to their parents and 13 consented to their child’s inclusion in this literacy study. To date, 13 participants have completed the following standardized tests: Woodcock Reading Mastery Test - 3rd Edition (WRMT-3); Comprehensive Test of Phonological Processing (CTOPP); and the spontaneous writing sub-test of the Test of Written Language (TOWL). Testing was completed within a quiet environment with each participant using their everyday listening condition (unilateral CI n=1; bilateral sequential CIs n=12).
Results: The mean age at first CI was 1.0 years (range 0.5-1.9; SD 0.41) and the mean age at test was 14.3 years (range 11.2-19; SD 2.6). Participants used a range of communication approaches in their previous early intervention programs and for their current communication needs; oral/aural (n=6), auditory/verbal(n=6), speech/sign and auditory/verbal (n=1). Analysis of the first 13 participant’s results indicated that reading (basic skills, vocabulary, and comprehension), phonological processing (awareness, memory and rapid naming) and spontaneous writing (construction and composition) were within the average range demonstrated by the normative sample from the general population. The mean standard score (SS), and standard deviation in parentheses (SD), for the WRMT-3 reading clusters were as follows: Basic Skill=98.5 (17.8); Reading Comprehension=111.6 (19.3); Oral Reading Fluency=101.7 (18.1); and Total Reading Cluster=105.1 (19.3). The mean SS (and SD) for the CTOPP composite scores were as follows: Phonological Awareness=102 (19.3); Phonology Memory=97 (15.5); Rapid Naming=92.6 (8.9); Alternative Phonological Awareness=100 (9.5); and Alternative Rapid Naming=87.5 (4.3). For both WRMT-3 and CTOPP, 100 (+ SD 15) is the average range for the normative groups from the general population. The mean scaled scores (and SD) for the TOWL were: Contextual Conventions=12.7 (2.09); and Story Composition=13.4 (2.59) where 10 (+ 2) is the average range for the normative population. Finally, the mean (and SD) Spontaneous Writing Index was 121.6 (11.5) where 100 (+ SD 15) is the average range for the TOWL normative population.
Conclusion: Preliminary analysis of this small group illustrates what is possible, in terms of long-term literacy outcomes, when infants and young children receive CIs younger than two years of age. Recruitment and testing of more participants is on-going.
Session: S3-2
Abstract ID: 390
Title: Literacy and Related Outcomes: Comparisons Between Children with Cochlear Implants and Hearing Aids
Presenting Author: Sneha Bharadwaj PhD
Author Block:
Sneha Bharadwaj, PhD, Whitney Barlow, MS, Brittany McGeehan, MS; Communication Sciences and Disorders, Texas Woman's Univ., Denton, TX.
Abstract:
Introduction: This study examined reading comprehension skills and factors that are known to be predictive of reading outcomes in children with hearing loss who are in elementary school. A secondary objective was to evaluate group differences in reading comprehension and related predictive factors in children who are hearing aid versus cochlear implant users.
Methods: The participants in this study included 19 children with bilateral hearing loss between the ages of 8 and 11 years and in grades 3rd through 5th. With one exception, all participants were identified with hearing loss before the age of 3 years. Ten children used hearing aids and nine used cochlear implants. All participants used spoken language to communicate and attended a private oral school for children with hearing loss. Over a period of approximately 2 hours, participants were administered a battery of subtests from the following standardized tests: Woodcock Reading Mastery Test, Woodcock Johnson Tests of Cognitive Abilities, Test of Integrated Language and Literacy Skills and Comprehensive Assessment of Spoken Language. The subtests evaluated reading outcome measure (e.g., passage comprehension) and factors that impact reading outcomes (e.g., oral vocabulary, verbal attention, number series, general information, grammatical morphemes, inference, paragraph listening, comprehension, non-word reading and non-word repetition). The standard scores obtained on these subtests were used to assess the children's performance on various subtests as well as for statistical analyses.
Results: Independent samples t tests were conducted to evaluate group differences between the children who use hearing aids and those who use cochlear implants. Data revealed that performance of both groups on reading comprehension and on the factors that impact reading outcomes were largely within normal ranges with the exception of the nonword repetition task. Analyses revealed significant group differences only on non-word repetition task (t(15) = -3.07; p=0.008). Group differences, however, also approached significance for the listening comprehension task (t(15) = -2.087; p=0.054).
Conclusion: These results will be discussed in reference to the role of auditory feedback and auditory deprivation on speech, language and literacy outcomes in children with hearing loss.
Session: S3-3  
Abstract ID: 432  
Title: Effects of Low Frequency Residual Hearing on Music Perception by Older Children  
Presenting Author: Jay Rubinstein, MD, PhD  
Author Block: Mustafa Yuksel, MSc 1, Meg Meredith, MA 2, Jay T. Rubinstein, MD, PhD 1; 1VM Bloedel, Univ. of Washington, Seattle, WA, 2Audiology, Seattle Childrens, Seattle, WA.  
Abstract:  
Introduction: Research with postlingually deafened adults demonstrates that low frequency residual hearing is highly beneficial for pitch and melody perception but less so for timbre perception. Research with prelingually deafened children shows generally poor music perception overall. This study was intended to assess music perception in older children with progressive hearing loss to determine if, as expected, their outcomes were more adult-like  
Methods: Six children with residual contralateral hearing were studied with the UW Clinical Assessment of Music Test. They were assessed in a soundbooth using both their CI and their contralateral hearing in its usual aided or unaided condition.  
Results: In five patients with steeply sloping contralateral residual hearing with good low frequency threshold, pitch and melody perception were better than typical CI users. In one patient who had a flat ~60 dB hearing loss, results were similar to typical CI users. In general timbre perception was not enhanced by residual hearing consistent with studies of postlingually deafened adults.  
Conclusion: When determining whether a patient is a candidate for a second-side cochlear implant, the impact of the possible loss of residual low frequency thresholds on music perception should be considered even if that ear has very poor or no measurable speech perception.
Session: S3-3
Abstract ID: 227
Title: The Role of Music in Families of Children with Hearing Loss in Australia, Finland and the UK
Presenting Author: Bjørn Petersen PhD
Author Block:
Valerie Looi, PhD 1, Ritva Torppa, PhD 2, Debi Vickers, PhD 3, Tania Prvan, PhD 4; 1SCIC - A Service of RIDBC, and Advanced Bionics APAC, Sydney, Australia, 2Department of Psychology & Logopedics, Univ. of Helsinki, Helsinki, Finland, 3Department of Clinical Neuroscience, Univ. of Cambridge, Cambridge, United Kingdom, 4Department of Mathematics and Statistics, Macquarie Univ., Sydney, Australia.
Abstract:
Introduction: This study aimed to evaluate how a hearing loss (HL) impacts a child’s participation and enjoyment of music, and whether parental attitudes for those with hearing impaired children towards music differed to parents with only normally hearing (NH) children. A secondary aim was to evaluate whether this differed between countries.
Methods: The Role of Music in Families Questionnaire (RMFQ) was developed and administered to parents of children aged 2-6 in Australia, Finland and the United Kingdom (UK). There were two groups of participants for each country - families with NH children only (NH group), and families who had a child with a hearing loss (HL group); these children used either hearing aids and/or cochlear implants. In Australia there were 60 in the NH group, 27 in the HL group; Finland: 180 NH, 21 HL; UK: 25 NH; 13 HL. Data was analysed to assess for differences between countries for NH families, and HL families, as well as within countries for the effect of hearing loss (i.e. NH vs. HL).
Results: An ‘overall participation score’ was calculated based on the number of musical activities the children participated in, and the frequency of participation. Initial data analyses suggests that there was no difference between the three countries for the NH children, however for the families of children with HL, the UK children participated significantly less than the Finnish children, with no other significant differences. There were no differences between the NH and HL children in Australia or Finland, however in the UK, the children with HL had significantly lower participation scores than their NH counterparts (p<0.0005). An ‘overall music-enjoyment score’ was calculated by averaging enjoyment ratings (from 1-10; 1=poorest) for 15 activities. Preliminary analyses showed no country differences for either the NH or HL groups, nor any effect of hearing loss within each country. In rating the importance of music in i) their family’s life, and ii) their child’s life, for the NH group only, the UK parents rated music as more important for both than Finnish parents (p=0.004), with no other differences. There were no country differences for the HL group, nor any differences between NH and HL within each country. Overall parental attitudes across all groups in all countries were very positive. A high proportion had purchased musical resources and most reported positive prospects for their child’s future music involvement, and that they would support their children if they wanted to pursue music as a career. There were few differences between the countries, or between the NH and HL groups within each country.
Conclusion: The role of music was relatively similar for families of NH children to those with HL. Parental attitudes to music were very positive, and children’s participation levels were similar. The findings suggest that the role and importance of music in the family does not appear to be negatively influenced if a child has a HL. There were only a few between-country differences, indicating that in general, at least for these three western countries, family involvement and attitudes to music were relatively similar.
Session: S3-3
Abstract ID: 400
Title: Impact of Flat Panel Computed Tomography-Based Cochlear Implant Fittings on Speech, Timbre & Pitch Perception
Presenting Author: Jay Rubinstein MD, PhD
Author Block: Melanie L. Gilbert, AuD, Nicole T. Jiam, MD, Patpong Jiradejvong, MS, Daniel L. Cooke, MD, Charles J. Limb, MD; Otolaryngology-Head & Neck Surgery, Univ. of California, San Francisco, San Francisco, CA.
Abstract:
Introduction: Music perception remains the most difficult listening endeavor for many cochlear implant (CI) recipients, due in part to the frequency mismatch that occurs between the cochlear neural interface and the frequencies allocated by the programming. Due to individual differences in CI users’ ear anatomy, electrode array length, and surgical insertion, great variability exists in CI users’ implants, but these differences are not typically accounted for by current CI programming techniques. Flat panel computed tomography (FPCT) technology has been used in recent years to visualize the location of the electrodes within the cochlea to improve pitch perception.
Methods: In order to assess the impact of FPCT-based CI fittings using custom frequency allocations, we scanned and administered a chronic use study on 12 CI recipients. Subjects used the FPCT-based program for 4+ weeks, and a test battery was administered at the beginning and end of the chronic trial. Speech metrics included words (CNC), vowels (hVd), and consonants (aCa); music assessments, developed by our lab, examined instrument timbre discrimination and puretone pitch scaling. Our fitting methodology involved assigning the center frequency of channels to that of the characteristic frequency (CF) of the corresponding electrodes. During this iteration of the multiphase study, we chose to deactivate electrodes located at CFs >16 kHz, and evenly distribute (logarithmically) the channels for electrodes with CFs from 2 to 16 kHz.
Results: Testing is ongoing; acute and chronic results to be presented during the conference.
Conclusion: Image-guided fitting is a promising tool, although additional research is necessary to identify optimum use of its findings. While the current sample size is small, this study may have significant implications for all CI recipients, and be especially relevant for very young children and special populations. This project and previous work suggests that an image-based approach to CI mapping may improve pitch perception outcomes by reducing pitch-place mismatch. Future studies in pediatric and newly-implanted CI recipients are needed to assess the full potential of personalized image-guided CI fitting strategies.
Session: S3-3
Abstract ID: 229
Title: Objective Measurements of Music Discrimination in Individual Cochlear Implant Users
Presenting Author: Melanie Gilbert AuD
Author Block:
Bjørn Petersen, PhD 1, Anne Sofie Friis Andersen, Medical student 2, Niels Trusbak Haumann, PhD 2, Martin Dietz, PhD 3, Andreas Højlund, PhD 4, Elvira Brattico, Professor, PhD 2, Franck Michel, Technical engineer 5, Søren Kamaric Riis, PhD 6, Peter Vuust, Professor, PhD 2; 1Ctr. for Music in the Brain/Royal Academy of Music, Aarhus Univ., Risskov, Denmark, 2Ctr. for Music in the Brain/Royal Academy of Music, Aarhus Univ., Aarhus, Denmark, 3Ctr. Functionally Integrative Neuroscience, Aarhus Univ., Aarhus, Denmark, 4Ctr. for Functionally Integrative Neuroscience, Aarhus Univ., Aarhus, Denmark, 5Clinic of Audiology, Aarhus Univ. Hosp., Aarhus, Denmark, 6Oticon Med., Smørum, Denmark.

Abstract:
Introduction: The EEG is a non-invasive, silent and objective method which offers the recording of event-related brain potentials (ERPs). The Mismatch Negativity (MMN) response represents a potentially useful tool for an objective, clinical evaluation of auditory discrimination functions at the group level. In individuals, however, the reliability of the MMN still has to be improved. This is particularly true for MMN responses in CI users. With this study, we aimed to test the validity of MMN responses to musical stimuli in individual experienced and newly implanted CI users as well as in normal hearing controls. Furthermore, we aimed to examine the plastic changes involved in the CI adaptation process of recently implanted CI users at both the individual and the group level.

Methods: EEG recordings were carried out using a new musical multifeature MMN-paradigm (CI MuMuFe). The paradigm integrates only deviants and presents no standard stimuli. Deviants in pitch, timbre, intensity and rhythm are embedded in an Alberti bass pattern and presented randomly at four levels of magnitude. Paradigm duration is app. 30 minutes. Eleven experienced CI-users, 7 recently implanted CI users and 14 normal hearing controls underwent EEG-recording while listening to the CI MuMuFe paradigm. Recently implanted CI users were measured twice: shortly after switch-on and again after three months. CI users received sound through direct audio input while NH controls listened through in-ear headphones. CI artifacts were minimized with independent component analysis by removing components with topographical centroids above implant site and waveforms different from ordinary brain activity. A new spike-density component analysis (SCA) method was used to isolate MMN from other brain activity.

Results: We found significant MMN responses to all deviants at all four levels in all of the individual experienced CI users as well as in NH controls. In addition, MMN amplitudes corresponded well with levels of deviation magnitude for > 65 % of NH controls. Except for the intensity deviant, MMN amplitudes of individual experienced CI users were in general less consistent with level hierarchy. MMN amplitudes and latencies exhibited a high level of variance across participants. At the group level, the CI MuMuFe paradigm elicited significant MMN responses across levels in recently implanted CI users at both times of testing. After 3 months of CI experience, the MMN amplitudes were significantly stronger for the pitch and timbre deviants compared to baseline responses. For the rhythm and intensity deviants, MMN responses remained unchanged at the second measurement. Preliminary analyses indicate that MMN responses may also reliably be recorded in recently implanted CI users at the individual level.

Conclusion: The results indicate that the novel musical EEG-paradigm and the new SCA methodology can provide measures of musical discrimination abilities and thresholds in individuals at a rate of reliability which is higher than previously reported. Particularly, the results from experienced and recently implanted CI users are promising and suggest that the methods may be applied in clinical use as a supplementary objective tool for both prognostication and follow-up measurements. This is especially
true for infants and small children with CI, as means for assessing the adequacy of the CI functioning, its improvement as a function of time of CI use, and the efficiency of different rehabilitation procedures.
Session: S3-3  
Abstract ID: 149  
Title: The Sound of Music - Two Novel EEG-Paradigms for Measuring Discrimination of Music in Cochlear Implant Users  
Presenting Author: Valerie Looi PhD  
Author Block:  
Bjørn Petersen, PhD 1, Anne Sofie Friis Andersen, Medical student 1, Niels Trusbak Haumann, PhD 1, Martin Dietz, PhD 2, Andreas Højlund, PhD 2, Elvira Brattico, Professor, PhD 1, Franck Michel, Technical engineer 3, Søren Kamaric Riis, PhD 4, Peter Vuust, Professor, PhD 1; 1Ctr. for Music in the Brain, dpt. of Clinical Med., Aarhus Univ. & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark, 2Ctr. for Functionally Integrative Neuroscience, Aarhus Univ., Aarhus, Denmark, 3Clinic of Audiology, Aarhus Univ. Hosp., Aarhus, Denmark, 4Oticon Med., Smørum, Denmark.  
Abstract:  
Introduction: Music listening with a cochlear implant is challenging due to the lack of temporal fine structure and a limited dynamic range in the CI signal. Hence, a number of ongoing efforts aim to improve music perception with a CI. For this purpose, objective and feasible music tests are in demand. Thus, the aim of this study is to design and validate two novel musical EEG-paradigms for use in future CI research. In a wider perspective, the study aims to investigate whether a novel sound processing strategy implementing output compression may be beneficial for music listening with a CI, as compared to front-end automatic gain control strategies.  
Methods: EEG paradigms 1. The CI Musical Multifeature Mismatch negativity (MMN) -paradigm integrates a new approach in which no standard stimuli are presented. Deviants in pitch, timbre, intensity and rhythm are embedded in an Alberti bass pattern and presented randomly at four levels of magnitude. 2. The Free-listening paradigm uses the Music Information Retrieval toolbox. Hereby, it is possible to investigate the relation between musical features and ERP responses. Here, participants listened to an excerpt of the tango piece Adios Noñino. Neither of the two approaches have previously been tested on CI-users. Participants. Eleven experienced CI-users and 14 normal hearing controls underwent EEG-recording while listening to the paradigms in two different sessions. In addition, they completed a behavioural test for discrimination of the music features and levels also presented in the MMN-paradigm.  
Results: The CI paradigm elicited significant responses to all deviants in both experimental groups, across levels. This indicates both the paradigm’s potential to measure CI-users’ discrimination of details in music and the success of the CI in transmitting them. However, overall MMN responses of CI-users were significantly smaller compared to NH listeners. While NH listeners showed MMN responses that were in accordance with the deviation level magnitude, CI users’ MMN amplitudes were less consistent with level hierarchy, mainly driven by undifferentiated responses to the levels of change in pitch. In the behavioral test, CI-users scored above chance, but significantly below the NH group in discrimination of all deviants, except rhythm. Hit rates corresponded well with levels of magnitude. Free-listening paradigm analyses showed significant N1 og P2 ERPs to increases in spectral flux and loudness in NH controls, but not in CI-users. For spectral flux, however, the N1 response of CI-users was not significantly smaller than that of NH, suggesting basic detection of changes in timbral features of “real music”. The lack of a significant response to increases in loudness may be explained by the strongly reduced dynamic range of the CI sound transmission.  
Conclusion: These results are encouraging indications of the potential of the two novel EEG-paradigms as tools for objective measurements of music discrimination. Despite high complexity, the CI Mumufe MMN paradigm is both accurate and feasible and may provide strong evidence of CI users’ musical discrimination abilities and thresholds. Free-listening paradigm results suggest that inferences of CI-
users’ music perception are possible under conditions that are comparable to their everyday music experience. However, more participants and more analyses are needed to make firm conclusions.
Session: S5-1
Abstract ID: 1015
Title: Slow Skill Emergence: The Role of Counseling and Multidisciplinary Care
Presenting Author: Nancy Young MD
Author Block:
Abstract:
Invited Presentation
Session: S5-1
Abstract ID: 1016
Title: Complex Cases: Multidisciplinary Management
Presenting Author: J. Thomas Roland, Jr. MD
Author Block:
Abstract:
Invited Presentation
Session: S5-1
Abstract ID: 1017
Title: Co-treatment in Complex Cases. The intersection of Audiology and Speech-Language Pathology
Presenting Author: Hannah Eskridge, MS and Pat Roush, AuD
Author Block:
Abstract:
Invited Presentation
Session: S5-1
Abstract ID: 1018
Title: Revisiting Communication Skills from Childhood to Adolescence
Presenting Author: Andrea Warner-Czyz PhD
Author Block:
Abstract:
Invited Presentation
Session: S5-2
Abstract ID: 406
Title: Evaluation of Novel Physiologic Measures to Estimate Cochlear Implant Stimulation Levels
Presenting Author: Jace Wolfe PhD
Author Block:
Jace Wolfe, PhD, Sara Neumann, AuD; Hearts for Hearing, Hearts for Hearing, Oklahoma City, OK.
Abstract:
Introduction: Determining appropriate stimulation levels (e.g., electrical threshold [T level], upper stimulation level [C level, M level, MCL], etc.) is often a challenging task for recipients (such as infants and young children) who cannot provide specific verbal feedback about the auditory stimulation they receive from their cochlear implant (CI). High-density (64-channel) electroencephalography (EEG) may be used to measure the cortical auditory evoked response (CAER). Research with animals and persons with normal hearing has shown that the amplitude of the CAER diminishes across time (a phenomenon known as habituation) when test signals are presented at loudness levels perceived to be soft or comfortable. However, CAER amplitude shows little to no attenuation across time when test signals are presented at loudness levels perceived to be loud or uncomfortable. Additionally, functional near-infrared spectroscopy (fNIRS) may be used to evaluate activity in the auditory areas of the brain in response to auditory stimulation from the cochlear implant. Use of fNIRS to evaluate auditory responsiveness of CI recipients is attractive because fNIRS measurements are not compromised by electrical artifact from cochlear implant stimulation. The objective of this research was two-fold: 1) to determine whether upper stimulation levels of CI recipients may be determined by CAER measures showing a lack of habituation, and 2) to determine whether electrical threshold (T level) may be estimated with the use of fNIRS.
Methods: Twenty CI recipients, ages 7 and older, were evaluated with high-density EEG and fNIRS. High-density EEG measures were used to measure the P1 component of the CAER to trains of pulsatile stimuli presented at levels that were judged by participants to be soft, comfortable, loud, and too loud but not uncomfortable. Additionally, activity in primary and secondary auditory cortices was measured in the hemisphere opposite the cochlear implant with fNIRS when trains of pulsatile stimuli were presented at -20%, 0%, 15%, 30%, 50%, 70%, and 100% of the electrical dynamic range. Results: CAER amplitude habituation was observed when stimuli were presented at levels judged to be soft to comfortable in loudness. In contrast, little to no CAER amplitude habituation was observed when stimuli were presented at levels judged to be loud and too loud. Additionally, activity in the primary and secondary auditory cortices was observed via fNIRS imaging when stimuli were presented within the lower half of the electrical dynamic range. A robust correlation was obtained between behavioral T level and the lowest stimulation level at which auditory activity was measured with fNIRS.
Conclusion: Assessment of habituation of CAER amplitude appears to harbor potential as a physiologic measure that may be used to estimate upper stimulation levels of CI recipients. Assessment of activity in the primary and secondary auditory cortices via fNIRS appears to harbor potential as a physiologic measure that may be used to estimate electrical thresholds (T level) of CI recipients.
Session: S5-2  
Abstract ID: 123  
Title: Clinical Practice Patterns: Advanced Noise Management for Children with Cochlear Implants  
Presenting Author: Ursula Findlen PhD  
Author Block:  
Ursula M. Findlen, PhD 1, Smita Agrawal, PhD 2; 1Clinical Therapies- Audiology Department, Nationwide Children's Hosp., Columbus, OH, 2Advanced Bionics, LLC, Valencia, CA.

Abstract:  
Introduction: A recent survey suggested significant variability in programing and validation practices for cochlear implants (CI) in the pediatric population (Hemmingson & Messersmith, 2018). Despite evidence that adaptive noise management technology benefits children listening in adverse listening situations (Pittman & Hiipakka, 2013; Wolfe et al., 2017), little is known regarding provision of advanced features in programming. The purpose of this study was to identify clinical practice patterns for providing advanced noise management technology for children using CI.

Methods: An electronic survey queried American and Canadian pediatric audiologists with current CI programming experience regarding provision of advanced noise management features from four CI manufacturers. Questions focused on automatic and manual noise management features and the motivating child-specific factors. Information about ages at which features are typically provided and rank ordering of features most important for school-aged children was requested. Dissemination occurred via REDCap through direct e-mailing and social medial posts between August and November 2018. Data analysis was completed through descriptive statistics for categorical questions and content analysis for comment variables to evaluate how comments may qualify discrete responses.

Results: Respondents included 160 audiologists from 35 US states and 5 Canadian provinces. Many audiologists reported providing automatic directional microphones in a patient’s primary program (57.5%); however, some (33.1%) provide them in a secondary manual program. Most audiologists provide automatic advanced signal processing features (ie: automatic noise cancellation, wind noise cancellers, impulse noise cancellers, etc.) in the primary program (74.6%). Some (30.6%) provide these features in a secondary manual program. Most audiologists indicated that advanced signal processing features are provided from activation regardless of age (62.4%), while concha-level microphones and automatic directional microphones are provided by most audiologists at 4 years or older (73.3%). Audiologists report the following child-specific factors are considered for these clinical decisions: 1) chronological/developmental age, 2) cognitive factors related to the ability to switch programs, 3) academic considerations, 4) parental capability/support, 5) the child’s typical listening environments, and, to a lesser extent, 6) duration of experience with the sound processor. Verification of benefit reportedly occurs through speech perception in noise testing (70.9%), while reports from patient/parent (69.4%) or professionals such as TOD, AVT, SLP (57.5%) are also taken into consideration. Only 17.9% reported completing no verification measures.

Conclusion: Multiple factors are considered when providing children with advanced noise management features in CI programming, underscoring the importance of treating the whole child. Although variability in programming practices has been suggested as a possible detriment to patient outcomes (Hemmingson & Messersmith, 2018), results of this study suggest that a customized approach to providing advanced noise management features may be most appropriate. Correlations between practice patterns and provider demographics will be discussed. More research regarding best practices for verifying benefit of advanced noise management features is indicated.
Session: S5-2  
Abstract ID: 73  
Title: Cochlear Implantation for Children with Cochlear Nerve Deficiency: Mapping Characteristics  
Presenting Author: Melissa Auchter AuD  
Author Block: 
Melissa Auchter, AuD 1, Lisa Park, AuD 1, Margaret Dillon, AuD 2, Kevin D. Brown, MD, PhD 2; 1The Children's Cochlear Implant Ctr. at the Univ. of North Carolina, Chapel Hill, NC, 2Univ. of North Carolina, Chapel Hill, NC.  
Abstract:  
Introduction: Cochlear implantation in children with cochlear nerve deficiency (CND) is becoming more common as indications and contra-indications change. As technology develops and we learn more about the capacity of pediatric cochlear implant recipients, children who may have not been considered for a cochlear implant, such as children with CND, are being implanted. Given the potential for anatomical difficulties and the nature of CND, different surgical approaches or electrodes choices are common for this group of patients CITATION Sen17 \ 1033 (Sennaroglu & Bajin, 2017). Despite this, very little is known about optimal programming procedures for this unique patient population as children with CND may experience a higher rate of non-auditory stimulation (e.g. facial nerve stimulation) than conventional cochlear implant recipients.  
Methods: A retrospective review of 56 cochlear implant cases who have been diagnosed with CND was completed. The map characteristics of the group were compared to the manufacturer default settings. The reviewed map characteristics (as applicable) included number of disabled electrodes, pulse width, pulse rate, number of maxima, strategy, map law compression, and input characteristics. Default mapping characteristics were determined based on manufacturer recommendations.  
Results: The maps of the majority (91%) pediatric CND cases were modified from the default settings. Interestingly, 75% of cases have at least one electrode disabled with 23% having at least half of their array disabled. The most common reasons for these electrodes being disabled included facial stimulation, no ECAP on the electrode, extracochlear placement, or lack of sound perception. Map characteristics were then reviewed for specific manufacturers. Forty-five ears were implanted with a Cochlear Corporation device and presented with reduced pulse rates (76% of sample) and wider pulse widths (82% of sample). Nine ears were implanted with a MED-EL Corporation device and presented with the least amount of mapping changes. Only 44% of these children required any mapping change at all with the most common mapping change being the map law compression. There were only 2 children implanted with Advanced Bionics Corporation devices. Both of these children had manual pulse widths that were increased in order to slow the rate.  
Conclusion: Children with normal anatomy typically are programmed within manufacturer’s recommendations for mapping parameters. Children with CND are likely to need changes to these parameters. High pulse widths and reduced rates were commonly seen across subjects as a way to achieve sound awareness and meet compliance limits. They may also require that more electrodes be disabled due to lack of sound percept or in some cases facial stimulation. While some changes such as slower rates are more consistent across this group of patients, other mapping characteristics are highly variable.
Session: S5-2
Abstract ID: 353
Title: Two Different Approaches to Record Electrically Evoked Compound Action Potentials: Comparison of Recording Success, Threshold Determination and Feasibility of Simultaneous Stapedial Reflex Recordings
Presenting Author: Federica Di Berardino MD
Author Block:
Diego Zanetti, MD 1, Eliana Filipponi, Audiologist 2, Sara Cavicchiolo, Speech Therapist 1, Federica Di Berardino, MD 1; 1Audiology Unit, Department of Clinical Sciences and Community Health, Univ. of Milan, Milano, Italy, 2.O.C. Direzione Professioni Sanitarie, Fondazione IRCCS Ca’ Granda Ospedale Maggiore Policlinico Milano, Milano, Italy.
Abstract:
Introduction: Electrically evoked compound action potentials (ECAPs) can be used to monitor neural nerve status or to support adjusting settings of a Cochlear Implant (CI). For deriving specific settings like the maximum stimulation level, stapedius reflex recordings are more suitable. The ECAP threshold, reflecting the minimum stimulation intensity where an ECAP can be detected, is typically derived via two alternative methods: a) By an Amplitude Growth Function (AGF), which plots ECAP amplitudes as a function of the stimulation intensity or b) by manually identifying the first visual ECAP appearance within the recorded curves. Here, we evaluated both definitions with two different ECAP recording approaches: a traditional method where the stimulus is presented in defined steps with manual interpretation of results and a fully automated novel approach were the stimulus is presented in a continuous fashion. The derived success rates and ECAP thresholds were compared. Furthermore, success of simultaneous stapedius reflex recordings was evaluated.
Methods: The study population consisted of 12 paediatric CI users aged between 1-16 years. ECAP recordings were collected with the clinical software MAESTRO at 44Hz stimulation rate and a research software termed “FineGrain” at stimulation rates of 40Hz and 80Hz. The evoked stapedius reflex was recorded during the ECAP recordings.
Results: ECAP recordings showed similarly high (> 90%) success rates across all conditions. Evaluation of individual electrodes revealed higher recording success in the basal region using 80Hz stimulation rate than 40Hz. AGF-Thresholds did not differ between the traditional and novel recordings (for all stimulation rates). First-visual thresholds did diverge: using the traditional method, first-visual thresholds were significantly higher compared with FineGrain at a similar stimulation rate (44Hz and 40Hz). Stapedial reflex recordings showed substantially higher recording success with the traditional approach compared to FineGrain. However, detection of the reflex was more difficult with the continuous stimulation as employed by FineGrain.
Conclusion: ECAP recordings showed comparable results in terms of success and AGF-based threshold determination, but FineGrain was faster: a recording for all 12 electrodes lasted circa 2.5 minutes compared to 4 minutes with the traditional approach, whereby the time to manually inspect the AGF for the traditional method is not included. We believe the FineGrain approach is a reliable and fast replacement for the traditional method in clinical practice for ECAP recordings. For pursuing particular research aims, like simultaneous ECAP and ESRT recordings, FineGrain is not ideal and should be evaluated on a case-to-case basis.
Session: S5-2
Abstract ID: 142
Title: Complex Cases. Complex Programming.
Presenting Author: Jannine Larky AuD
Author Block:
Jannine Larky, AuD 1, Melissa Hall, AuD 2; 1Otolaryngology, Stanford Univ., Palo Alto, CA, 2UF Health Speech and Hearing Center, Univ. of Florida Health, Gainesville, FL.
Abstract:
Introduction: Managing pediatric cochlear implant recipients is certainly rewarding and fulfilling. Managing complex cases, where the outcomes veer widely from expectations can leave even the most experienced clinician stumped. The clinician new to cochlear implant case management and mapping often feels overwhelmed by the technology, how to manage unique and challenging cases and how to identify irregularities and concerns with internal and external equipment. Awareness to possible challenges is important as more traditionally non-cochlear implant centers in outlying and rural areas will take on cochlear implant mapping in order to support patients unwilling or unable to drive long distances to larger implant programs. We will convene a panel of pediatric experts to share their expertise regarding complex cases that required “out of the box” thinking and resolution. Each panelist will present their own case and will also be asked to comment on unfamiliar and challenging cases submitted by others.
Methods: Each clinician on the panel will present a complex case of their own. Following, the chairs will present a case or two to the panel soliciting management recommendations. The number of cases and panelists will depend on the time allotted.
Results: The process for finding a satisfactory resolution to these complex cases will be described. Each process and resulting solution is unique to the case.
Conclusion: Complex mapping cases from a panel of experienced pediatric cochlear implant audiologists will be shared. Cases unfamiliar to the panel of experts will also be discussed.
Session: S5-2
Abstract ID: 257
Title: The Use of Artificial Intelligence (FOX) in Programming the Pediatric Patient
Presenting Author: William Shapiro AuD
Author Block: William Shapiro, AuD, Janet Green, AuD, Susan Waltzman, PhD; Otolaryngology, NYU Sch. of Med., New York, NY.
Abstract:
Introduction: Cochlear implant (CI) technology and techniques have advanced over the years. The only component which has not changed is the programming of the implant devices. The purpose of this study was to compare performance in cochlear implant pediatric subjects using experienced clinician (EC) standard programming methods versus an Artificial Intelligence (AI) based algorithm for programming and evaluation.
Methods: Three adolescents ages 15(S1), 16(S2) and 16(S3) were enrolled in the study. All were full-time cochlear implant users for a period of 12 years, were good performers and had been programmed using traditional programming techniques since implantation. All are auditory/oral and attend mainstream schools. CNC words and AzBio sentences in noise (+10dB SNR) were performed in a sound booth followed by a direct connect psychoacoustic battery using the experienced clinician (EC) program. The subjects were then programmed using the AI technique and sent home with that MAP. Testing was repeated one month later using the optimized AI program. Subjective measures of patient satisfaction were also measured.
Results: Performance for the EC program were compared to the AI program for CNC words and AZ Bio sentences in noise (+10dB SNR). Following one month using the AI program, S1 performed the same for both programming methods. For S2, words scores were equivalent but performance was better for sentences in noise using AI technique. S3 performed better with AI programming on both word and sentence tests. S1 and S2 preferred the AI program immediately while S3 required a period of adjustment despite the better performance on word and sentence tests. All three continue to use the AI programs.
Conclusion: The study demonstrated that performance using the AI technique were equivalent to or better than performance using traditional programming methods in these adolescent subjects. In addition, use of AI for programming and evaluation allows for standardization across centers and fewer appointments thereby saving time and increasing access for many individuals who could benefit.
Session: S5-2  
Abstract ID: 369  
**Title:** Evaluation of a Novel Algorithm to Optimize Audibility in Cochlear Implant Recipients  
**Presenting Author:** Amy Stein AuD  
**Author Block:**  
**Abstract:**  
**Introduction:** A positive relation between audibility and speech understanding has been established for cochlear implant (CI) recipients. Sound-field thresholds of 20 dB HL across the frequency range provide CI users the opportunity to understand soft and very soft speech. However, programming the sound processor to attain good audibility is time consuming and difficult for some patients. To address both issues, a novel noise gate algorithm was developed. The present studies aimed to evaluate the efficacy of this algorithm in optimizing CI recipients’ audibility and soft speech understanding.  
**Methods:** Two studies were conducted, Study 1 and 2. Study 1 consisted of Study 1A and 1B. Sixteen adult, CI recipients participated in Study 1A. Acute testing was performed using a sound processor programmed with participants’ preferred everyday-use program (Everyday) and that same program but with the noise gate algorithm applied (Noise Gate). Speech recognition measures were administered in the unilateral CI condition at several presentation levels in quiet (35 - 60 dB SPL) and in noise (60 dB SPL). In Study 1B, ten of the participants compared Everyday and Noise Gate at home to obtain feedback regarding use of the Noise Gate program in various environments. During Study 2, soft-speech perception was acutely measured with Everyday and Noise Gate for ten of the participants using a newer-generation sound processor. Results with the two processors. Additionally, Study 2 examined and evaluated programming options (electrode T-level settings or Ts) thought to improve the usability of the Noise Gate programs in daily life.  
**Results:** Study 1A showed significantly higher scores with Noise Gate than Everyday at soft presentation levels (35, 40, 45 and 50 dB SPL) and no significant differences between programs in quiet or in noise at conversational levels (60 dB SPL). After take-home experience with Noise Gate and Everyday, five of ten Study 1B participants reported preferring Noise Gate over Everyday; however, six reported bothersome environmental sound when listening with Noise Gate at home. Results of Study 2 indicated similar soft-speech perception between different generation sound processors. In addition, programming Noise Gate with Ts at the manufacturer’s default setting of 10% of Ms reduced participants’ reports of bothersome environmental sound during take-home experience; conversely, soft-speech perception was best with Noise Gate when Ts were behaviorally set above 10% of Ms.  
**Conclusion:** Noise Gate has the potential to be a useful tool in optimizing CI users’ audibility and in turn, soft speech perception, especially when behaviorally setting Ts is not an option. The small number and above average performance of participants and their long-term use of raised T-level programs may have influenced results. Employing more participants and those using a variety of T-levels in their Everyday program as well as exploring programming parameters that may benefit soft-speech perception when used in combination with Noise Gate (e.g., increased IDR) may clarify findings.
Session: S5-2  
Abstract ID: 158  
Title: Protocol for Measuring the Electrically-Evoked Compound Action Potential in Children with Cochlear Nerve Deficiency  
Presenting Author: Shuman He MD, PhD  
Author Block:  
Shuman He, MD, PhD 1, Angela Pellittieri, AuD 1, Xiuhua Chao, MD 2, Lei Xu, MD 2, Holly F. B. Tealge, AuD 3, Lisa Park, AuD 4, Kevin Brown, MD, PhD 4, Michelle Shannon, AuD 5, Cynthia Warner, AuD 5, William Riggs, AuD 1; 1Otolaryngology - Head and Neck Surgery, The Ohio State Univ., Columbus, OH, 2Otolaryngology - Head and Neck Surgery, Shandong ENT Hosp., Jinan, China, 3Department of Audiology, The Univ. of Auckland, Auckland, New Zealand, 4Otolaryngology - Head and Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC, 5Audiology, Nationwide Children's Hosp., Columbus, OH.

Abstract:  
Background: Prolonged pulse-phase durations and high stimulation levels are often used in implanted children with cochlear nerve deficiency (CND) as a combined result of the lack of guidance for selecting these parameters, the absence of reliable behavioral responses, and the overall poor responsiveness of these patients to electrical stimulation of the cochlear implant (CI) (Teagle et al., 2010; Buchman et al., 2011). Both of these manipulations substantially increase the likelihood of electrical artifact contamination on electrically-evoked compound action potential (eCAP) responses, making measuring the eCAP in these patients challenging. In addition, results of our previous study (He et al., 2018) suggest that the hypoplastic CN requires longer time to recover from refractoriness than the normal-size CN, and children with CND seem to have better neural survival at the basal end of the cochlea than the apical end. As a result of these two unique biological characteristics in children with CND, modifications in eCAP testing parameters are required. This study reports a newly developed protocol for measuring the eCAP in children with CND.

Methods: There were 50 implanted children with CND who were included in this work. All of these children were Cochlear® Nucleus™ CI users. Their clinical diagnosis of CND was based on results of MRI scans interpreted by the implanting surgeon. The eCAP was measured using the Advanced Neural Response Telemetry (NRT) function implemented in the Custom Sound EP commercial software from multiple CI electrodes using parameters that were optimized for individual patients.

Results: Key stimulating and recording parameters for eCAP measures are described. The protocol includes three recommended steps: initial screen, optimize pulse phase duration, and determine the lowest stimulation level that can evoke the eCAP.

Conclusions: The eCAP can be measured successfully in children with CND after adjusting and optimizing stimulating and recording parameters following the general idea presented in this protocol.
Acoustic Component Programming in Children with Cochlear Implants Using Electrocochleography

Presenting Author: Sarah Coulthurst MS

Author Block:
Sarah Coulthurst, MS 1, Smita Agrawal, PhD 2, Kanthaiah Koka, PhD 2; 1UCSF Benioff Children’s Hosp., Oakland, CA, 2Advanced Bionics, LLC, Valencia, CA.

Abstract:
Introduction: Evaluating, programming and ensuring benefit in a difficult pediatric population brings great challenges to centers serving young children with cochlear implants. Objective measurement could help streamline appointments and improve reliability and effectiveness of CI programming for our patients. In cochlear implant patients with preserved residual hearing, intra-cochlear electrode/s from the implant array can be used to measure electro-cochleography (ECoG) thresholds in response to acoustic pure tone stimuli. The cochlear microphonic (CM) portion of the ECoG response has been shown to correlate with pure tone audiometric thresholds in adult cochlear implant recipients with residual hearing. The goal of the present study was to determine if the CM thresholds can be used to obtain reliable targets for fitting the acoustic component to the implanted ear.

Methods: To date, 7 children (aged 12 months to 15 years, 8 ears) implanted with Advanced Bionics HiFocus Mid-Scala electrode array have been studied. Candidacy criteria included capability of providing subjective feedback and reliable speech testing. Behavioral thresholds were measured via routine audiometry (warble tones, insert ear phones). ECoChG thresholds were recorded using apical-most electrode of the implanted array in response to calibrated acoustic pure tones presented at 75-110 dB HL in a non-sound treated programming room. Age and language appropriate speech outcomes and subjective feedback were obtained.

Results: Significant benefit was observed when using both acoustic and electric input as compared to electric only. After successful use of this behavioral threshold fitting for at least 3 months, children were refit using ECoChG thresholds. A comparison of outcomes across the two fitting methodologies shows equivalent speech understanding and subjective acceptance.

Conclusion: Our data suggest that ECoChG can be used to measure and monitor residual hearing in pediatric CI recipients and to reliably fit the acoustic component. This methodology is not meant to replace behavioral clinical methods but to supplement the fitting process.
Session: S5-3  
Abstract ID: 124  
Title: Lessons From 18 years of Longitudinal Data in an Inclusive Educational Model  
Presenting Author: Meredith Ouellette MS  
Author Block:  
Meredith Ouellette, MS 1, Sharlene Ottley, PhD 1, Nancy Mellon, MA 1, Christine Mitchell, ScM 2; 1The River Sch., Washington, DC, 2Bloomberg School of Public Health, Johns Hopkins, Baltimore, MD.  
Abstract:  
Introduction: Many children with cochlear implants (CIs) face social and academic challenges in the classroom. Inspired by statistics regarding deficient literacy skills for children with hearing loss (Marschark et al., 2007), and the important role that the literacy environment can play in children’s acquisition of skills, we developed an early literacy preschool program to help children with CIs gain age appropriate language, social, and academic skills alongside hearing peers. Educational programs that include children with CIs with hearing peers must consider a range of factors that influence educational outcomes in children who have experienced early auditory deprivation and consequent language delay. Our model uses an SLP as a co-teacher in each classroom and embeds early literacy and social emotional opportunities into the curriculum and classroom activities. Children benefit from explicit teaching of vocabulary, phonology and other early literacy skills and from natural opportunities to hone their communication skills during everyday interactions with peers and teachers. Over the past 18 years, comprehensive speech and language evaluations have been administered biannually. Our data indicated a 3-to 5-year intervention interval for full rehabilitation of children undergoing early implantation (under 12 months) and education in our program. For those on the longer trajectory, factors such as Childhood Apraxia of Speech and delayed sequential processing skills have been identified as variables. Other variables include other cognitive factors, SES/parent education, age at intervention and duration of deafness.  
Methods: The Kaplan-Meier survival function estimated the median time to achieve age-appropriate scores for each of three outcomes (vocabulary, core language, and pragmatic language). Vocabulary: Peabody Picture Vocabulary Test (PPVT) and the Receptive One-Word Picture Vocabulary Test (ROWPVT). Core language: Core Language Scores from the Comprehensive Assessment of Spoken Language (CASL) and the Clinical Evaluation of Language Fundamentals (CELF) or Clinical Evaluation of Language Fundamentals - Preschool Edition (CELF-P).Pragmatic Language: Test of Pragmatic Language (TOPL) and Pragmatic subtest of the CASL. Academic Achievement: Wide Range Achievement Test (WRAT).  
Results: Longitudinal assessment will provide context for adjustments to elements of our model. In our study, of 88 students with vocabulary scores, 77.2 % achieved age-appropriate scores during the follow-up period; median time to age-appropriate scores was 20 months post-activation. Of 75 students with core language scores, 65.6% achieved age-appropriate scores during the follow-up period; median time to age-appropriate scores was 31.1 months post-activation. Of 56 students with pragmatic language scores, 80% achieved age-appropriate scores during the follow-up period; median time to age-appropriate scores was 30.1 months post-activation. Preliminary data from reading, spelling, and math scores on the WRAT administered at K and 2nd grade, compared to normative data, indicate 95.2% within age-appropriate level by Kindergarten for Word Reading, 92.9% within average for Spelling, and 95.2% within average for Math on the WRAT.  
Conclusion: Data indicate a 3-year intervention interval for rehabilitation of children with CIs in our inclusive model. For those who take longer to reach age norms, supports have grown broader in scope and more individualized.
Session: S5-3
Abstract ID: 190
Title: Impact of Age of Enrollment in Highly Specialized Listening and Spoken Language Intervention Programs on Speech and Language Skills by Pediatric Cochlear Implant Users
Presenting Author: Tamala Bradham PhD, DHA
Author Block:
Tamala S. Bradham, PhD, DHA 1, Christopher Fonnesbeck, PhD 2, Barbara Hecht, PhD 3; 1Quality, Safety, Risk Prevention, Vanderbilt Univ. Med. Ctr., Nashville, TN, 2Department of Biostatistics, Vanderbilt Univ. Med. Ctr., Nashville, TN, 3Clarke, Boston, MA.
Abstract:
Introduction: Early hearing detection and intervention are essential steps toward management of children with hearing loss. Evidence suggests that children with hearing loss can achieve language abilities similar to hearing peers if identification by 6 months and intervention services by 11 months are received. To further underscore the importance of early intervention, a recently published paper concluded that young children with hearing loss had significantly higher vocabulary scores when they met the Early Hearing Detection and Intervention (EHDI) 1-3-6 guidelines versus those who did not. No studies, however, have examined the impact of early age of enrollment in highly specialized therapy and instruction programs dedicated to developing listening and spoken communication and speech, vocabulary, and language outcomes of children with hearing loss. The purpose of this study was to examine the impact of early age of enrollment of intervention by highly qualified professionals and educators on articulation, expressive and receptive vocabulary, and expressive and receptive language skills of 4-and 5-year-old children with hearing loss with cochlear implants.
Methods: Participants for this presentation were drawn from a population-cohort who participated in an international data repository project that started in 2010. There are approximately 1,800 4-year-old and 1,400 5 year-old children with hearing loss enrolled in a highly specialized intervention program focusing on developing listening and spoken language. Demographic information (audiological, child- and family-related, and service provisions related variables) and assessment data measuring expressive and receptive language, expressive and receptive vocabulary, and articulation were collected. Percentages for the population characteristics were calculated based on nonmissing values. Standard scores from assessments in each domain were “normalized” using the same protocol used in LSHSS (2018), in order to compare standard scores across different measures of language.
Results: Standard scores for each outcome measure across age ranges were analyzed using a series of regression models that evaluate the impact of each factor on the standard score in a given speech, vocabulary and/or language domain. Forest plots were used to graphically display the estimated results for each variable and its contribution to the speech, vocabulary, and language outcomes. This study will discuss differences in speech, language, and vocabulary outcomes between the two groups, those who received their highly specialized intervention in listening and spoken language by 6 months of age and those who started their intervention after 6 months of age, and the demographic variables associated with these differences. Data is currently being cleaned and analyzed and will be ready for July conference.
Conclusion: Comparing outcomes for children with cochlear implants who receive highly specialized intervention by 6 months of age versus afterwards has helped increase better understanding of how the intervention environment with qualified professionals relate to the development of listening and spoken language in children with hearing loss. Data from this study will be presented and discussed in terms of timing of early intervention services.
Session: S5-3
Abstract ID: 40
Title: Visual Prosody to Improve the Expressive Reading of Readers with a Hearing Loss
Presenting Author: Maarten Renckens PhD Candidate
Author Block:
Maarten Renckens, PhD Candidate Media, Arts & Design, Hasselt Univ., Hasselt, Belgium.

Abstract:
Introduction: Spoken language conveys information in multiple layers: namely content and prosody. Content transfers a message between individuals. Prosody is the ‘music of speech’, produced by variations in loudness, duration and pitch of the voice. Prosody forms questions, statements and emphasis. Depending on the used prosody, the meaning of the content can change. In the example ‘That old man cannot understand you very well’, an emphasis placed on ‘cannot’ or on ‘you’ changes the meaning. Therefore, the expressiveness of the voice is important in understanding the exact intention of the narrator. Children with a hearing loss encounter more difficulties with the correct development of their speech compared with normal hearing children, even with hearing aids and cochlear implants. This includes speech prosody. Extra speech therapy is useful in this case. An improved visualization of prosody is developed to support the reading aloud with more prosody.

Methods: Speech variations have no representation in text, resulting in text that does not fully indicate the intended meaning. Typographic adjustments by means of typeface variations have been developed previously, to illustrate and to practice speech prosody. Proving that text can offer possibilities to display the missing prosodic information, the typographic adjustments visualize speech prosody, adding the extra layers of information on top of the text. In 2015, new research has been executed to test improved visualizations of the speech components aimed at beginner readers with a normal hearing. Beginner readers often read with less expression. A louder voice was visualized by a bolder font, a slower voice by an extended font and a higher pitch by a higher placed typeface. Those parameters had the intended impact on the vocalization while reading the prosodic cues aloud. In the current project, aiming at children with a hearing loss, all speech components were visualized by means of prosodic cues: loudness (louder/softer by a bolder/lighter font), duration (faster/slower/pause by an extended/condensed font or an enlarged space), pitch (higher/lower by a font raised or lowered from the baseline). This is the first time that the seven abstract speech features are visually represented and tested. 35 readers with a hearing loss from 8 till 18 years old participated and read the presented prosodic cues aloud. The vocalization of the participants was recorded and analyzed to determine the amount of variation in loudness, duration and pitch.

Results: The prosodic cues intended for a louder, softer, slower, higher voice and a pause proved to be effective stimuli for the intended speech variation while reading aloud. The prosodic cues intended for a faster voice and a lower voice showed a trend towards the intended speech variations while reading aloud. However, those results are not significant.

Conclusion: The results indicate that these prosodic cues in type design could be suited for the training of prosodic speech variations during speech therapy for readers with a hearing loss aged 8 to 18 years. The prosodic cues prove to have a low threshold and are easy to understand. Most participants read the prosodic cues correctly aloud. The results show that typographic design research can have a positive influence on the reading aloud. This research has several possible applications such as speech therapy, learning applications and opens novel pathways into future research concerning voice therapy.
Session: S5-3
Abstract ID: 318
Title: Building Professional Capacity to Support Families Before and After Cochlear Implantation
Presenting Author: Wendelyn DeMoss MS LSLS Cert AVT
Author Block:
Wendelyn DeMoss, MS, LSLS Cert AVT, Teresa Caraway, PhD, LSLS Cert AVT, Marge Edwards, MS, LSLS Cert AVT;
Hearing First, Oklahoma City, OK.
Abstract:
Introduction: Current research indicates that early cochlear implantation can significantly improve outcomes for infants and young children identified as deaf or hard of hearing. As such, professionals must be held to a high standard of care to ensure every child is making adequate listening and spoken language (LSL) progress with their cochlear implant technology. Yet, many professionals lack basic knowledge and skills about cochlear implant (CI) technology, assessment of listening progress and LSL strategies for working with children before and after cochlear implantation. The Professional Learning Community (PLC) was developed to provide an accessible LSL connection point across the career journey for professionals to have immediate and ongoing access to peers and thought leaders in the LSL field. The PLC offers a digital ecosystem to 1) Increase the number of qualified professionals providing services to children with cochlear implants and their families and 2) provide professionals with the necessary knowledge and skills to guide and coach families of children who are deaf or hard of hearing before and after cochlear implantation.
Methods: The PLC offers knowledge and skills-based learning experiences led by LSL thought leaders on key topics including but not limited to: hearing technology, speech acoustics, assessment of infants and children, working with babies before and after cochlear implantation, parent coaching, early intervention and listening and spoken language strategies. Learning experiences are designed in a blended, “Seek-Sense-Share” model that establishes a high level of learner engagement whereby professionals expected to apply the learning to real practice. Learning experiences are specifically designed to meet current best practices in listening and spoken language for children before and after cochlear implantation.
Results: To date, the PLC has offered 19 structured virtual learning experiences for which over 2100 professionals have registered and participated in 57 learning sessions to further their LSL knowledge and skills specific to providing services for children with cochlear implants and their families. In addition, 30 professionals current participate in a LSL mentoring program. This session will explore the blended Seek-Sense -Share learning model, reach, outcomes of professional learning to date and the extent to which learners have applied new skills in their practice to improve the outcomes children with cochlear implants.
Conclusion: The PLC was developed in response to a critical shortage of professionals qualified to meet the needs of an ever increasing number of infants and young children who are candidates for or who have cochlear implants. The community offers an accessible online learning hub for professionals from a variety of disciplines, across the career journey. The digital ecosystem has enabled an increasing number of professionals to engage in a variety of learning opportunities to better support families in facilitating their child’s listening and language before and after cochlear implantation.
Session: S5-3
Abstract ID: 99
Title: Read Up: Reading Achievement in Children with Hearing Loss in a Listening and Spoken Language Program
Presenting Author: Elaine Smolen MAT, LSLS Cert AVEd
Author Block:
Elaine R. Smolen, MAT, LSLS Cert AVEd 1, Maria Hartman, PhD 1, Ye Wang, PhD 1, Ronda Rufsvold, PhD, LSLS Cert AVEd 2, Monica Dorman, MS, LSLS Cert AVEd 3, Jessie Ritter, MA, LSLS Cert AVEd 3; 1Health and Behavior Studies, Teachers Coll., Columbia Univ., New York, NY, 2CCHAT Ctr., Sacramento, CA, 3Sunshine Cottage Sch. for Deaf Children, San Antonio, TX.
Abstract:
Introduction: Historically, children with hearing loss graduate high schools for the deaf with a fourth-grade reading level, a statistic that has not changed significantly over years of research (e.g., Karchmer & Mitchell, 2003). This severe reading delay limits the ability of many children with to “read to learn” and thus impacts their global academic development. Children whose families speak a language other than English, including those of Latinx origin who speak Spanish, have also historically experienced challenges in acquiring English literacy (August & Shanahan, 2006). Children with hearing loss who use listening and spoken language have access to spoken phonology and might have higher reading skills than students from schools included in the “fourth-grade” statistic. Recent research, in fact, found no significant difference in reading comprehension and word-reading skills between eight-year-olds with typical hearing and their hard-of-hearing peers who listened and talked (Tomblin et al., 2018). This study extends existing research to incorporate children with all degrees of hearing loss, including deaf students with cochlear implants.
Method: Researchers partnered with speech-language pathologists and teachers of the deaf at a large school for children with hearing loss in the Southwestern United States. Sixty students with hearing loss in prekindergarten through grade 3 (ages 4 through 10 years) participated. Over 60% of participants’ families identified as Latinx or Hispanic and/or spoke primarily Spanish in the home. The participants’ reading skills were assessed using eight subtests of the Woodcock-Johnson IV Tests of Achievement (WJ IV), including measures of letter-word identification, word attack, passage comprehension, fluency, and vocabulary. Each student’s performance on yearly assessments of language, vocabulary, and speech production from prekindergarten onward was also collected, as was demographic information.
Results: Most participants with hearing loss performed within or above the average range (defined as a standard score of 85 or higher) based on the WJ IV’s norms for children with typical hearing. About 80% of participants demonstrated age-appropriate skills in general reading, letter-word identification, spelling, passage comprehension, and reading vocabulary. Fewer (68%) had an average or better reading rate, while fewer still (51.67%) demonstrated age-appropriate sentence- and word-reading fluency.
Conclusion: Results of this study show that children with hearing loss, including those with cochlear implants, can attain general reading skills commensurate with their hearing peers with the support of a listening and spoken language elementary program. These children generally capitalize on their auditory access to excel at spelling, vocabulary, letter-word identification, and other skills requiring phonological awareness. More children in pre-k and kindergarten demonstrated reading delays than did those in the later grades, suggesting that an intensive elementary program can help close the reading gap with hearing peers. However, many older students experienced challenges with an often-overlooked area of reading instruction: fluency at both the single-word and the sentence level. Implications for practice and preliminary results of a longitudinal analysis of predictors of reading success will be discussed.
Abstract:

**Introduction:** Children who are deaf/hard of hearing (DHH) can develop listening and spoken language (LSL) when they are identified early, have optimum auditory access, and receive high quality LSL intervention from professionals who have expertise in developing LSL skills. Language proficiency and readiness to enter a general education preschool at 3 years of age is dependent on multiple factors including quality and quantity of intervention. Some children need continued support during the preschool years. These children can participate in highly specialized LSL intervention programs that have a multidisciplinary team of providers to implement evidence-based LSL strategies that facilitate language and literacy skills. A consortium of these highly specialized LSL intervention programs has developed quality standards for the programs, which are currently being validated. To capture the language outcomes of children who attend these focused intervention programs this presentation will share key features of the standards as well as language outcomes of 3 to 5 year old children who have attended the programs.

**Methods:** Participants for this presentation were drawn from a population who participated in an international data repository project that started in 2010. Data permission was obtained to examine vocabulary (n=371) and language outcomes (n=180) from standardized assessment of the children who are DHH at age 3, 4, and 5, who did not demonstrate optimum skills to enter a general education preschool classroom at 3 years of age. Approximately 40% of participants started LSL intervention before 18 months and another 40% between 19-36 months. Approximately 40% of the participants used bilateral cochlear implants while 40% used bimodal hearing technology. Approximately 20% of the children in this sample are children whose learning was impacted by other factors, including additional disabilities, pre-maturity, and early trauma including adoption.

**Results:** Vocabulary scores of 371 participants, as measured by two sets of standardized assessments, Receptive & Expressive One-Word Picture Vocabulary Test (n = 256) and Peabody Picture Vocabulary Test & Expressive Vocabulary Test (n = 125) were analyzed. On average, receptive and expressive vocabulary scores improved over time. At age 3 approximately 50% of the participants were within the average range, but by age 5 approximately 75% were within the average range. Connected language scores of 180 participants, as measured by two standardized assessments, Clinical Evaluation of Language Fundamentals - Preschool; (n = 108) and Oral Written Language Scales (n = 72) were analyzed. On average, language scores improved over time. At age 3 years, less than 25% of the participants were within the average range, but by age 5 years, approximately 50% were within the average range.

**Conclusion:** Early childhood programs that provide specialized, evidence-based LSL intervention in adherence to the quality standards set forth by the consortium of programs, promote development of spoken language in children who are DHH. In this data sample, a majority of children who were DHH demonstrated age-appropriate vocabulary and spoken language skills at age 5, indicating that they had
“caught up” to their hearing peers. Even though some children did not achieve age-appropriate language scores by age 5 all children demonstrated improvement in language proficiency.
Session: S5-3
Abstract ID: 364
Title: Analysis of Factors Influencing Early Postoperative Pediatric Cochlear Implant Data Logging
Presenting Author: Mallory Raymond MD
Author Block:
Mallory Raymond, MD 1, Cinzia Marchica, MD 1, Jolie Fainberg, MA 2, Kavita Dedhia, MD 1; 1Otolaryngology, Emory Univ., Atlanta, GA, 2Atlanta Speech Sch., Atlanta, GA.
Abstract:
Introduction: Early hearing restoration is crucial for appropriate language development in children with hearing loss (HL), and there is an abundance of evidence supporting cochlear implantation (CI) for this purpose. The recommended daily use of CI is between 8-10 hours, yet not all children achieve this goal. Data logging offers an opportunity to objectively examine the “on-time” of CI users, identify risk factors for poor use and direct future care.
Methods: We performed a retrospective chart review of pediatric CI performed at a tertiary care pediatric hospital between January 2014 and December 2017. Pediatric patients (<18 years) with no prior history of CI and recorded data logging were included. Data collection included: demographics, age of initial HL diagnosis and amplification, age of CI, implant device and laterality, and initial 2 years of data logs post-implantation. Average device “on-time” was calculated for postoperative intervals of 0-6, 6-12, and 12-24 months by weighting logged times based on the interval over which the device had been measured. Fisher exact and spearman correlation tests were used to analyze patient characteristics associated with average daily “on-time” of ≥ 8 hours.
Results: Twenty-one patients (29 ears) met our inclusion criteria. Fifty-seven percent were female, 24% had developmental delay, 43% were ethnic minorities and 62% had government-sponsored insurance. The average age of HL diagnosis was 7.7 months (range: 1-24), with initial amplification occurring on average at 10.4 months (range: 1.5-60). CI occurred on average at 42 months (median: 12, range: 10-191). Data logs were available for 24, 16 and 15 ears for the 0-6, 6-12, and 12-24 month intervals respectively. The average “on-time” for the three postoperative intervals was 7.6 hours (range: 2.4-16), 8 hours (range: 3-16.6), and 5.9 hours (range: 1.3-15.1). The percentage of patients with an average of at least 8 hours/day of “on-time” decreased from 58% to 50% to 30% over the two years. There was no statistically significant association between age at HL diagnosis, age at initial amplification, age at initial implantation, gender, developmental delay, or ethnicity and “on-time” average over any of the postoperative periods. However just 38% of the ears of patients with government-sponsored insurance compared to 82% with private insurance had an average “on-time” of 8 or more hours daily in the first 6 months (p = 0.047).
Conclusion: Most patients in our cohort received at or near the recommended daily CI “on-time” use. Over the two-year postoperative period, however, there was decline in use. While many patient factors did not correlate with average daily use, having government-sponsored insurance may predict early poorer daily use. Larger sample sizes are needed to further characterize the role of insurance and socioeconomic status on average daily use and evaluate for potential barriers to care.
Session: S5-3
Abstract ID: 168
Title: Peer Interaction and Language Development in an Intervention Classroom for Children with Hearing Loss
Presenting Author: Lynn Perry PhD
Author Block:
Lynn K. Perry, PhD, Samantha G. Mitsven, BA, Stephanie A. Custode, MA, Daniel S. Messinger, PhD; Psychology, Univ. of Miami, Coral Gables, FL.
Abstract:
Introduction: Children with hearing loss (HL) are quite heterogeneous with respect to their language development outcomes. Although cochlear implants (CI) or hearing aids (HA) can ameliorate the effects of HL, many children using these devices still exhibit delays in oral language development. Many children with HL attend intervention schools featuring curricula focused on improving their oral language skills. However, to our knowledge, there is no research investigating the contribution of peer input on language outcomes in these programs. Furthermore, despite the considerable attention that has been paid to their parental input, there is also relatively little research on the impact of peers on TH children’s language development. Given that many intervention programs utilize an inclusion model, with typically hearing (TH) peer models enrolled alongside children with HL, this represents a critical gap in the literature. Thus, here we employ a big data approach to modeling the role of social contact and peer input on children’s vocalizations in an oral language inclusion program for children with HL and TH.
Methods: Data were collected weekly over ten consecutive weeks in an inclusive oral language intervention classroom of seven children with HL (5 with CI; 2 with HA) and three TH peers (Mage<sub>sub</sub>=37 months). Continuous, objective measurements of infants’ location and orientation were collected using the Ubisense system. Periods of social contact were defined as instances where children were oriented towards one another and within 1.5m of each other, a distance at which co-location occurs more than would be expected by chance. Infants also wore Language ENvironment Analysis (LENA) audio recorders, allowing for automated analysis of day-long vocal recordings. Synchronized LENA and Ubisense measurements indicated when infants were in social contact and vocalizing.
Results: Children with HL tended to produce fewer vocalizations than those with TH, t(9)=2.91, p=.009. Similarly, a comparison of the rate of vocalizations children made while in social contact with their peers revealed those with HL were also less likely to vocalize in social contact than children with TH, t(9)=2.83, p=.001. Furthermore, there were no group differences in the amount of vocalizations children heard from their peers while in social contact, p>.10, suggesting that although children with HL vocalize less than their TH peers do, both groups interact with peers at similar rates and are exposed to similar amounts of peer input. Next, we examine what consequences this input has on children’s own vocalizations and development. The more input children heard from their peers, the more they subsequently vocalized to those peers. Linear mixed effects models revealed a significant effect of peer input on children’s vocalizing during the following observation, X 2(1)=12.20, p=.0005. Additionally, there was no effect of their own previous vocalizations, nor any effect of hearing status, ps>.10, when peer input was included in the model.
Conclusion: Together these results suggest peer input is a better predictor of children’s future vocalizations than either their own previous vocalizing or their hearing status. This study highlights the importance of peer interaction and vocal input on children’s language development and motivates the presence of TH peer models in inclusion classrooms for children who use CI or HA.
Session: S6-1
Abstract ID: 61
Title: Let’s Meet Outside the Box: Collaborative Efforts for Optimizing Technology
Presenting Author: Jolie Fainberg MA, Audiology
Author Block:
Jolie Fainberg, MA, Audiology, Sylvia Rotfleisch, MSc, LSLS AVT; 1Clinic, Atlanta Speech Sch., Atlanta, GA; 2Hear to Talk, Los Angeles, CA.
Abstract:
Introduction: Many of the children we work with are using sophisticated hearing aids or cochlear implants. However, though it seems that all the pieces are there, we can’t put the puzzle together and the child isn’t making the expected progress.
Methods: This presentation looks at the “missing puzzle pieces” and how critical information about auditory skills allows the audiologist to optimize the technology settings. We will identify typical areas of difficulty in auditory abilities, speech perception and production and language development as determined by the listening specialists and how the audiologist is able to adjust the programming to address the problem areas. Through case studies the audience will learn to identify areas of difficulty and analyze the acoustic parameters of this information.
Results: Discussion will address how to share the information with the team members so that the child can maximize their potential. Professionals will be guided to think in an analytic way to be innovative, spearhead progress and just ignore the box!
Conclusion: Audiologist and SLP/AVT can work together to optimize the cochlear implant and hearing aid technology for children. This relationship is critical in managing the speech and language outcomes for these children.
Session: S6-1  
Abstract ID: 93  
Title: Benefits of Early Acoustic Hearing for Speech Perception and Language in Pediatric Cochlear Implant Recipients  
Presenting Author: Ann Geers PhD  
Author Block:  
Ann Geers, PhD, Lisa Davidson, PhD; Otolaryngology, Washington Univ., St. Louis, MO.  
Abstract:  
Introduction: The primary aim of our current project is to determine the degree to which a period of hearing aid (HA) use facilitates language development in children following the receipt of their first cochlear implant (CI). Specifically, we seek to determine critical threshold levels and duration of HA use that should be applied before proceeding to bilateral CIs (BCI). Although CIs support high levels of phoneme perception (segmental) necessary for word recognition, the contribution of suprasegmental perception (i.e. stress, pitch and prosody) that bootstraps language development may be lacking, partly due to reduced frequency resolution of current CIs. We hypothesize that early exposure to some suprasegmental cues via a HA may facilitate more rapid language acquisition for children with CIs compared to their peers with less acoustic experience.  
Methods: We have tested 117 pediatric cochlear implant recipients ranging in age from 5-8 years (mean age 7 years, SD 1.25) on tests of speech perception, receptive vocabulary and language. The speech perception test battery includes word recognition in quiet and noise (segmental perception) and talker and stress discrimination as well as emotion identification (suprasegmental perception). Standardized tests of receptive vocabulary and language are included (Peabody Picture Vocabulary tests; PPVT and Clinical Evaluation of Language Fundamentals; CELF). A continuum of residual hearing levels and length of HA use are represented by children with bimodal devices (CI+HA; N=29) who have longer periods of HA use and better acoustic hearing; others have received their second CI (2CIs) either simultaneously (N=23) or sequentially (N=65) at varying time intervals since their first CI (CI interval mean 13.45 months; SD 11.42 months) and had some prior acoustic hearing experience. The mean age at first (or only) CI was 2.07 years (range from 8 months to 4.62 years). Pre-implant hearing data have been collected on all participants to quantify early acoustic experience using unaided thresholds and duration of HA use. These data have been analyzed in a multiple regression analysis to determine the effects of early acoustic experience on speech perception (suprasegmental and segmental) and ultimately vocabulary and language.  
Results: 1) Segmental and suprasegmental speech perception skills contribute independently to receptive language and vocabulary performance. 2) Lower (better) unaided thresholds are associated with higher (better) segmental and suprasegmental speech perception scores. 3) For speech perception and ultimately language development, the optimum period of HA use prior to a second CI depends on unaided threshold levels.  
Conclusion: Based on regression models: children with the most profound hearing losses (HL, i.e., PTAs ~111 dB HL) have the best speech perception scores with the shortest durations of HA use (i.e., they do best when bilateral CI surgery is performed as early as possible); children with severe-to-profound HL (PTAs of ~92 dB HL) benefit in suprasegmental perception by up to ~3.5 years of HA use while HA use has ~no effect on their segmental perception; and children with severe levels of HL (PTAs of ~73 dB HL), segmental perception may increase with continued HA use, while suprasegmental perception may reach a maximum with ~3.5 years of HA use.
Session: S6-1
Abstract ID: 14
Title: When to Replace Legacy Cochlear Implants for Technological Upgrades: Indications and Outcomes
Presenting Author: Meredith Holcomb AuD
Author Block:
Meredith A. Holcomb, AuD 1, Jane Burton, AuD 2, Elizabeth Camposeo, AuD 1, Ted Meyer, MD, PhD 1, Ted McRackan, MD 1; 1Med. Univ. of South Carolina, Charleston, SC, 2Vanderbilt Univ., Nashville, TN.
Abstract:
Introduction: To determine indications, surgical efficacy, and audiologic outcomes of replacing legacy internal cochlear implant devices as a means of technology upgrade.
Methods: Retrospective review of ten patients (10 ears) that were initially implanted as a child (mean age = 3.87 years) and underwent cochlear implant reimplantation (CIR) with current internal device as a young adult (mean duration of implant use = 15.66 years). Demographic data and pre- and post-CIR speech perception scores were collected.
Results: Technology upgrade was the primary (9) or secondary (1) motivation for CIR. No surgical complications were noted and full insertion was obtained in 9 cases. Intraoperative impedance levels and neural response imaging measures were within normal limits for 8 patients. At most recent post-CIR follow up evaluation, all patients (100%) performed within or better than the 95% confidence interval of their pre-CIR word and sentence recognition scores; 55.6%, 50.0%, and 50.0% of patients performed above the 95% confidence interval of their pre-CIR scores for the CNC words, sentences in quiet, and sentences in noise, respectively.
Conclusion: Post-CIR audiological benefit was stable or improved compared to pre-CIR results in all categories by 3 months after reactivation. Given these results, patients who are unable to use the most current external processors due to incompatibility with a legacy internal device could consider reimplantation to optimize their overall performance with a cochlear implant.
Session: S6-1
Abstract ID: 86
Title: Electrode Impedance Fluctuations and Loss of Residual Hearing: Possible Effects of Device and Age
Presenting Author: Nicholas Thompson MD
Author Block:
Nicholas J. Thompson, MD, Margaret T. Dillon, AuD, Emily Buss, PhD, Harold C. Pillsbury, III, MD, Brendan P. O’Connell, MD, Kevin D. Brown, MD, PhD; Otolaryngology/Head & Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC.
Abstract:
Introduction: Postoperative low-frequency hearing preservation is routinely possible following cochlear implantation. Cochlear implant (CI) recipients with low-frequency hearing preservation experience significantly improved speech perception when listening with acoustic plus electric stimulation (EAS) as compared to the CI alone. Prolonged benefits with EAS rely on long-term low-frequency hearing preservation. Recent reports on a single device suggest a relationship between fluctuations in electrode impedance and loss of low-frequency hearing in adult CI recipients. There is a need to evaluate this relationship for other device types and in pediatric CI recipients to help support a lifetime of EAS use. The objectives of this study are to determine if there is an association between electrode impedance fluctuations and loss of residual hearing in pediatric CI recipients, and to determine if device type or other variables affect this relationship.
Methods: We conducted a review of pediatric and adult CI recipients from 2013-2016 with postoperative hearing preservation. The correlation between impedance change and change in residual low-frequency hearing at 12 months was assessed. Regression analysis evaluated the effect of age, array type (lateral wall vs. perimodiolar), manufacturer, and preoperative hearing on impedance.
Results: Ninety-four CI recipients, including 48 pediatric recipients, presented with postoperative hearing preservation. An overall association between change in impedance and change in residual low-frequency hearing at 12 months was observed, however, this differed between manufacturers (R²=0.30, p=0.01 vs. R²=0.01, p=0.77). Average absolute impedance changes were higher for a slim electrode array inserted to 20 mm than a flexible electrode array inserted to 24 mm, approaching significance (p=0.08). A multivariate regression analysis demonstrated a statistically significant association between preoperative low-frequency pure-tone average (p=0.048), device manufacturer (p=0.012), and electrode array type (p=0.02) on impedance changes. There was no effect of patient age on this relationship.
Conclusion: Impedance fluctuations appear to be a marker for delayed loss of residual hearing in some electrode array types and manufacturers but not others. There was no effect of age on this relationship. Specific electrode arrays may affect the cochlear microenvironment differently, resulting in a local reaction with subsequent negative impact on postoperative hearing preservation. These results may have a particular importance in the pediatric population for maximizing audibility and speech perception during speech and language development, especially as cochlear implantation criteria and technology continue to expand.
Session: S6-1
Abstract ID: 137
Title: An Updated Comparison of Outcomes and Programming Parameters for Precurved Versus Straight Electrode Arrays
Presenting Author: Jourdan Holder AuD
Author Block: Jourdan T. Holder, AuD 1, Ashley Nassiri, MD, MBA 2, Robert J. Yawn, MD 2, Robert T. Dwyer, AuD 1, Alejandro Rivas, MD 2, Robert Labadie, MD, PhD 2, René H. Gifford, PhD 1; 1Hearing and Speech Sciences, Vanderbilt Univ., Nashville, TN, 2Otolaryngology-Head and Neck Surgery, Vanderbilt Univ., Nashville, TN.
Abstract: Introduction: The two main types of cochlear implant (CI) electrode arrays (EA), precurved and straight, have advantages and disadvantages. Ideal placement of precurved arrays tend to be closer to the modiolus and spiral ganglion cells resulting in improved stimulation specificity and reduced charge required for upper stimulation levels. However, several previous studies have shown that precurved electrodes are prone to scalar translocation (Wanna et al. reported 42%) and intracochlear trauma, which is not conducive to hearing preservation. Conversely, straight arrays are less likely to translocate and are therefore more likely to result in hearing preservation. However, the resting place of straight electrodes is further from the spiral ganglion cells, potentially requiring higher charge for upper stimulation levels and hence, lower channel specificity. One CI manufacturer recently released a new precurved device, which utilizes a sheath-based insertion tool. This new electrode has shown much lower rates of translocation than previous generation precurved devices. Given lower rates of translocation, the current study aimed to compare adult CI outcomes and programming parameters for precurved, non-stylet EAs and straight EAs from a single manufacturer. We hypothesized that the new precurved electrode would provide 1) comparable hearing preservation, 2) better speech understanding scores, 3) lower impedances, 4) lower overall charge, and 5) preferable programming parameters compared to the straight EAs.
Methods: Fifty-eight adults—29 implanted with a straight EA and 29 implanted with a precurved EA using an external straightening sheath for insertion—were included. CI recipients from each group were matched with respect to age, preoperative hearing thresholds, and duration of CI use. Consonant-Nucleus-Consonant (CNC) words, AzBio sentences, and residual hearing thresholds were measured at least 6 months post activation. Pulse duration, maxima, impedances, and overall charge measurements were used to characterize programming parameters.
Results: Postoperative low frequency pure tone average was significantly lower (i.e. better) for the precurved EA group (94.71±14.79dB HL) than the straight EA group (102.13±9.57dB HL, p=0.028). CNC scores were significantly higher for the precurved group (56.97±21.47%) than the straight EA group (43.34±20.38%, p=0.016). Impedances and pulse durations were statistically significantly lower for the precurved group, but there was no difference in overall charge for upper stimulation levels between the two groups.
Conclusion: The precurved EA group showed favorable or similar results on all measures when compared to the straight EA group. Results suggest that the precurved EA may be an advantageous substitute for the straight EA, which exploits better perimodiolar positioning while maintaining similar or better rates of hearing preservation.
Session: S6-2
Abstract ID: 118
Title: Trauma-Informed Practice for Pediatric Cochlear Implant Users and Their Families
Presenting Author: Elizabeth Rosenzweig MS, LSLS Cert AVT
Author Block: Elizabeth A. Rosenzweig, MS, LSLS Cert AVTTeachers Coll., Columbia Univ., New York, NY.

Abstract:
Introduction: Adverse Childhood Experiences, or ACEs, refers to a diverse set of potentially traumatic events in childhood that may be unfavorable to health and development across the lifespan (Shonkoff & Garner, 2012). Exposure to Adverse Childhood Experiences (ACEs), such as child abuse, neglect, maltreatment, inconsistent caregiving, and poverty is a risk factor for child development (Felitti et al., 1998) and children with disabilities are more likely to experience ACEs than their typically-developing peers (U.S. Department of Health and Human Services, 2003). While advances in hearing technology, early intervention, and special education law have greatly improved language, academic, and social outcomes for children with hearing loss, there remains a subset of children who are deaf or hard of hearing whose listening, speech, and language outcomes lag behind their peers -- both those with hearing loss and without (Ching, 2015; Moeller, 2000; Moeller & Tomblin, 2015; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). While there are many plausible explanations for this phenomenon that relate directly to hearing loss (e.g., late identification, abnormal cochlear etiology, lack of highly qualified service providers), another source of this variation in outcomes may be found in more general factors, such as ACE exposure and parent-child relationships. De Bellis (2001) proposes that, “the potential psychobiological sequelae of child maltreatment may be regarded as an environmentally induced complex developmental disorder” (p. 540). What, then, are the compounding effects of this “environmentally induced complex developmental disorders” on children who already have a diagnosis of another communication disorder: hearing loss?

Methods: This presentation will include information on the neurobiological and epigenetic consequences of early childhood adversity and how these may affect (re)habilitative progress in children with hearing loss. Participants will learn how to implement an ACE screening protocol into their cochlear implant program and evidence-based interventions that can be incorporated into clinical practice to support vulnerable children and families.

Results: Preliminary results of a dissertation study on ACE exposure and children with hearing loss will be shared.

Conclusion: Children with hearing loss are disproportionately affected by adverse childhood experiences, yet professionals receive little/no training in trauma-informed practice in their professional preparation programs. Incorporation of trauma-informed practices in cochlear implant care may improve patient outcomes.
Session: S6-2
Abstract ID: 395
Title: Early Language Predictors of Long-Term Psychosocial Outcomes
Presenting Author: Derek Houston PhD
Author Block:
Irina Castellanos, PhD 1, David B. Pisoni, PhD 2, William G. Kronenberger, PhD 3, Derek Houston, PhD 1; 1Otolaryngology, The Ohio State Univ., Columbus, OH, 2Indiana Univ., Bloomington, IN, 3Indiana Univ. Sch. of Med., Indianapolis, IN.
Abstract:
Introduction: Most research concerning outcomes after cochlear implantation in prelingually deaf children has focused on auditory and proximal spoken language skills. Consequently, much less is known about the effects of early auditory deprivation, language delay, and cochlear implantation on critical quality-of-life (QoL) outcomes such as psychosocial functioning. Psychosocial functioning includes social, emotional, and behavioral components. Our understanding of the mechanisms that underlie psychosocial outcomes are not well understood and represent a significant gap in our knowledge, and is a barrier to the development of novel targeted interventions to help children with CIs. The objectives of this study were to examine the extent to which early parent-reported expressive language skills predict long-term psychosocial outcomes in a sample of prelingually deaf, early-implanted CI users.
Methods: The MacArthur-Bates Communicative Development Inventories (CDI; Fenson et al., 2006) was used to index the early expressive language skills of pediatric CI users after an average of 1 year of CI experience. Long-term psychosocial outcomes were measured using the Behavior Assessment System for Children (BASC-2; Reynolds & Kamphaus 2004), a well-validated self-completed and parent-completed questionnaire.
Results: Analyses revealed that early expressive language skills, collected on average 1 year post cochlear implantation, predicted long-term social, emotional, and behavioral outcomes up to 16 years later.
Conclusion: These findings suggest that language development during the toddler and preschool years is an important predictor of long-term psychosocial outcomes in early-implanted, prelingually deaf children. Children’s early expressive language skills as reported by parents on the CDI is a strong predictor of long-term social, emotional, and behavioral outcomes. Measures of language obtained as early as toddlerhood can be used to identify very young CI users who may be at high risk for disturbances in long-term psychosocial outcomes.
Session: S6-2
Abstract ID: 157
Title: Implementation of a Screener for Depression and Anxiety: Addressing the Mental Health Needs of Adolescents with Hearing Loss
Presenting Author: Nicole Lorenzo MS
Author Block:
Nicole E. Lorenzo, MS 1, Ivette Cejas, Phd 2; 1Pediatrics, Univ. of Miami, Miami, FL, 2Otolaryngology, Univ. of Miami, Miami, FL.
Abstract:
Introduction: Deaf and hard of hearing (d/Dhh) children face a number of challenges across the lifespan that affect their developmental, social, and educational outcomes. Cochlear implant teams often focus on listening and spoken language development, and behavioral and emotional development is often not addressed. The prevalence of internalizing problems, characterized by sad or worried affect, social withdrawal, and negative emotions is 25-38% in children and adolescents who are d/Dhh (Barker et al., 2009). Research has also shown that d/Dhh children have higher levels of anxiety compared to typical hearing children (Theunissen et al., 2012; van Eldik, 2005). Similarly, studies have reported a higher prevalence of depression in d/Dhh children and adolescents compared to typical hearing children (Bozzay et al., 2017; Fellinger, Holzinger, Sattel, Laucht, & Goldberg, 2009). Despite the high prevalence rates, as many as 2 in 3 youth with depression are not identified and fail to receive services (Burns et al., 1995). The American Academy of Pediatrics recommends that adolescents should be screened annually for depression as part of a universal screening to identify these adolescents early (Cheung, Zuckerbrot, Jensen, Laraque, & Stein, 2018). Given the high rates of comorbidity between depression and anxiety (Cummings, Caporino, & Kendall, 2014), it is also important to screen for anxiety within the primary care setting. Therefore, the goal of the current study is to examine the implementation of a universal screening for anxiety and depression in a clinical setting for adolescents with hearing loss.
Method: Implementation consisted of a multi-step process to assure proper training. The goal was to screen all adolescents age 12-17 years-old with hearing loss who came in to the clinic for audiology and/or speech and language services. The first step of the process consisted of informing and training providers (i.e., audiologists, speech therapists, etc.) with an overview of adolescent anxiety and depression. Subsequently, the psychology and social work staff administered the screening, which included the Patient Health Questionnaire (PHQ-8) for depression and the Generalized Anxiety Disorder (GAD-7) questionnaire. Additionally, adolescents were asked to rate how difficult the associated mental health concerns were affecting their school and home life. Adolescents who scored a 10 or above on either measure or who reported difficulty due to those concerns (i.e., very difficult or extremely difficult) were then further assessed.
Results: This presentation will review the mental health screening protocol, as well as how the otolaryngology team was educated on depression and anxiety. Data will be presented on the number of adolescents screened in our clinic and the percent who screened high for depression and/or anxiety. Furthermore, we will review the process of establishing a mental health screener for adolescents throughout our clinic and the obstacles of implementing a screener in a primarily audiological setting.
Conclusion: For children with hearing loss, the need for a comprehensive support system is imperative in order to improve their long-term outcomes. Integration of mental health care as part of a hearing loss clinic is the direction that health care models are pushing toward, and would substantially improve the lives of children and adolescents who struggle with anxiety and depression.
Session: S6-2  
Abstract ID: 97  
Title: Adolescents With Hearing Loss and Bullying: A Call to Action  
Presenting Author: Rachel Glade PhD, LSLS Cert AVT  
Author Block:  
Rachel Glade, PhD, LSLS Cert AVT 1, Nanette Nicholson, PhD 2, Krista Scruggs, MS 3, Kimberly Frazier, PhD 1, Lauren Burkhalter, BS 1; 1RHRC, Univ. of Arkansas, Fayetteville, AR, 2Audiology, Nova Southeastern Univ., Ft. Lauderdale, FL, 3Audiology/Speech Pathology, Arkansas Children's Hosp., Little Rock, AR.  
Abstract:  
Introduction: The purpose of this study was to explore personal experiences of bullying among adolescents who are deaf or hard of hearing. In 2001, Nansel and colleagues conducted a study with a representative sample of teen participants across the nation. They reported 13% of adolescents admitted to being a bully, 11% reported being a victim of bullying, and 6% reported being both a bully and a victim of bullying (Nansel et al., 2001). Based on their 2009 study, Wang, Iannotti & Nansel stated that among adolescents in the United States, 37.4% reported involvement in verbal bullying of their peers, while 36.5% reported being a victim of verbal bullying. While research studies detailing bullying among adolescents are plentiful; few studies have been conducted to explore the impact bullying has among adolescents who are deaf or hard of hearing (Kowalski & Limber, 2007; Nansel et al., 2001, Olweus, 1993). Very little research has been done to address this issue and to further examine the issue of bullying among adolescents who are deaf or hard of hearing. This is important and timely with recent state and federal initiatives introduced over the past few years in an effort to decrease the occurrence and impact of bullying in mainstream schools.  
Method: Participants Inclusionary criteria to participate in this study included: being deaf or hard of hearing, being between the ages of 10 to 18, and obtaining parental consent to participate. A participant incentive was provided in the form of a $10 gift card. Participants were recruited through a summer camp, through electronic mail distribution, and via social media posts. Data were collected over the course of 6 months. Fifty-six adolescents aged 11 to 18 years who were deaf or hard of hearing participated in a survey. Participants were from across the United States and used a variety of hearing technologies. Procedure A survey based on the Owleus Bullying Questionnaire (1993; 1996) was generated using Qualtrics software (Qualtrics, Provo, UT). The survey included 6 qualitative and 21 quantitative items targeting the perception and impact of bullying experiences. Health literacy was considered in survey development. The readability analysis for the final survey was a Flesh-Kincaid grade level of 4.3.  
Results: The most common primary communication modality of participants to be spoken language (n=35; 62%). Eight adolescents reported using both sign language and spoken language as their primary communication modality and eight adolescents reported using only American Sign Language (ASL) as their primary communication modality. Twenty-four participants (43%) reported experiencing bullying at some point in their lives. Of those that reported bullying experiences, most reported being bullied 2-3 times per week.  
Conclusion: Given that around 30% of adolescents report some involvement in bullying (Nasel et., al, 2001), this study supports previous findings that adolescents with disabilities experience bullying at higher rates than their same aged peers (Flynt & Morton, 2004; Norwich & Kelly, 2004). This finding also supports Pinquart & Pfeiffer’s (2014) research indicating that children with hearing loss experience bullying more frequently than their peers. This study was unique in that the evaluation of bullying experiences was of adolescents who were from the US and detailed information regarding communication modality and hearing technology was collected.
Session: S6-2
Abstract ID: 211
Title: Effect of Auditory Status on Visual Processing of Emotion Cues in Adolescents
Presenting Author: Andrea Warner-Czyz PhD
Author Block:
Andrea Warner-Czyz, PhD 1, Julia L. Evans, PhD 1, Lyn S. Turkstra, PhD 2, Delaney Evans, BS 1, Meredith Schepple, MS 1, Abigail Suen, BS 1; 1Communication Sciences and Disorders, The Univ. of Texas at Dallas, Dallas, TX, 2Speech-Language Pathology, McMaster Univ., Hamilton, Canada.
Abstract:
Introduction: Adolescent cochlear implant (CI) users experience significantly more peer problems and higher rates of peer victimization than adolescents with typical hearing (TH), which may stem from deficits in peer social dynamics. Successful social interactions require perception of not only message content, but also integration of sensory input to infer a speaker’s emotion from visual (facial expressions) and auditory (prosody) cues. CI users may process emotion cues differently than TH peers. That is, inherent biases of CI users to visual cues - especially attention to the mouth to supplement degraded auditory input - may detract from important emotion cues in the upper face and eyes. In this study, we ask if CI user’s bias to focus on mouth regions as a compensatory listening strategy results in qualitatively different visual fixation patterns from TH peers during a gated visual emotion recognition task.
Methods: Participants included 34 adolescents with CIs and 24 with TH. CI users had a mean age of 13.3 years, mean age at first CI of 2.7 years, and mean duration of CI use of 10.7 years. TH peers had a mean age of 13.7 years. All participants completed a visual world paradigm gated emotion recognition task (60%, 80%, 100% gates) with videos of 4 individuals expressing happy or angry emotions. Participants labeled the emotion in the image from a closed-set list. We recorded mouse clicks to assess behavioral accuracy and used eye tracking to capture visual fixations to facial features via regions of interest (ROIs).
Results: The groups did not differ in behavioral accuracy identifying happy or angry emotions at 60%, 80%, and 100% gate durations. However, qualitative group disparities in visual fixation patterns emerged for both emotions at all gate durations. In the happy condition, CI and TH groups had similar fixation patterns, with greater proportion of look time to the mouth versus eye ROIs at 60%, 80%, and 100% gate durations. In the angry condition, TH peers fixated longer on mouth versus eye ROIs at the 60% gate, but shifted to equally distributed fixation on mouth and eye ROIs at 80% and 100% gate durations. In contrast, the CI group spent a greater proportion of time fixated on mouth ROIs at all gates.
Conclusion: Adolescent CI users are as effective as TH peers in processing positive facial expressions. When processing negative facial expressions, CI users fixate longer on mouth versus eye ROIs at the earliest time when the emotion is recognized correctly (80% gate). This suggests inherent biases/compensatory strategies of adolescent CI users to focus on the mouth may detract from effective processing of negative affect cues. Qualitatively different patterns of affect cue processing by CI adolescents may make them more vulnerable to poor social cue processing in peer-to-peer interactions. Knowledge of CI adolescents emotion processing skills could lead to more effective, efficient therapeutic intervention related to social deficits in adolescents with CI.
Session: S6-3  
Abstract ID: 216  
Title: Long Term Results of Cochlear Implantation in Patients with Common Cavity Malformation  
Presenting Author: YONGXIN LI Professor  
Author Block:  
Natalia Liau, Bachelor, Yongxin Li, Professor, Zhang Li Fang, Bachelor, Ying Shi, Bachelor; Beijing Tongren Hosp., Beijing, China.  
Abstract:  
Introduction: Common Cavity Deformity (CCD) is an inner ear malformation (IEM) with ill-defined and rudimentary but nonetheless distinguishable cochlea, vestibule, and semicircular canals. The cochlea is round or ovoid and the internal auditory meatus (IAM) usually enters the cavity at its center. Since CI in the ear with Common Cavity Deformity (CCD) was firstly reported by Jackler in 1987, it has been widely accepted as a safe and effective treatment for CCD. However, the intraoperative and postoperative complications in CCD patients have always been challenges for otologist. Such as intraoperative cerebrospinal fluid (CSF) gusher, anomalous course of the facial nerve, penetration of the electrode array into the internal auditory canal (IAC) and post-operative meningitis. The previous studies reported that the outcomes of CI in different CCD individuals varied a lot. Whether the electrode stays sticking to the outer wall of the CC has an influence on the outcomes. To make the electrode sticking to the wall, the traditional electrode isn’t suitable for CCD patients. What’s more, the long-term postoperative audiological and speech development are effective evaluation tools.  
Methods: A retrospective review of eighteen patients with CCD malformations. Seven patients underwent cochlear implantation surgery with traditional recess approach, and other eleven patients went through cochlear implantation with slotted labyrinthotomy approach. For patients with slotted labyrinthotomy, temporal muscle was used to seal the labyrinthotomy. Intraoperative and postoperative complications were reviewed. Auditory Performance (CAP), Speech Intelligibility Rating (SIR), Meaningful Use of Speech Scale (MUS) and meaningful auditory integration scale/infant-toddler meaningful auditory integration scale (MAIS/IT-MAIS) were used to evaluate speech reception. We tested the children at 1, 3, 6, 12, 18, 24 months post first fitting. And postoperative imaging examination high-resolution computed tomography (CT) of the temporal bone were obtained to confirm the position of electrodes.  
Results: The transmastoid slotted labyrinthotomy approach filled with muscle was used in 16 patients. After using the single-slot cochleostomy approach, 2 patients were found with intraoperative CSF leakage and the 3 patients that used the traditional facial recess approach also presented with intraoperative CSF leakage. None occurred postoperative complications. MED-EL short electrodes were used in all 8 patients with the traditional facial recess approach. 16 patients received customized electrode which was designed based on the character of their cochlea. Now the patients recovered well. Speech reception tests were performed two years regularly after implantation, their CAP, SIR, MUS, IT-MAIS results measured in this study show a chronological improvement over time. One year postoperative CT scans results confirmed that the electrode arrays were situated along the outer wall of the cavity for all patients with no anomalies.  
Conclusion: For patients with common cavity malformation, optimized surgical approach should be selected according to their cochlea characters. Temporal muscle fascia can be utilized to seal the labyrinthotomy in slotted labyrinthotomy approach. Customized electrodes can be considered for patients with severe inner ear malformation.
Session: S6-3
Abstract ID: 259
Title: Auditory Skills and Surgical Challenges Regarding Cochlear Implantation in Children with Charge Syndrome
Presenting Author: Luis Lassaletta Head Section of Otology
Author Block:
Luis Lassaletta, Head Section of Otology, Paula Aragón-Ramos, Otolaryngologist, Maria Fernanda Pedrero-Escalas, Otolaryngologist, Rosa Pérez-Mora, Otolaryngologist, Belén Herrán, Speech Therapist, Javier Gavilán, Head of the Department; Otolaryngology, La Paz Univ. Hosp., Madrid, Spain.
Abstract:
Introduction: Objective: To assess the auditory outcomes and skills of pediatric cochlear implant (CI) users with CHARGE syndrome. To determine the influence of inner ear malformations on surgical procedure and speech understanding outcomes in this population.
Methods: Imaging, auditory testing, intraoperative findings, complications, and postoperative auditory skills and outcomes of pediatric CI users with CHARGE syndrome were recorded. The auditory development of all subjects was evaluated via the Ling 6 test, Vowel Recognition Test, selected tests from the Evaluation of Auditory Responses to Speech (EARS®) test battery, and the Categories of Auditory Performance (CAP) test. Additionally, the children’s main mode of communication was documented.
Results: Six children (8 ears) were included. The mean age of implantation was 37 months. Six of the 8 ears presented cochlear malformation the most frequent being hypoplasia type III. Intraoperatively, the transmastoid facial recess approach was used in 5 ears and abnormalities of the facial nerve anatomy were found in 5 ears. All the electrode insertions were complete. All children were, to a varying degree, able to detect and identify sound. Verbalization skills were developed by 2 children, 1 of whom used oral language as his/her primary mode of communication.
Conclusion: Cochlear implantation in CHARGE syndrome is a safe procedure with adequate treatment planning and an experienced surgeon. All children had improved auditory skills although the improvement was variable.
Session: S6-3  
Abstract ID: 426  
Title: Electrically Stimulation of the Cochlear Second Turn  
Presenting Author: Paul Van de Heyning MD PhD  
Author Block:  
Paul Van de Heyning, MD PhD  
Antwer Univ. Hosp., Antwerp-Edegem, Belgium.  
Abstract:  
Introduction: Patients with single sided deafness can compare acoustic versus electrical percepts. In this study the stimulation in the second turn was evaluated in patients implanted with a deep electrode insertion into the second cochlear turn.  
Methods: Cochlear implant (CI) recipients with single-sided deafness and an electrode insertion extending in the apex (MED-EL 28 and 31mm electrode) compared pitch percepts between normal acoustic stimulation in the normal hearing ear with electric stimulation in the cochlear implanted deaf ear. Compared to Greenwood’s map, the mean shifts of the obtained frequency-place functions were -0.33 octaves in the basal (< 240°) region, -0.35 octaves in the middle, and 0.26 octaves in the apical region (> 480°).  
Results: Electrical pitch percepts corresponding to pure tones from 100 to 300 Hz could only be elicited by applying a correspondingly low rate code on electrodes beyond 360 degrees insertion depth.  
Conclusion: Deep electrode insertion applying phase locking low frequency electric stimulation allows clear low tone perception.
Title: Audiologic Outcomes of Cochlear Implantation in Inner Ear Malformations: A Comparative Analysis of Lateral Wall & Perimodiolar Electrode Arrays

Abstract:
Introduction: Cochlear implantation in children with inner ear malformations (IEMs) is beneficial, with improved performance over time on clinical measures of speech perception. IEMs require special consideration when selecting the electrode array type, as this may impact speech understanding and daily usage. The aim of our study is to evaluate if either the lateral wall (LW) or perimodiolar (PM) electrode arrays confer any performance outcome advantages in IEMs cochlear implantation.

Methods: This study was a retrospective evaluation of consonant-nucleus-consonant (CNC) word scores obtained following cochlear implantation in patients with IEMs. Children with recorded open set speech perception scores who were diagnosed with inner ear malformations and implanted with a cochlear implant in our institute in the last 10 years were eligible for inclusion in the study. Each ear implanted was evaluated separately. Exclusion criteria included less than 1 year of listening experience with the cochlear implant, children with additional disabilities that preclude spoken language development or any ears with suspected cochlear nerve deficiency. 104 ears with inner ear malformations met these criteria, from which 41 ears were diagnosed with cochlear malformations. Ears were grouped into LW or PM recipients. A multivariate regression analysis of variables was performed using the highest CNC score obtained for each ear as the dependent variable. A secondary analysis was performed with ears with IP2 malformations using a non-parametric T test and Mann-Whitney post-test analysis.

Results: Multivariate regression of variables demonstrated that the type of cochlear malformation and presence of enlarged vestibular aqueduct were not correlated with CNC scores (p=0.387 and p=0.307 respectively), while the electrode type had a statistically significant impact on CNC score (p=0.049). We analyzed the speech perception outcomes in the larger group of the IP2 malformations. This demonstrated a statistically significant better outcome in ears implanted with a LW electrode than the PM electrodes (79±9 vs 69±10 respectively, p=0.028).

Conclusion: IEMs require special consideration when selecting the electrode array type, as this could lead to differences in speech understanding and impact daily usage. In the short cochlea of IP2 malformation the LW electrodes confer better speech perception outcomes.
Hearing and Speech Outcomes in Children Following Cochlear Implantation of Congenital Inner Ear Malformations

Presenting Author: Owen Darr MD

Author Block:
Owen A. Darr, MD 1, Teresa A. Zwolan, PhD 2, Ellen S. Thomas, M.A., CCC-SLP 3, Marc C. Thorne, MD, MPH 2; 1Pediatric Otolaryngology, Children's Hosp. Colorado, Denver, CO, 2Otolaryngology, Univ. of Michigan, Ann Arbor, MI, 3Otolaryngology, Univ. of Michigan, Ann Arbor, CO.

Abstract:
Introduction: Cochlear implantation candidacy has expanded to offer hearing rehabilitation to children with congenital inner ear malformations (IEM) and profound sensorineural hearing loss. Despite extensive preoperative evaluation, postoperative outcomes are inconsistent, leading to difficulty in family counseling and prognostication. The presented data explores the outcomes of cochlear implantation in children born with IEM, with the purpose of creating a predictive regression model for hearing, speech and language outcomes based on preoperative patient metrics.

Methods: Using a prospectively collected database at the University of Michigan, a retrospective chart and imaging review was conducted, compiling data for 93 patients born with IEM who underwent cochlear implantation before the age of 18. The control group included 98 patients implanted before age 18, without IEM and pursuing oral communication. Malformation type was assessed by preoperative CT scan. Groups were analyzed using comparative statistics. Primary outcomes included soundfield detection (SFD), speech perception, and expressive speech and language outcomes, using the best result within 2 years postoperatively. The influence of independent preoperative variables on outcomes was assessed using univariate and multivariate logistic regression models.

Results: Using univariate comparative statistics, no significant effect on postoperative hearing and speech outcomes were detected on the bases of age at implantation, sex and preoperative PTA. Among children with IEM, those with comorbid cognitive delay were significantly less likely to achieve sound detection postoperatively, OR 0.03 (95% confidence interval 0.01-0.11). Stratifying by type of IEM, positive SFD was achieved in 100% of normal controls, 83% (5/6) of those with cochlear hypoplasia (CH), 40% (2/5) with common cavity (CC), 78% (7/9) with type I incomplete partition (IP-1), 93% (40/43) with type II incomplete partition (IP-2), 50% (5/10) with narrow internal auditory canal (NIAC) and 92% (11/12) with isolated enlarged vestibular aqueduct (IEVA). In regards to speech perception, subjects with CH did not significantly differ from controls, IP-2 and IEVA performed better, with OR of 3.2 (95% CI of 1.5-7.1) and 5.0 (1.2-20.2), respectively, and all patients with CC, IP-1 and NIAC failed to achieve age-appropriate normal results. In speech and language assessment, there were no significant differences between CH, CC, IP-1, IP-2 or IEVA compared with controls, however, no patients with NIAC achieved age-appropriate results. In the univariate logistic regression model, cognitive delay was the only significant variable correlated to SFD, with OR of 0.03 (95% CI 0.01-0.11); speech perception correlated to older age with OR 1.01 (95% CI 1.002-1.02) and lower pre-operative PTA with OR 0.96 (0.94-0.98). All patients with cognitive delay failed to achieve age-appropriate speech and language outcomes, and no other variables were significantly correlated to expressive speech and language.

Conclusion: Presence of more severe IEM and comorbid cognitive delay are associated with poorer outcomes in hearing, speech and language after cochlear implantation in children. In this cohort, however, children with less severe IEM, such as IP-2 or isolated EVA, performed as well or better than counterparts with no IEM.
Title: Using the LENA System to Investigate Conversational Partners in Children With and Without Cochlear Implants

Presenting Author: Hillary Ganek PhD

Author Block:
Hillary Ganek, PhD, Deja Forde-Dixon, BS, Sharon Cushing, MD, Blake Papsin, MD, Karen Gordon, PhD; The Hosp. for Sick Children, Toronto, Canada.

Abstract:

Introduction: The main objective of this study is to identify whether children with cochlear implants are exposed to the same amount of language as typically hearing peers in their natural environments. Children with cochlear implants are at risk for delayed language, cognition, and academic skills because their auditory abilities may prevent them from easily conversing with those around them. Previous literature has shown that children with hearing aids participate in a similar number of conversational turns with adults as typically hearing children. To date, however, no objective observations have been made of the conversations children with cochlear implants participate in with adults or peers.

Methods: Seventeen children with cochlear implants and seventeen without wore a Language ENvironment Analysis (LENA) System digital language processor for one day when they were home with their families. The audio recording was uploaded to LENA software and automatically analyzed for adult and child vocalizations. Using a custom script in R software, conversational turns between the key child, adults, and other children were extracted for analysis. Participants also underwent a language assessment protocol including the Mullen Scale of Early Learning (Mullen, 1995), the Expressive One-Word Picture Vocabulary Test (Martin and Brownell, 2010), and a mean length utterance (MLU) calculation. Caregivers completed a demographic questionnaire related to cultural background, socioeconomic status, and maternal mental health. A linear mixed effects model compared results across the two groups, including social determinants and language skills as fixed effects.

Results: Preliminary LENA data has been collected for 14 children, nine with cochlear implants and five without. The children with cochlear implants (M=30.94 months, SD=8.46) are similar in age to children with normal hearing (M=38.28 months, SD=9.83) (t(7.34)=-1.4, p=.2). Four of the cochlear implant users and one of the typically hearing children are girls. Current preliminary LENA data indicates a high inter-participant variability. Adults engaged in a similar number of turns with children regardless of hearing status (t(8.76)=-1.26, p=.24). In addition, both groups appear to take similar numbers of turns with other children (t(8.69)=.12, p=.91). On the other hand, some differences between the groups are becoming clear; children using cochlear implants are more likely to play the role of ‘responder’ and children with typical hearing initiate conversational turns more often (F(1,27)=12.47, p<.001; F(1,13)=7.23, p=.02).

Conclusion: Preliminary data suggests that children using cochlear implants are developing some age appropriate “real world” conversational abilities but differences remain. Further analyses will focus on the influence of social determinants and language levels on children’s conversational behaviors.
Session: S7-1
Abstract ID: 365
Title: The Emergence of Speech Intelligibility in Long-Term Pediatric Cochlear Implant Users
Presenting Author: Kathryn Wiseman AuD

Author Block:
Kathryn Wiseman, AuD 1, Andrea Warner-Czyz, PhD 1, Ann Geers, PhD 1, Nae-Yuh Wang, PhD 2, Christine Mitchell, ScM 2, Olga Peskova, MS 1, Laurie Eisenberg, PhD 3; 1Univ. of Texas at Dallas, Dallas, TX, 2Johns Hopkins Univ., Baltimore, MD, 3Univ. of Southern California, Los Angeles, CA.

Abstract:
Introduction: This study sought to determine which variables contribute to attainment of speech intelligibility skills in pediatric cochlear implant (CI) users between 4 and 8 years post-CI.

Methods: Participants include 159 children with CIs enrolled in a longitudinal, multi-center project evaluating development in children after cochlear implantation. All received a CI by 5 years of age (M=2.4 years). The control group included 81 children with typical hearing (5-13 years of age over the course of the study). Children completed the McGarr Sentence Intelligibility Test between 4 and 8 years post-CI. This task required them to imitate 36 sentences with either high (“Eat the cake”) or low (“My name is Nancy”) context. Adults with typical hearing and no prior experience listening to the speech of deaf individuals were instructed to write down as much of the sentence as they understood. Three judges provided responses to each sentence, and no judge listened to more than one sentence from the same child. Each overall intelligibility score represents the percent of 36 key words correctly understood across a total of 108 judgments. Data were analyzed using a mixed-effects linear model utilizing all available speech intelligibility data 4-8 years post-CI.

Results: The typical hearing control group attained mean speech intelligibility levels between 77-84%. Mean speech intelligibility for the CI group increased annually from 46% at 4 years post-implant to 68% at 8 years post-implant and, on average, did not reach the levels of the group with typical hearing. However, the proportion of participants with CIs who achieved speech intelligibility ≥ 75% increased steadily from 14% at 4 years post-CI to 41% at 8 years post-CI. The CI group had not only lower mean speech intelligibility rates, but also twice the variability in scores versus hearing peers. Presence of residual hearing at baseline, younger age at implantation, better speech recognition scores at 3 years post-implant, and better consonant production accuracy at 4 years post-implant significantly related to better speech intelligibility over the 4-8 year follow-up period.

Conclusion: Intelligibility of the speech of pediatric CI users continues to improve with increased duration of device use, with nearly half of the sample attaining adequate intelligibility (scores greater than or equal to 75%) by 8 years post-implant. The strong connection to speech production accuracy may not fully capture the nuances of communication (e.g., longer pauses, longer sentence durations) that could negatively affect dynamic social interactions. Thus, children with lower speech intelligibility (with or without articulation issues) may require more therapeutic intervention and support to maximize communication and social success.
Session: S7-1  
Abstract ID: 275  
Title: Longitudinal Speech and Language Outcomes in Paediatric Cochlear Implant Recipients  
Presenting Author: Julie Hare BSc Speech Sciences  
Author Block: Julie Hare, BSc Speech Sciences 1, Tracey Sear, MSc Communication Studies with Deaf People 1, Debi Vickers, PhD Human Communication and Deafness 2; 1Auditory Implants, Univ. Coll. London Hosp., London, United Kingdom, 2Department of Clinical Neuroscience, Univ. of Cambridge, Cambridge, United Kingdom.

Abstract:
Introduction: A main aim of paediatric cochlear implantation are the development of age appropriate spoken language skills and intelligible speech. To support this developmental trajectory, regular follow up is necessary after device activation. Much research excludes children with additional difficulties, and those whose home language is not the same as the test measures. An expanding paediatric implant population necessitates the reduction of follow ups, and streamlining the rehabilitation pathway. This research was a service evaluation of all children implanted in a cochlear implant programme. Data from children over 5 years post implant was included. No child was excluded based on demographics. The goals of this research were to: 1. Describe the development of speech and language skills over time following implant activation. 2. Understand the factors that influence rate and extent of speech and language acquisition. 3. Develop a triage system to support the paediatric cochlear implant rehabilitation pathway.

Methods: Longitudinal data was collected for children under 18 years old, implanted between 1998 and 2013 with at least 5 years of listening experience with their cochlear implant. The standard paediatric cochlear implant rehabilitation pathway was followed. Data was collected at the following clinic time points: pre-implant, and post-implant activation at 12 months, two-years, three-years, five-years, seven-years, ten-years. Data will be presented from the 5, 7 and 10 year intervals. There are datasets from 158 children at 5 years, 113 children at 7 years and 80 children at 10 years post-implant activation. At 5 years there were 83 males and 75 females. The mean age at first implant was 45 months (median 35 months) ranging from 10 to 138 months. For device configuration there were 24 children implanted unilaterally, 14 with bimodal implants, 70 sequentially implanted and 50 with simultaneous implants. Outcome measures reported were the Speech Intelligibility Rating (SIR) and the Clinical Evaluation of Language Fundamentals (CELF) version 4; core, receptive and expressive language scores.

Results: Results demonstrated improvement from implant activation for SIR and CELF scores. A multinomial logistic regression suggested that age at implantation, type of loss, device configuration and home language were the main predictors of outcome. These findings will be explored and the implications for a triage system explained.

Conclusion: Speech and language skills develop over time following device activation. If simultaneously bilaterally implanted at a young age and from a family speaking the native home language, many children would be expected to achieve levels of speech and language abilities within the typical range. A triage system to determine families where additional support is required to optimise their child’s outcomes with a cochlear implant is suggested.
Title: The Role of Feedback and Use of a Mobile App in Supporting Adult-Child Language Interactions in the Home

Presenting Author: Shani Dettman PhD

Author Block:
Dawn Choo, Master of Speech Pathology, Shani Dettman, PhD, Richard Dowell, PhD, Robert Cowan, PhD; The HEARing CRC/ Univ. of Melbourne, Melbourne, Victoria, Australia.

Abstract:
Introduction: Cochlear implants (CI) and hearing aids (HA) enable young children with significant hearing loss to participate in verbal communicative interactions, thus facilitating language acquisition. Research supports the pivotal role which adult language input and adult-child interactions play in promoting children’s early communication development. Establishing how best to engage parents and provide them with feedback on their contributions to their child’s language development in the context of everyday life, however, has proven to be challenging. This prospective intervention study investigated the impact of providing either feedback (derived from automated speech and language processing technology), and/or guidance from use of a mobile application, on parents’ efforts to increase the amount of spoken language directed to their children in the home. Parental app ratings were also explored.

Methods: Two groups of dyads were recruited for this study: (1) hearing mothers and their typically developing children with normal hearing; (2) hearing mothers and their children with significant, bilateral prelingual hearing loss using HA and CI. A repeated-measures study design was used to assess the impact of two interventions through changes to each dyad’s baseline language estimates. Day-long audio recordings were analysed using automated speech and language processing technology to generate estimates of adult word count (AWC) and adult-child conversational turn count (CTC). The no-feedback condition was similar to baseline; audio recordings were collected and analysed for AWC and CTC. In the feedback condition, verbal feedback was provided to mothers about their respective AWC and CTC based on the automated analyses. In the app condition, both feedback and the use of a free mobile app which provided daily suggestions for parent-child shared activities, was examined. Dyads completed all three conditions, but the order of conditions was randomised. At the end of the study, mothers evaluated the app with the user version of the Mobile Application Rating Scale (uMARS; Stoyanov et al., 2016).

Results: Outcomes of the intervention study suggested that provision of feedback to mothers of children with normal hearing or mothers of children using HA and/or CI did increase the quantity of spoken language directed to their children. Use of the app also increased the quantity of spoken language, but not to the same extent as feedback. Mothers assigned the app an overall mean rating of 3.78 out of 5 (median 4) reflecting an average to good app quality rating.

Language Performance of Adolescents with Cochlear Implants: Strengths, Weaknesses, and Contributing Factors

Susan Nittrouer PhD

Socio-economic status, non-verbal cognitive skills, measures of child language performance during the preschool years, and historical and current audiologic variables.

At 14 years of age, children with CIs continued to lag behind their peers with NH. Effect sizes were greatest for measures involving complex syntax, written language, and any skill dependent upon sensitivity to phonological structure. Regression models for data from the children with CIs consistently revealed that certain historical and contemporary factors explained variability in performance, especially for the measures demonstrating the largest deficits. These explanatory factors included how intelligible the speech of children with CIs was in preschool, nonverbal IQ, and socioeconomic status. Of interest was the finding that age of first CI did not explain any variability in outcomes at adolescence.

Children with CIs were able to develop fairly typical lexicons, and learn to generate syntactically appropriate sentences and construct oral narratives. Where these children struggled was with tasks involving complex morphosyntactic structures, written language, or any skill dependent upon the child having sensitivity to word-internal phonological structure. Acquisition of these late-developing skills in children with CIs appears to depend strongly on the child’s sensorimotor development for speech production at younger ages, as well as on cognitive abilities.
Session: S7-1
Abstract ID: 72
Title: Maternal Vocabulary Use to Children During the First Year of Hearing: Group Comparisons between Children with Cochlear Implants and Children with Normal Hearing
Presenting Author: Jongmin Jung PhD
Author Block:
Jongmin Jung, PhD 1, Yuanyuan Wang, PhD 1, Tonya Bergeson, PhD 2, Derek Houston, PhD 1; 1Otolaryngology-Head and Neck Surgery, The Ohio State Univ., Columbus, OH, 2Communication Sciences and Disorders, Butler Univ., Indianapolis, IN.
Abstract:
Introduction: Numerous studies have demonstrated that mothers adjust their speech style as their children grow (e.g., Rowe et al., 2005). This maternal speech adaptation is assumed to provide optimal language input that would facilitate children’s language and cognitive development. This notion is supported by Song et al.’s (2013) finding that maternal use of word tokens and word types predicts children’s later language outcomes. However, little is known about maternal speech style to young infants with cochlear implants (CIs). In this study, we compared the maternal use of words to young children with CIs and children with normal hearing (NH) during their first year of hearing experience. We focused on word categories (e.g., nouns, predicates) in maternal speech to understand how maternal vocabulary use changes as a function of children’s hearing experience.
Methods: We examined the maternal use of words during the 5-minute free play session from 15 mothers and their children with CIs, who were implanted before 2 years of age, and all interactions were recorded at 3 and 12 months post-activation. As a control, the maternal speech from 15 mothers and children with NH at 3 and 12 months of age was examined. The maternal speech was transcribed using the Systematic Analysis of Language Transcript (Miller & Chapman, 2000). Every content word (i.e., common nouns, adjectives, and verbs-finite and infinite forms), social response (e.g., uhoh, thank_you, meow, proper nouns) and grammatical word (e.g., copula, auxiliary verbs, pronouns, adverbs) was transcribed and categorized into four categories: common nouns, predicates, social-words, and closed-words. The tokens of each category, its proportion, and the type-token ratio (TTR) of content words were calculated.
Results: We conducted repeated measures (RM) ANOVA for the longitudinal effect between groups. The testing variables were the tokens of each category, their proportion, and TTR. The token of social words significantly decreased across the intervals (p = .039). Analyses revealed that the proportion of common nouns increased significantly across the intervals (p = .001). A decrease in common noun TTR across intervals approached statistical significance (p = .073). No additional main effects or interactions were observed in the main analyses. Post-hoc paired t-test for each group revealed that the common noun proportion increased significantly only in the NH group, p = .001.
Conclusion: The results suggest that the patterns of word use in the maternal speech were overall very similar between the two groups, which is consistent with findings that some aspects of mothers’ speech to children with CIs are more similar to speech directed to NH children matched by hearing experience than to NH children matched by chronological age (Bergeson et al., 2006). Further comparison with chronological age-matched peers is currently underway. In contrast, we found the proportion of nouns increased only in the NH group, suggesting that the two groups of mothers adjusted their common noun use differently. Given that children with CIs acquire substantial expressive vocabulary during the first year (e.g., Ertmer et al., 2009), investigating the relationship between maternal vocabulary use and children’s language ability will extend our understanding of maternal adjustment of language input for their children.
Session: S7-2  
Abstract ID: 188  
Title: Word Recognition and Audiometric Profiles of Cochlear Implant Candidacy  
Presenting Author: Camille Dunn PhD  
Author Block: Camille C. Dunn, PhD, Bruce J. Gantz, MD; Otolaryngology, Univ. of Iowa, Iowa City, IA.

Abstract:  
Introduction: Candidacy criterion for cochlear implantation has changed over the past several years. This is a result of a better understanding of who will benefit from a cochlear implant, but also because of changes to the design of electrode arrays. Electrodes are thinner, more flexible, and can be shorter in length. This has presumably led to decreased trauma to the inner ear during the surgical procedure. As a result of the expanded candidacy, knowing when to refer patients for a cochlear implant evaluation has become less transparent. Word recognition tests using NU-6 words are often calculated at the time of an audiogram by referring audiologists. This talk will discuss what audiometric profiles and word recognition scores warrant a referral for a cochlear implant evaluation.

Methods: Two-hundred audiometric profiles and median word recognition scores at evaluation in the ear to be implanted and in the contralateral ear were calculated for listeners who qualified for cochlear implantation. Calculations were broken down into various groups of cochlear implant candidates at the time of implantation: 1) standard electrode users <65 years of age; 2) standard electrode users ≥ 65 years of age; and 3) electric and acoustical stimulation (EAS) in the ear to be implanted.

Results: Word recognition scores for the groups of candidates were significantly different. Those who were implanted over the age of 65 years had significantly poorer word understanding than those who were implanted under the age of 65 years of age. This is likely due to insurance guidelines. In addition, those who were candidates for EAS had the best pre-op word understanding scores. Exact numbers will be described for each of these groups.

Conclusion: Cochlear implant candidacy has expanded. As a result, a wide range of word recognition scores and audiometric profiles should be referred for cochlear implant evaluations. Even if it is determined that the patient is not a candidate for a cochlear implant at the time of referral, this establishes a baseline for that patient should a change in hearing status become apparent.
Session: S7-2  
Abstract ID: 243  
**Title:** The Need For a New Cochlear Implant Candidacy Protocol  
**Presenting Author:** Allison Biever AuD  
**Author Block:**  
Allison Biever, AuD  
Rocky Mountain Ear Ctr., Englewood, CO.  
**Abstract:**

**Introduction:** Current FDA guidelines stipulate that candidates score 60% in the best-aided condition and 50% in the ear to be implanted on a sentence task in order to qualify for a cochlear implant. Medicare requires that patients score 40% or poorer in the best aided condition on a sentence task. Per these guidelines, most clinics have adopted a protocol which qualifies subjects based on their sentence scores in noise; however the signal to noise ratio may vary from one clinic to another (some clinics using +5dB SNR, others using +10dB SNR). Testing in noise not only tests hearing, but also tests a patient’s ability to centrally process what they are hearing. This results in a wide range of scores that are not necessarily reflective of hearing ability. As there is inconsistency across testing practices in clinics, it is necessary to determine if sentences in noise are an appropriate metric to be used as a means of qualifying adult subjects for cochlear implantation.

**Methods:** As part of a large, multicenter prospective trial, speech perception was collected on a group of cochlear implant candidates. At the evaluation, subjects were tested with monosyllabic words in quiet, sentences at +5 dB SNR and sentences at +10 dB SNR. The tests were administered again at 6 months post-implantation and scores from this dataset were analyzed within subjects.

**Results:** At six months post-implantation, over 90% of subjects showed a significant improvement on monosyllabic word scores in quiet, 70% of subjects showed a significant improvement on sentence scores at +10 dB SNR and fewer showed significant improvement at +5dB SNR. There was a broader range of sentence scores in noise in both SNR conditions as compared to the monosyllabic words in quiet scores.

**Conclusion:** The data from this study suggests a shift toward using a measure in quiet (such as a CNC word task) that is not as cognitively taxing for subjects as a sentence task in noise. Although there was significant improvement in both quiet and noise, the noise scores were highly variable, indicating the involvement of additional processing. Consideration should be given to using a monosyllabic word test in quiet during the candidacy evaluation, paired with specific counseling on expectations on hearing in both quiet and noise.
Title: Using Word Recognition Testing to Predict Cochlear Implantation Candidacy
Presenting Author: Brandon Isaacson MD
Author Block:
Anthony M. Tolisano, MD, Bethany Baumgart, AuD, Cherysse Lanns, AuD, Johanna Whitson, AuD, Joe W. Kutz, Jr, MD, Brandon Isaacson, MD, Jacob B. Hunter, MD; Otolaryngology-Head & Neck Surgery, Univ. of Texas Southwestern Med. Ctr., Dallas, TX.

Abstract:
Introduction: A small minority of adult patients who would be eligible for cochlear implantation (CI) actually receive one. CI evaluations are expensive, require trained CI audiologists to administer, and are not available everywhere. Furthermore, there is a poor understanding of which patient would qualify for CI among both the lay and medical communities. Pure-tone audiograms are much more readily available and more easily interpreted. The objective of this study, therefore, was to explore the relationship between word recognition score (WRS) testing and cochlear implantation (CI) candidacy.

Methods: This retrospective chart review from a single university-based CI program evaluated consecutive adult patients who had both pure-tone audiograms with monosyllabic WRS testing and CI evaluations using best-aided AzBio sentence recognition testing in quiet or noise. CI candidacy, defined as AzBio sentence recognition ≤60% for privately insured patients and ≤40% with patients using government-sponsored health insurance, was determined.

Results: There were 648 CI evaluations performed between late 2011 and 2018, of which 430 (mean age of 64.9 years) met study inclusion criteria. Overall, 24.2% failed to meet CI candidacy requirements (13.3% for private insurance vs. 28.8% for government-sponsored insurance, p=0.0003). Of the 326 patients who qualified, 201 (60.9%) pursued implantation. Patients who did not qualify for CI had larger median WRS in the better hearing ear (72% vs. 31%, p<0.0001) and higher AzBio sentence recognition in quiet (87.5% vs. 33%, p<0.0001), compared to those who qualified for CI. For patients with private insurance, 98.8% of patients met CI candidacy requirements when their WRS in their better hearing ear was ≤60%. For patients with government-sponsored insurance, 82.3% of patients met CI candidacy requirements when their WRS in their better hearing ear was ≤60%.

Conclusion: Adults with WRS scores ≤60% in their better hearing ear are likely to qualify for CI. Patients with private insurance meet CI candidacy requirements significantly more than patients with government-sponsored insurance.
Session: S7-2
Abstract ID: 35
Title: Rethinking Unaided Word Recognition Score Minimums to Increase Number of Implant Candidates.
Presenting Author: Anna McCraney AuD
Author Block:
Jack J. Wazen, MD FACS, MD 1, Anna McCraney, AuD 2; 1Otology, Silverstein Inst., Sarasota, FL, 2Audiology, Ototronix, St. Paul, MN.
Abstract:
Introduction: It has been reported that no more than 10% of patients who might benefit from a cochlear implant actually receive one. The primary trigger for a CI evaluation is typically the presence of an unaided word recognition score ≤ 50%. It is common practice to assume that word recognition scores measured under insert earphones accurately estimate aided word recognition. For example, it is often assumed patients with > 50% unaided WR will receive sufficient aided benefit so as to not be considered a CI candidate. Therefore, these patients are rarely recommended for a CI evaluation. Recent research shows that inferring aided performance based on unaided WR is unsupportable not only because there is poor correlation between unaided and aided WR, but also because it leads to delayed CI evaluations for many whose unaided WR is better than 50% but whose poor aided performance would qualify them for a CI if only they were tested.
Methods: Following IRB approval, a retrospective chart review was performed at a private otologic clinic for patients who were evaluated for CI candidacy between January 2012 and May 2017. Unaided word recognition (Wearphones<sub></sub>) was tested using recorded NU-6 word lists presented at speech reception threshold plus 40 decibels (dB) (SRT+40), or most comfortable listening (MCL) level if SRT+40 was too loud. CI candidacy was tested in the aided condition using AzBio sentence testing at 60 dB SPL. Patients were divided into 2 cohorts: 1) those with Wearphones≥50% and 2) those with Wearphones<50%. Each cohort was evaluated for the number of patients who qualified for a CI based on speech recognition testing. An experimental design of two factors, score type and individuals, was used for statistical testing. Tukey multiple comparisons of means was used for pairwise comparisons. Statistical analyses were performed using R software (Vienna, Austria14). Linear regression models were used to assess correlations between word recognition scores (Wearphones<sub></sub>, HA, CI).
Results: 321 ears in 172 adult patients (average age: 74.7 years old, range 23-97 years) had complete data for HA CNC and Wearphones<sub></sub>. 122 of the ears were female. 36% (114/321) of ears tested had Wearphones≥50%. The average Wearphones for this cohort was 67.7% ± 11.4% (range 52%-100%). Average HA CNC for this cohort was 34.7% ± 21.1% (range 0%-86%). 65% (207/321) of ears tested had Wearphones<50%. The average Wearphones for this cohort was 20.9% ± 15.4% (range 0%-48%). Average HA CNC for this cohort was 14.4% ± 16.0 (range 0%-60%). 80% (255/321) of all ears tested met CI candidacy. 89% (185/207) of the Wearphones<50% cohort met CI candidacy requirements. 62.5% (70/114) of the Wearphones≥50% cohort met CI candidacy requirements.
Conclusion: Our study showed that aided testing of patients with Wearphones≥50% resulted in a 38% increase in the number of CI candidates. Low CI utilization rates and treatment delays may, in part, be caused by failure to consider those patients whose aided performance is disproportionately poor relative to their unaided word recognition ability. While it is commonplace to reserve aided testing for cochlear implant evaluations, research unequivocally shows that aided benefit cannot be accurately predicted from unaided word recognition. As such, the adoption of early and regular aided testing particularly for those patients who have unaided WR >50% is warranted.
Session: S7-2
Abstract ID: 343
Title: Better Defining Best-Aided Condition: The Role of Hearing Aids on Cochlear Implantation Qualification Rates
Presenting Author: Brandon Isaacson MD
Author Block:
Anthony M. Tolisano, MD, Bethany Baumgart, AuD, Cherysse Lanns, AuD, Johanna Whitson, AuD, Joe W. Kutz, Jr, MD, Brandon Isaacson, MD, Jacob B. Hunter, MD; Otolaryngology-Head & Neck Surgery, Univ. of Texas Southwestern Med. Ctr., Dallas, TX.
Abstract:
Introduction: According to the Centers for Medicare and Medicaid Services (CMS), cochlear implantation (CI) evaluations should be performed under best-aided conditions. Nevertheless, determining best-aided condition is not always straightforward and likely varies among patients at least in part according to whether they have been fitted properly with hearing aids (HAs). The objective of this study was to describe the patterns of HA use for patients undergoing CI evaluations at a large university-based CI program.
Methods: Consecutive adult CI evaluations were identified between January 2013 and September 2018 at a single university-based CI program. The electronic medical record was reviewed to identify HAs used for each CI evaluation. Cases were excluded if no HA data was present. The primary outcome measure was comparing CI qualification rates for patients who currently used HAs as compared to patients who did not. Secondary outcome measures examined whether patients were tested utilizing their own versus stock HAs, age of the current set of HAs, and years of prior HA use.
Results: There were 595 adult CI evaluations performed during the study period that met inclusion criteria. The average patient age at time of CI evaluation was 64 years, and 44.7% were female. At the time of CI evaluation, 72.3% of patients currently wore at least one personal HA that was an average of 3.4 years old. Overall, 87.1% of patients had worn HAs at some point in their lives for an average duration of 16.6 years. In contrast, 12.6% of patients had never used HAs, and an additional 18.8% had discontinued HAs due to perceived lack of benefit for a median period of 3 years preceding the CI evaluation. HAs used for CI evaluations were most often the patient’s own (59.7%), followed by stock (26.2%), both (9.6%), or none (4.5%). Patients who did not currently use HAs were more likely to qualify for CI when compared to patients who did currently use at least one HA (88.0% vs. 78.9%, p=0.0122). Patients who used binaural HAs were less likely to qualify for CI when compared to patients who were monaurally aided (76.0% vs. 86.2%, p=0.0188). Patients who utilized stock HAs were equally likely to qualify for CI as compared to patients who utilized their own HAs (p=0.3877).
Conclusion: Patients who do not currently use HAs are more likely to qualify for CI when compared to patients who do wear HAs, whereas binaural HA use is associated with lower CI qualification rates. Utilization of stock versus patient’s own HAs for CI evaluations does not affect qualification rates. Future studies are necessary to better define best-aided condition to optimize CI evaluations.
Session: S7-3
Abstract ID: 375
Title: Air and Bone-Conducted Vestibular-Evoked Myogenic Potentials in Cochlear Implants
Presenting Author: Aniket Saoji PhD
Author Block:
Aniket A. Saoji, PhD 1, Douglas Totten, MD 2, Matthew L. Carlson, MD 1, Colin L. W. Driscoll, MD 1, Devin L. McCaslin, PhD 1; 1Mayo Clinic, Rochester, MN, 2Vanderbilt Univ., Nashville, TN.
Abstract:
Introduction: Vestibular-evoked myogenic potentials (VEMPs) are somatosensory responses that can be used to evaluate the otolith organs and the vestibular nerves. They are most commonly evoked using high intensity air-conducted (AC) stimuli, though bone-conduction (BC) stimuli are being used with increasing frequency. One area of study using VEMPs is in patients with cochlear implants. Conventional wisdom would suggest that the trauma of the surgery would potentially put the vestibular end-organs at risk for impairment. In fact, there are investigations that suggest that as many as 50% of patients that generated normal VEMPs preoperatively do not have a measurable response postoperatively. However, studies where VEMPs were recorded from cochlear implant patients pre- and post-operatively have produced mixed findings. One reason for the disparity may be that these studies have relied primarily on using AC-VEMPs. It is our contention that there may be an alternative hypothesis: that an alteration in middle ear function occurs postoperatively. It is well known that even a small amount of conductive loss will abolish an air-conducted VEMP, as any change in middle ear mechanics would result in an attenuation of sound transmission through the middle ear. However, the status of the middle ear should have no effect on VEMPs obtained in response to bone-conducted stimuli. We explored this second hypothesis—that middle ear function may play a role in the absence of VEMPs following CI surgery—by comparing both air- and air-conducted VEMPs in this population.
Methods: Fifteen implanted CI patients underwent VEMP testing, comprising air and bone conduction cervical and ocular VEMPs at 500 Hz. Bone conduction was tested using a B-81 bone transducer placed on the mastoid while air conduction was tested using an insert earphone. In unilaterally implanted patients, the contralateral ear served as a control. In bilaterally implanted patients both ears were evaluated as test ears. Findings were recorded and compared between conditions.
Results: The mean age of the fifteen subjects was 52 (range: 25-69). Of these fifteen study participants, VEMP reflexes were present in nine (60%). In six of the nine (66.7%) patients (5 unilateral, 1 bilateral) a BC-VEMP was present in the implanted ear while an AC-VEMP was absent. In the five unilaterally implanted patients both AC and BC-VEMPs were present in the contralateral ear. Detailed analysis of results will be discussed during the presentation.
Conclusion: Cochlear implantation contributes to conductive hearing loss in a subset of patients. This conductive component likely explains the phenomenon of robust bone-conducted VEMPs in the absence of air-conducted VEMPs.
Session: S7-3  
Abstract ID: 112  
Title: Feasibility of Pediatric Robotic Cochlear Implantation in Phantoms  
Presenting Author: Gabriela Bom Braga MD; PhD  
Author Block:  
Gabriela Bom Braga, MD; PhD 1, Daniel Schneider, Msc 1, Jan Hermann, Msc 1, Fabian Muller, Msc 1, Wilhelm Wimmer, PhD 1, Stefan Weber, PhD 1, Marco Caversaccio, MD; PhD 2; 1ARTORG Center for Biomedical Engineering Research, Univ. of Bern, Bern, Switzerland, 2Otolaryngology, Univ. of Bern, Bern, Switzerland.

Abstract:  
Introduction: Objective: Studies have shown that early hearing stimulation improves language development and perception in pediatric recipients. Residual hearing preservation through minimally invasive surgical procedures (where a keyhole tunnel is drilled through the facial recess) and atraumatic insertion have been performed in adults. The aim of this study is to investigate the feasibility of pediatric robotic cochlear implant surgery in 3D printed patient specific phantoms by anatomical study, robotic drilling experimentation and electrode insertion.

Study design: Pilot study, non-clinical  
Materials and Methods: Computed tomographic images of pediatric patients (n=24; age range from 8 to 48 months old) who underwent prior cochlear implant surgery, were studied. Study included analysis using a task specific computer planning system for Cochlear Implantation. A subset of the datasets was used to reprint the mastoid region and the inner ear in 3D. Robotic cochlear implantation was carried out on those datasets including elements of patient positioning, robotic middle ear access, robotic inner ear access and manual electrode insertion.

Results: Results: In 17 of 24 sides a safe and optimal robotic trajectory to the cochlea was planned. In 3 cases (13%) a trajectory could not have been planned due to a too small facial recess and 4 cases could not have been investigated due to insufficient image quality. Robotic inner ear access was successfully performed in 8 sides, followed by electrode insertion. Two pediatric phantoms (full size Cardio Pulmonary Resuscitation-CPR- training models, ages 6 months and 3 years old) were used to study patient positioning and suitability of the robotic setup for pediatric patients.

Conclusion: Conclusion: Pediatric robotic cochlear implantation seems to be feasible from a technical point of view. Clinical aspects including bone growth after surgery and effects on electrode array position and migration will require further study.
Session: S7-3
Abstract ID: 241
Title: The First HEARO Robotic Inner Ear Access Trials
Presenting Author: Vedat Topsakal Professor
Author Block:
Vedat Topsakal, Professor Universitair Ziekenhuis Antwerpen, antwerp, Belgium.
Abstract:
The first HEARO® robotic inner ear access trials Clinical evaluation of the HEARO procedure Vedat Topsakal, Griet Mertens, Marco Matulic, Vincent van Rompaey, Paul van de Heyning University Hospital Antwerp, University of Antwerp, Belgium
Abstract: The HEARO robotic cochlear implant procedure can be broken down into the 6 steps of: 1) fiducial screw placement, 2) high-resolution CT imaging, 3) preoperative trajectory planning, 4) patient-image registration, 5) robotic middle ear access and 6) robotic inner ear access. Upon the completion of the HEARO procedure the electrode is manually inserted inside the cochlea. The aim of this study was to perform the first in-human evaluation of the full HEARO procedure including the electrode insertion. Prior to the human trials, a pre-clinical evaluation was performed on 10 formalin flushed temporal bone (5 full human head) specimen. Preoperative imaging was performed after positioning of 4 fiducials screws (CAScintion AG, Switzerland) using the mobile CBCT scanner, XCAT XL (Xoran Ltd., USA) with 0.1mm reconstruction. The surgeon was able to segment all anatomy of interest, to measure the cochlea parameters and to plan a trajectory to the inner ear using the OTOPLAN® software. The robotic middle and inner ear access was then performed by the HEARO system and the electrode was inserted by the surgeon. In 9 cases it was possible to complete the procedure and in all the 9 cases the HEARO system was able to create a consistent opening on the cochlea while preserving the round window membrane. The HEARO system’s accuracy at the level of the round window was recorded as 0.194 mm (SD=0.059 mm). The average angular insertion depth in 9 cases was 525° with no observed tip fold-over or scala deviation. The preliminary results of the first in-human trial of the HEARO procedure in Antwerp will be presented.
Session: S7-3  
Abstract ID: 442  
Title: A Model to Evaluate Electrode Explant Force and Trauma  
Presenting Author: J. Thomas Roland MD  
Author Block:  

Abstract:  
Introduction: Objectives: To develop an in-vitro model to characterize electrode explant forces and dynamics. Cochlear implant (CI) explantation can be required for many reasons, with removal of the intra-cochlea electrode array potentially resulting in trauma. Literature on electrode explant force or trauma typically involves explant immediately post implantation in plastic models or in human cadaveric temporal bones. Clinically however explant typically takes place many year’s post implantation by which time a fibrous capsule has formed around the electrode array and potentially some greater level of fibrosis and/or ossification within the scala.

Methods: Study design: An in-vitro model using gel constructs to represent different tissue densities surrounding the electrode array was developed to measure explant forces and examine the explant dynamics of the electrode array. The standardized tools and protocols developed lend themselves to accurate characterization of the explant force profiles and explant dynamics of different electrode positions with the scala (modiolar or lateral wall) and also different insertion depths (from 360° to 720°). Measurements for explant force were obtained via instrumented load cell, with high definition video used to capture the explant dynamics in terms of explant path, lumen created by explanted electrodes and level of disruption of the surrounding gel due to the explant.

Results: Results: Explant forces can vary considerably depending on the presence and density of gel surrounding electrode array, and as expected a patent lumen results in the least force required. Two peak forces were identified in the presence of the gel, with an initial peak representing the breaking of the bond between the silastic interface with the gel and a second peak representing the maximum force of explant. Electrode path during explant and disruption to the surrounding gel also varied considerably, with insertion depth being the contributing factor in the differences observed. explant dynamics also varied Potential disruption of tissues formed post implantation by both perimodiolar and straight lateral wall electrodes is examined and their influence on cochlear structures is discussed

Conclusion: Conclusion: Measurement of electrode explant forces and dynamics in patent scala tympani is not a representative model of explantation which typically occurs some years after initial implantation. An in-vitro model using gel constructs that can mimic tissues surrounding the electrode may provide insights into the in-vivo conditions and provide a better understanding of the effects of explant on the electrode/tissue interface, potential for explant trauma and how these may be managed clinically.
Session: S7-3
Abstract ID: 186
Title: Subtotal Petrosectomy and Mastoid Obliteration in Pediatric Cochlear Implant Recipients
Presenting Author: Jose Carlos Casqueiro MD
Author Block:
Jose Carlos Casqueiro, MD 1, Gracia Aranguez, MD 2, Miguel Aristegui, MD 2; 1Otolaryngology, Hosp. Universitario Severo Ochoa, Leganes, Spain, 2Otolaryngology, Hosp. Gen. Universitario Gregorio Marañon, Madrid, Spain.
Abstract:
Introduction: Subtotal petrosectomy (SP) with obliteration of the middle ear and mastoid and closure of the external auditory canal in cochlear implant (CI) candidates is a consolidated technique in adult patients with chronic otitis media. Middle ear disease continues to be an obstacle for cochlear implantation furthermore in pediatric candidates that typically suffer from recurrent acute otitis media at the age of implantation. Other indications for SP with CI in children include inner ear malformations, conditions with augmented risk of CSF leak and meningitis and facilitating surgical exposure for difficult cochleostomies. The aim of our study was to analyze the technical difficulties and outcomes of SP in pediatric cochlear implant recipients.
Methods: A retrospective study was carried out in a single quaternary referral center for otology and skull base surgery in Madrid, Spain between 2011 and 2018. The study group consisted of 22 patients, 14 men and 8 women, aged 11 months to 13 years. All patients underwent SP with primary CI implantation. 8 patients received bilateral implantation so in the end 30 ears were analyzed.
Results: In all cases CI was successfully placed. 12 patients associated inner ear malformations (most of them Mondini dysplasia and enlarged vestibular aqueduct). No complications occurred during the time of the study.
Conclusion: The use of subtotal petrosectomy with middle ear and mastoid obliteration with cochlear implants is a safe and reliable technique when strict surgical steps are applied. Especially in pediatric population with recurrent acute otitis media and patients with inner ear malformations. In difficult anatomy, subtotal petrosectomy also enhances exposure of the cochlea.
Session: S7-3
Abstract ID: 222
Title: Effects of Early Asymmetric Hearing on Cortex and Brainstem
Presenting Author: Andrej Kral MD, PhD
Author Block:
Peter Hubka, PhD 1, Monique Hajduk, MUC 1, Jochen Tillein, PhD 2, Andrej Kral, MD, PhD 1; 1Dept. of Experimental Otology, Med. Univ. Hannover, Hannover, Germany, 2ENT Department, J.W.Goethe Univ., Frankfurt am Main, Germany.
Abstract:
Introduction: Unilateral congenital deafness leads to developmental structural and functional reorganization of the auditory pathways resulting in overall hearing ear preference (Kral et al., 2013, Brain; Tillein et al., 2016, Cereb Cortex). Corresponding observations were also made in subjects with sequential cochlear implantations both in animals and CI subjects from our center (Kral et al., 2013, Brain; Illg et al., 2013, Otol Neurotol; Illg et al., 2018, Hear Res). Here, we compared electrically evoked auditory brainstem responses (eABR) and cortical activation in a natural model of congenital deafness - adult congenitally bi- and unilaterally deaf cats.
Methods: 4 adult hearing control, 4 adult bilaterally congenitally deaf cats (bCDC) and 4 unilaterally congenitally deaf cats (uCDC) were used. All animals were bilaterally electrically stimulated by cochlear implants (CI). For ABRs, single biphasic electric pulses (200 µs/phase) were delivered to CI in broad bipolar configuration. The cortical responses were evoked by a train of 3 biphasic electric pulses (200 µs/phase, 500 Hz). The intensities up to 12 dB above ABR threshold were used. The ABRs were recorded using Ag-AgCl subcutaneous wire electrodes placed caudo-ventrally from the respective pinna and at the head vertex. Cortical activations (local field potentials and multiunit activity) were recorded using linear multichannel arrays (16 channels) covering all layers of the primary auditory cortex. The overall morphology, peak amplitudes, activation latencies and relation to binaural cues (interaural time and level differences - ITD and ILD, respectively) were evaluated.
Results: No difference in the amplitude of eABR signals was found between hearing controls and responses to the hearing ear in bCDC (comp. Tillein et al., 2012, Neural Plast). In uCDC, smaller amplitudes of eABR to the electric stimulation of the deaf ear were found in comparison to the hearing ear. This could be the consequence of reduced activation or a desynchronization of activity in the brainstem. Cortical unit responses showed shift in favor of the hearing ear irrespective of the recorded cortical hemisphere. Binaural stimulations showed dominance of the hearing ear resulting in weakly modulated ITD functions. The ILD functions were dominated by the intensity function of the hearing ear with small effects of the deaf ear input.
Conclusion: The present results indicate that the response to the deprived ear is affected already at the level of the brainstem in uDCDs. Following unilateral congenital deafness, abnormal and incongruent binaural spatial cues were observed at the cortical level. Supported by Deutsche Forschungsgemeinschaft (Exc 1077)
Session: S8-1  
Abstract ID: 415  
Title: The Journey to Trilingual Skills in Spoken and Sign Language After Early Implantation  
Presenting Author: Paula Berkley BA Dip Aud, MAud SA  
Author Block:  
Paula Berkley, BA Dip Aud, MAud SA 1, Kylie Chisholm, BA App Sc (Sp Path), Cert AVT LLS 1, Jodie Lenton, BA Early Education, Grad Cert Deafness, NATII 2 2; 1SCIC/RIDBC, Gladesville, NSW, Australia, 2RIDBC, North Rocks, NSW, Australia.  
Abstract:  
Introduction: The choice of cochlear implantation for children of Deaf parents where the primary language is sign language is a complex one. The learning of one auditory verbal language is common for a child with cochlear implants. However, when there is an additional spoken language used with an extended family further consideration must be given to children’s language acquisition. The learning of three languages, Auslan (Australian Sign Language) and two spoken languages, is one that has been successfully adopted by two children who attend our clinic. Australia’s universal newborn hearing screening program, early access to early intervention and cochlear implant assessment has enabled infants to be diagnosed with significant hearing losses at a very early age with cochlear implantation often being offered by the age of six months.  
Methods: Essential to these cases have been intensive initial counselling and support regarding the cochlear implant journey within a Deaf culture. Early implantation at 6 months is our standard, followed by appropriate mapping. Individual therapy sessions focusing on auditory verbal principles involving parents and extended family and ongoing multi discipline team supporting the family is vital. Central to the holistic philosophy has been enrollment into a bilingual preschool education in Auslan and spoken English.  
Results: Considering the whole family’s communication needs, engagement and hopes for their children, committed approached to developing spoken language through listening with cochlear implants and access to preschool education in their family’s home language of Auslan and well as English, has yielded a firm foundation in two spoken languages and sign language for these two children. Formal speech and language assessments in spoken English have indicated at 4 years and 5 years these children have skills in the average and high average range. The ability to code switch given the environment and/or audience is evident. Clinical team learnings in how to support Deaf families as they navigate cochlear implantation for their children will also be discussed.  
Conclusion: The data suggests tri-lingual acquisition, including sign language, following early cochlear implantation is possible, particularly when pre-requisites such as strong family engagement, support in family decision making, therapy and education options are optimal. The absence of comorbidities as well as early use of the cochlear implants are also important factors. This has provided access all modes of communication within the family.
Word Repetition Properties in Maternal Speech Predict Language Development in Children with Cochlear Implants

Yuanyuan Wang PhD

Yuanyuan Wang, PhD 1, Jongmin Jung, PhD 1, Tonya Bergeson, PhD 2, Neil Wright, AuD 3, Derek Houston, PhD 1; 1Otolaryngology, The Ohio State Univ., Columbus, OH; 2Communication Sciences and Disorders, Butler Univ., Indiana, IN; 3GN ReSound, Chicago, IL.

Abstract:

Introduction. Early language environment plays an important role in child language and cognitive development (e.g., Gilkerson et al., 2018; Hart & Risley, 1995). In the landmark longitudinal study, Hart and Risley (1995) found that the amount of parent talk to children between 10 to 36 months of age significantly predicted language outcomes at 3 years. Subsequent research has provided additional evidence that: (1) the properties of speech input to children change as a function of child development (Bergeson, Miller, & McCune, 2006; Stern, Spiker, Barnett, & MacKain, 1983); and (2) multiple properties of early linguistic input are associated with child language outcomes (Newman, Rowe, & Bernstein Ratner, 2016). In this study, we focused on the effects of hearing loss on word repetition properties of caregiver speech, properties that have been implicated in children’s speech perception and language development (McRoberts et al., 2009; Newman et al., 2016), and their relationship with language development in children with cochlear implants (CIs).

Methods. We recorded 17 mothers and their prelingually deaf children who received CIs before 2 years of age (CI group) at two post-CI intervals: 3 and 6 months post implantation; 18 hearing age-matched children with normal hearing (NH) and their mothers (NH-HAM group); and 14 chronological age-matched children with NH (NH-CAM group). The mother-child dyads were provided with a set of quiet toys to play with in a sound-attenuated room. Mothers were instructed to interact with their children as they would normally do at home. We used the conventions of Systematic Analysis of Language Transcript (Miller & Chapman, 2000) to transcribe the total number of target words produced, the number of unique target words used, the maximum repetition of target words, and the number of target words that were repeated three times or more. We also calculated the total number of words produced by the mothers during each session. To assess language development, we administered Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 2007), the Preschool Language Scale-Fourth Edition (PLS-4) (Zimmerman, Steiner, & Pond, 2002), and Pediatric Speech Intelligibility (PSI) (Jerger & Jerger, 1984), on children with CIs approximately 2 years after implantation.

Results. To determine the effects of hearing loss on word repetition properties, we fit repeated measures ANOVAs with Interval (3 months, 6 months) as the within-subjects factor, and hearing status (CI group, NH-HAM, NH-CAM) as the between-subjects factor for each measure. No significant main effects or interactions were found, ps > .083. To determine the relationship between word repetition properties and language development, we ran bivariate correlational analyses and found that word repetition measures and the total number of words produced during 6 months post implantation were significantly correlated with PPVT and PLS measures in children with CIs. However, no significant correlations were found between measures taken at 3 months post implantation and language measures.

Conclusion. The findings suggest that maternal speech directed to children with CIs, similar to maternal speech directed to children with NH, has repetitive properties that may benefit child speech processing and language development. These findings will inform early intervention programs for providing age-appropriate language input to children with CIs.
Session: S8-1  
Abstract ID: 325  
Title: Quality of Life for Youth with Hearing Loss Who Use Spoken Language.  
Presenting Author: Amy Melick PhD  
Author Block:  
Amy Melick, PhD, Terra Boulse-Archaro, MA, Erin Christianson, PhD, Kathryn Whitlock, MS, Kathleen Sie, MD, Susan Norton, PhD; Childhood Communication Center, Seattle Children's Hosp., Seattle, WA.  
Abstract:  
Introduction: The impact of hearing loss on quality of life (QoL) for children and adolescents is unclear. Our facility offers regular monthly social group meetings for youths with hearing loss who use spoken language. The social groups are led by a psychologist with expertise in hearing loss with support from aural habilitation therapists (SLPs) and audiologists. The goal of the current study was to measure QoL in youths with hearing loss who regularly attend the social groups.  
Methods: This is an ongoing observational study. Subjects are a cohort of youths with hearing loss who regularly attend a social group at a pediatric hospital. Institutional review board approval was obtained. A reading screener was administered to confirm reading ability was of 4th grade level or higher. The Youth Quality of Life-Deaf and Hard of Hearing (YQoL-DHH) (Patrick DL, Edwards TC, Skalicky AM, et al. 2011) instrument was administered. This instrument is comprised of 32 questions separated into three domains: Self-Acceptance/Advocacy, Perceived Stigma, and Participation. T tests were used to assess differences between domains and between CI and HA QoL. Pairwise associations of social group attendance, age and QoL were evaluated in separate regression models.  
Results: To date, a total of 15 subjects, mean age = 14 years (range = 11-18 years), participated in this study. There were 6 male subjects. Seven subjects use unilateral or bilateral hearing aids (HA) and 8 subjects have unilateral or bilateral cochlear implants (CI). One CI subject has single sided deafness and does not use her device. Data from this subject were not included in post-hoc analyses. All of the subjects attend the social groups regularly. Most subjects (93%) participated in other extracurricular activities. Results from the reading screener showed that all subjects had average or above average reading ability. The YQoL-DHH group t-test results (n = 15) showed a significant difference (p = 0.003) between the Participation and the Self-Advocacy/Acceptance domains. There was also a significant difference (p = 0.001) between the Participation and the Perceived Stigma domains. There was not a significant difference between the Self-Advocacy/Acceptance and Perceived Stigma domains. Post-hoc analyses (n = 14) showed no significant difference in QoL between the HA and CI groups for each domain. More frequent social group attendance was associated with higher QoL in the Participation domain (p = 0.022). There was a similar trend for the Perceived Stigma domain (p = 0.051) but not for the Self-Advocacy/Acceptance domain. Age was not significantly associated with differences in social group attendance or QoL.  
Conclusion: The current study examined the YQoL-DHH scores in children and adolescents with hearing loss who regularly attend organized social groups in a pediatric hospital setting. The results of this study indicate that youths who attend the social groups more often have higher QoL in the Participation domain and show a similar trend for the Perceived Stigma domain. There was not a significant difference between the YQoL-DHH results for youths who use HAs compared to CI users.
Session: S8-1  
Abstract ID: 319  
Title: Binaural Hearing in Infants (BIHI) Parent Questionnaire for Assessing Binaural Hearing Capabilities in Infants in with Cochlear Implants  
Presenting Author: Liat Kishon-Rabin Professor, PhD  
Author Block:  
Liat Kishon-Rabin, Professor, PhD 1, Riki Salem, MA 2, Daphne Ari-Even Roth, PhD 1, Ronen Perez, Professor, MD 2; 1Communication Disorders, Tel-Aviv Univ., Tel-Aviv, Israel, 2Otolaryngology, Head and Neck Surgery, Shaare Zedek Med. Ctr., Jerusalem, Israel.  
Abstract:  
Introduction: Behavioral assessment of auditory functioning of young infants with hearing loss is important for evaluating habilitation protocols and the efficiency of sensory devices (e.g., hearing aid, cochlear implant, bone-conduction aids). Because the young age of these infants impose difficulties on direct evaluation of their behavioral auditory functioning, behavioral auditory assessment tools include primarily parent questionnaires, such as, the Infant-Toddler Meaningful Auditory Integration Scale (ITMAIS), Little EARs, PEACH and the PRoduction Infant Scale Evaluation (PRISE). While these questionnaires have shown to be sensitive to the infants' auditory capacity and capabilities, they were not developed to assess binaural or bilateral hearing capabilities. The increasing numbers of infants with hearing loss that are implanted bilaterally with cochlear implants (CIs) have emphasized the need for a behavioral assessment tool that will be sensitive to the integration of information from two ears, i.e., to binaural hearing. We have recently developed a parent questionnaire, Binaural Hearing in Infants (BIHI) that includes 10 questions, nine of which assess the advantages of binaural hearing, such as, localization and listening in noise. The purpose of this study was to assess hearing in infants with bilateral cochlear implants (BCI) using the BIHI questionnaire. Specific purposes were: (1) to evaluate the sensitivity of the BIHI questionnaire to binaural hearing of BCI by comparing their performance to that with the ITMAIS and PRISE questionnaires, and (2) to compare the BIHI performance of BCI to that of bilateral normal hearing (BNH).  
Methods: Participants included 111 infants with normal hearing aged 3-26 months and 14 infants with severe-to-profound hearing loss. All but two infants were implanted simultaneously with CI at the age of 8-12 months. Infants had no known risk factors for developmental delays (other than hearing loss for the CI group) based on parent reporting. Auditory functioning and pre-verbal capabilities were assessed using the BIHI, ITMAIS and PRISE questionnaires at approximately 3 and 6 months post implantation. The experimenter explained the questions to the parents (followed with examples) and asked them to observe their infant for the specific behaviors of interest in the home environment. After a week, the parents were interviewed on each of the questions and scoring was given based on the frequency of occurrence of the tested behaviors.  
Results: (1) Performance of BNH infants increased monotonically with age reaching 90% at 21 months; (2) For all infants, ITMAIS performance was better than that of the BIHI, supporting the notion that the BIHI included more challenging listening conditions compared to the ITMAIS; (3) All CI infants showed ITMAIS performance within the normative range whereas for some, BIHI performance fell below the norms, suggesting that the BIHI is more sensitive to hearing capabilities of BCI compared to the ITMAIS; and (4) Preverbal production capabilities were better associated with the BIHI than with the ITMAIS for all infants.  
Conclusion: BIHI was found to be a behavioral assessment tool that is sensitive to the difficulties the BCI have in challenging listening conditions that require binaural hearing capabilities. In the lack of such tools for young infants, the BIHI may be useful in routine clinical settings for assessing binaural auditory functioning.
Session: S8-1
Abstract ID: 305
Title: First Cochlear Implant Under 12 Months, Contralateral Cochlear Implant Simultaneous and Sequential Comparison
Presenting Author: Catherine Birman MBBS PhD FRACS GAICD
Author Block:
Catherine Birman, MBBS PhD FRACS GAICD 1, Nadia Ashraf, BMedSci BMBS FRCS 2; 1SCIC, Sydney, Australia, 2Univ. Hosp. of Derby and Burton, Derby, United Kingdom.
Abstract:
Introduction: Bilateral auditory input from a young age allows for better hearing overall, better hearing in noise, removes the head shadow effect and allows for localisation. For cochlear implant (CI) recipients, depending on the level of hearing loss, this can be provided by bilateral cochlear implants or a cochlear implant and contralateral hearing aid. The aim of our study was to review children who received their first cochlear implant under 12 months old, and the second either simultaneously or sequentially
Methods: The Sydney cochlear Implant Center database and chart review for children receiving their first CI at 12 months, and either simultaneous or sequential second side CI.
Results: There were 147 identified, who received their first cochlear implant under the age of 12 months: the contralateral ear was implanted simultaneously in 71 and sequentially in 76 children. Developmental delay, a history of CMV or syndrome was present in 30 children (20%). Preschool Language score V (PLSV) for receptive and expressive language showed no significant difference in the simultaneous compared with the sequential groups. The additional disabilities group did have overall poorer performers as would be expected. IT-MAIS test showed no significant difference but the simultaneous group had a higher mean (not significant). Numbers were smaller when testing speech perception and language (Manchester Junior Word; PLSV; PPVT-IV) at 5 years and 9 years of age, but there was no significant difference between the two groups.
Conclusion: Receiving a CI under 12 months, affords great protection ensuring good language learning. There was no statistical significance between the simultaneous and sequential outcomes, but a trend of better language earlier for the simultaneous. Developmental delay affects language outcomes. The limitations of our study were over time some tests had limited data points
Session: S8-1
Abstract ID: 90
Title: Cochlear Implant Quality of Life (CIQOL): Development of profile (CIQOL-35 Profile) and a global (CIQOL-10 Global) quality of life instruments
Presenting Author: Theodore McRackan MD, MSCR
Author Block:
Theodore McRackan, MD, MSCR 1, Brittany Hand, PhD 2, Ci Quality of Life Development Consortium ., MD's, PhD's, AuD's 3, Craig Velozo, PhD 1, Judy Dubno, PhD 1; 1Med. Univ. of South Carolina, Charleston, SC, 2The Ohio State Univ., Columbus, OH, 320 institutions across the United States, Charleston, SC.
Abstract:
Introduction: Functional outcomes beyond speech recognition are rarely measured in adult cochlear implant (CI) users. Valid, reliable, and efficient patient-reported outcome measures (PROMs) are needed to quantify functional outcomes to supplement information obtained from performance-based outcomes, such as speech recognition scores. This study focuses on assessment of quality of life (QOL) after cochlear implantation and reports the psychometric properties of a 35-item CIQOL-Profile instrument and a 10-item CIQOL-Global measure
Methods: Patients referred from the Cochlear Implant Quality of Life Development Consortium (n=371), consisting of 20 CI centers across the United States provided responses to the 81-item CIQOL item bank, which comprises 6 domains (communication, emotional, entertainment, environment, listening effort, social). The development and psychometric evaluation of the CIQOL item bank was reported in an earlier publication. Patients were included if they were: 18-89 years of age, CI users for ≥1 year, and not recipients of a CI for single-sided deafness. Analysis of the CIQOL item bank using item response theory determined individual item difficulty, discrimination, and model fit. This information was used to select the set of items for each CIQOL instrument that would optimize its measurement characteristics.
Results: Subjects represented the full range of age, duration of CI use, speech recognition abilities, and listening modalities of the adult CI population and used all three CI manufacturers’ devices. The CIQOL-35 measures outcomes in each of the 6 domains of the CIQOL item bank, whereas the CIQOL-10 is a 10-item instrument that produces a single, overall QOL score. After ensuring the upper and lower ends of the item difficulty continuum were represented (item difficulty range: -2.48 to 2.47), the items with the highest discrimination ability for each domain were selected for the CIQOL-35 (discrimination range 0.84 to 1.37). Items were selected for the CIQOL-10 in a similar manner, but without grouping items by domains. The 10 items selected have a high discrimination (range: 0.92 to 1.35) and cover the ability continuum (item difficulty range: -0.31 to 3.18) of the population.
Conclusion: This study presents the initial development of two new PROMs that evaluate and differentiate adult CIQOL across the quality of life continuum. The work presented here can help guide clinicians and researchers to select the appropriate CIQOL instrument to meet their needs.
Session: S8-1  
Abstract ID: 270  
Title: Early Auditory Development of Cochlear Implanted Children  
Presenting Author: Anita Obrycka PhD  
Author Block:  
Anita Obrycka, PhD, Artur Lorens, PhD, Henryk Skarzynski, Prof; World Hearing Ctr. of the Inst. Physiology and Pathology of Hearing, Warsaw, Poland.

Abstract:  
Introduction: As candidacy criteria for cochlear implantation (CI) have been progressively relaxed to include very young children and those with residual hearing, there is the special interest in evaluation of early auditory development in these groups of children. The research question is whether there are differences in early auditory development between children with and without residual hearing.

Methods: 63 with residual hearing and 59 with profound deafness were tested with the LittlEARS questionnaire. The test was performed at CI activation assessing pre implant auditory development and up to 12 months of CI use. The LittlEARS normative values were used to calculate the delay in auditory development of children from both groups. The delay in auditory development was analyzed separately for children implanted before the age of 12 months and for children implanted at the age of 12 to 24 months.

Results: In children implanted before 12 months of age the delay in auditory development decreased over 12 months of CI use from 8 months to 1 month in the group with profound deafness and from 7 months to 1 month in children with residual hearing. In children implanted at the age of 12 to 24 months the delay in auditory development decreased over 12 months of CI use in both groups. However in children with profound deafness this delay after 12 months of CI experience was significantly higher comparing to the delay in auditory development in children with residual hearing.

Conclusion: Cochlear implantation before first year of life promotes accelerated auditory development in children with profound deafness.
Session: S8-1
Abstract ID: 407
Title: Receptive Vocabulary Acquisition in Young Children with Hearing Loss
Presenting Author: Andrea Warner-Czyz PhD

Author Block:
Andrea Warner-Czyz, PhD 1, Kristin Uhler, PhD 2; 1Communication Sciences and Disorders, The Univ. of Texas at Dallas, Dallas, TX, 2Audiology, Speech Pathology, and Learning Services, Children’s Hosp. Colorado, Denver, CO.

Abstract:
Introduction: Children with cochlear implants (CIs) have better receptive and expressive language outcomes than children with similar degrees of hearing loss who continue to use hearing aids, but still lag behind hearing peers from acquisition of language to language proficiency. To the best of our knowledge, no studies to date provide a detailed report of the most common words children with hearing loss understand at 12 and 18 months. The present study aimed to develop a better understanding of the receptive lexicons (size and composition) of children with hearing loss, and the variables that affect vocabulary size (e.g., sex, degree of hearing loss, duration of device experience).

Methods: Participants include 115 English-learning children with various degrees of hearing loss between 12 and 18 months of age (M = 14.9 months) and mean age at identification of hearing loss of 3.1 months. The sample included 95 hearing aid (HA) users with a mean fitting age of 5.1 months and mean device experience of 9.9 months, and 20 CI users with a mean implantation age of 13.1 months and mean device experience of 2.8 months. Parents completed the MacArthur-Bates Communicative Developmental Inventory: Words and Gestures, a normed and validated parent report checklist of early vocabulary outcomes from 8-18 months of age. A three-way analyses of variance was conducted to assess the main and interaction effects of sex (male, female); degree of hearing loss (mild to moderate, moderately severe to profound); and device type (HA, CI) on receptive vocabulary size. We also analyzed the composition of receptive vocabularies to determine the most commonly understood semantic categories and individual words by children with hearing loss.

Results: Mean receptive vocabulary of children with hearing loss was 81.2 words. Vocabulary size increased with chronologic age (24.8 and 57.8 words at 12 and 18 months, respectively), but still lagged behind norms for age-matched children with typical hearing. Children with higher degrees of hearing loss using CIs had larger vocabularies than those with the same degree of hearing loss using HAs (p<.05). Larger receptive lexicons coincided with lesser degrees of hearing loss (p<.01), younger age at device fitting (p<.05), longer duration of device experience (p<.05), and younger age at intervention (p<.05). The most prominent semantic categories include action words, games and routines, and animal names. At least half of the children in our sample understood a core set of words, headlined by mommy, daddy, and bye-bye.

Conclusion: Young children with hearing loss increase the number of words in their receptive lexicon as a function of chronologic age and device experience, but overall vocabulary size does not reach the level of hearing peers. Patterns of semantic categories and individual words understood by children with hearing loss approximate those in age-matched peers. Fine-grained analyses of specific words in the receptive lexicon of young children with hearing loss will provide the foundation by which to create a contemporary speech recognition test, which could supplement the lower levels of the Pediatric Minimum Speech Test Battery.
Session: S8-2
Abstract ID: 435
Title: Role of Medicaid in Pediatric Cochlear Implantation
Presenting Author: Donna Sorkin MA
Author Block:
Donna L. Sorkin, MA, Nichole Westin, MA; American Cochlear Implant Alliance, McLean, VA.
Abstract:
Introduction: In 2017, Medicaid was the largest funder of pediatric cochlear implants in the United States covering over 50% of surgeries and follow-up care followed by employer plans, government insurance (i.e., Tricare), Affordable Care Act plans, and self-funded mechanisms. Given that Medicaid is poorly funded in many states, there is concern that the program may not be appropriately providing services for low-income children covered by the program. The Early Periodic Screening Diagnostic and Treatment (EPSDT) program requires that Medicaid covered children are provided with services needed to aid children with disabilities reach their development potential. Hence there is federal oversight of the program’s impact in this regard and the potential to bring shortcomings to the attention of Federal policy-makers in states that have not met their responsibilities under the law.
Methods: The study utilized a survey of 45 cochlear implant (CI) clinics in 35 states that perform at least 10 surgeries per year to identify issues challenging concerns in providing the CI intervention to children under Medicaid. Survey questions were answered by a CI audiologist in the surveyed clinics in most instances. Responses were tabulated and analyzed to identify the major problems that Medicaid rules present. We then reviewed the state Medicaid regulations and discussed process concerns with clinic personnel. States not included in the survey were also reviewed so that the study covered all 50 states.
Results: The two most widespread concerns with Medicaid coverage of cochlear implants are equipment replacement challenges and very low reimbursement for cochlear implant surgery and related services. Although caps on the number of therapy sessions had been mentioned repeatedly, “hard” caps were confirmed in only two states. The real culprit in harming access is the time-consuming, bureaucratic nature of obtaining authorizations for therapy sessions beyond the number that are automatically allowed by state regulations. Medicaid Managed Care (MCO) rules present concerns for the future as more states strongly encourage their use as a cost containment strategy.
Conclusion: Medicaid is undeniably significant as a funder of cochlear implants in children. The nature of the services is largely consistent with that provided by private health insurance. Indeed even the ability to change rules (such as lowering the age at which surgery can be covered below the FDA 12 month guideline) has been achieved in some states. Clinics have an important role in working with state Medicaid agencies to help ensure that children are provided with appropriate care. The biggest challenge remains the financial burden that Medicaid reimbursement places on the hospital or clinic which may receive only a small proportion of actual cost.
Session: S8-2
Abstract ID: 119
Title: How Cochlear Implant Industry and Cochlear Implant Clinics Can Collaborate to Improve Clinical Efficiency
Presenting Author: Meredith Holcomb AuD
Author Block:
Meredith A. Holcomb, AuDMed. Univ. of South Carolina, Charleston, SC.
Abstract:
Introduction: Cochlear implant devices and accessory options have become increasingly complex over the years consequently requiring a more in depth discussion with patients following CI activation. This level of involvement and time commitment can be overwhelming for patients and monopolize an excessive amount of non-billable time for the audiologist. Including the CI company representatives in this process can off load non-billable work from the audiologist. Our CI program contacted the three manufacturers and established monthly sessions off campus where the company representative met 1-on-1 with CI recipients, discussed and demonstrated use of accessories, reviewed troubleshooting and device use, and introduced aural rehabilitation exercises. This presentation will discuss ways a large CI center streamlines the non-billable process of counseling and accessories to improve clinical efficiency.
Methods: A review of the success of 1-on1 workshops was conducted for a large CI center at an academic institution over a period of 1 year. Audiology work-load for the CI center was analyzed as well.
Results: Audiologists at the CI center spent 86% of their time with existing CI patients and 14% with new CI patients. And while there is 1.1 FTE cochlear implant audiology services at the CI center, the audiologists are performing work equal to 1.9 FTE. Over the course of 1 year the CI company representatives spent 78 hours with patients at the 1-on-1 workshops, releasing two full weeks of non-billable work for the CI center.
Conclusion: Involving the CI companies in the post-operative care for CI patients is necessary to reduce non-billable time spent in the clinic and to better educate patients on the company devices, accessories, and aural rehabilitation materials. Additionally, reducing non-billable tasks allows for more opportunities to see new patients and increase surgical numbers.
Session: S8-2  
Abstract ID: 161  
Title: Expanding a Cochlear Implantation Program: Identifying Bottlenecks and Resource Demands through Process Mapping  
Presenting Author: Ashley Nassiri MD, MBA  
Author Block:  
Ashley M. Nassiri, MD, MBA, Robert J. Yawn, MD, Nauman F. Manzoor, MD, Rene H. Gifford, PhD, David S. Haynes, MD, MMHC; Vanderbilt Univ. Med. Ctr., Nashville, TN.  
Abstract:  
Introduction: As advocacy and awareness efforts have and will continue to increase demand for cochlear implants (CIs), providers and institutions will need to accommodate larger volumes of patients. In order to expand a cochlear implant program, a detailed understanding of the service delivery model and its shortcomings is necessary prior to enacting changes to increase capacity. This study evaluates a high-volume CI program to identify bottlenecks and resource scarcities causing prolonged wait times for patients pursuing CI and to improve future service delivery.  
Methods: Observational data was collected from the time of initial referral through to the date of surgery for adults who underwent CI at a large-volume tertiary referral center. Data collected included: process events, length of individual process steps, wait times, and human resource requirement. Outcome measures included length of process events, wait times between events, and resource availability.  
Results: From initial referral to the date of surgery, a patient case navigated nine distinct process events including CI coordinator intake, completing & uploading patient information packet to electronic medical record, audiology screening & uploading, coordinated surgical, audiological and imaging appointments, insurance approval, surgery scheduling, and device ordering. On average, the process took 22 weeks, 2 days, 20 hours; importantly, 20 hours of this process was active work by an employee, while 22 weeks and 2 days were wait times between active events. Delays were associated with patients returning information packets (4 weeks), coordinated appointments (7 weeks), insurance approval (4 weeks), and surgical scheduling (4 weeks). The CI coordinator, responsible for inputting patient data and coordinating appointments, was identified as a scarce resource prompting prolonged wait times. The following opportunities for improvement were identified: use of interactive online records for patient packets, hiring more CI coordinators, Telehealth for CI candidacy evaluation, outsourcing preoperative imaging, and improving surgeon availability with pre-reserved CI appointments coordinated with audiology and radiology on the same day.  
Conclusions: Increasing demand for CI is straining the current service delivery model, which can delay patient treatment and surgical dates. Process mapping is an effective method to identify resource scarcities, which when addressed, can improve process efficiency and increase patient capacity. Addressing bottlenecks and causes of yield loss is critical in expanding a CI program and improving delivery of care.
Session: S8-2
Abstract ID: 164
Title: The Benefits of Using Audiology Assistants in a Cochlear Implant Program
Presenting Author: Teresa Zwolan PhD
Author Block: Teresa Zwolan, PhD Otolaryngology, Univ. of Michigan, Ann Arbor, MI.
Abstract:
Introduction: Medical facilities are placing greater emphasis on factors such as clinical productivity, provision of billable services, targets for patient access, and improvements in patient satisfaction and quality of care. Previous research, such as the CI-Smart study performed in 2009, and more recent research, such as that described by Camille Dunne at ACIA 2018 indicate that audiologists spend as much as 50% of their time providing non-billable services. Although manufacturer-based programs have helped, additional steps are needed to reduce the amount of time audiologists spend providing non-billable services. There are steps that can be taken to further reduce non-billable time spent by professionals and to improve the quality and quantity of services being provided by cochlear implant programs. One such step is the hiring of an audiology assistant.
Methods: Our large, academic medical facility cochlear implant program requested and received approval for an audiology assistant in 2015. This assistant performs a variety of duties, including serving as a test assistant for audiometric tests and programming appointments for children who are less than 4 years of age; equipment preparation for mapping appointments; maintenance, calibration, and sterilization of test equipment; maintenance and dispensing of loaner hearing aids and sound processors; and in-person or over the phone troubleshooting and instruction related to sound processors, hearing aids, and accessories, to name a few.
Results: Our audiology assistant serves as a test assistant for approximately 10 appointments each week. Prior to the introduction of this position, audiologists or speech-language pathologists served as test assists. This has resulted in an increase of approximately 40 hours of billable time each month. The additional duties performed by the audiology assistant have reduced the non-billable duties being performed by audiologists, resulting in improvements in patient access - both on the audiologists’ schedules as well as improved access for troubleshooting and sound processor accessory assistance - procedures performed by the audiology assistant.
Conclusion: This session will highlight steps taken by a large tertiary medical clinic to reduce the amount of time spent by professionals on non-billable services. We will provide an overview of the return on investment (ROI) document used to request the new position, and will describe duties performed by the audiology assistant. We will discuss the positive impacts this position has had on our program including improved access to care for patients, an increase in the number of available slots for audiologists, and how the position has resulted in improvements in quality of care.
Session: S8-2
Abstract ID: 239
Title: Increasing Efficiency While Maintaining Patient Outcomes and Satisfaction: One Clinic’s Approach to a New Service Delivery Model
Presenting Author: Regina Presley Doctor of Audiology
Author Block:
Regina Presley, Doctor of Audiology
Presbyterian Board of Governors Cochlear Implant Ctr. of Excellence @ GBMC, Baltimore, MD.
Abstract:
Introduction: As the number of cochlear implants have increased, centers have looked for ways to increase clinic efficiency while maintaining profitability, patient satisfaction and outcomes. This has included redefining the responsibilities not only of the audiologist but other professionals within the clinical care model.
Objectives: A retrospective review of one clinic’s experience redefining the clinical care model for cochlear implant patients will be presented.
Methods: An overview of the changes made to our clinical model and the impact on clinic efficiency and patient satisfaction will be presented. These include monthly device counseling workshops, development of counseling videos that can be viewed on center website, components of the activation and counseling moved to the SLP sessions, and the use of administrative staff and/or CI tech for the completion of non-billable tasks.
Results: A reduction in the number of overall visits from 8 to 5, doubling of the number of CI surgeries over the past year with minimal staff changes, a reduction in counseling time from 8 hours per month to 2 hours per month, a reduction in non-billable appointments and increased profitability for CI related tasks completed by the SLP, and clinician observation of increased patient confidence.
Conclusion: The data presented shows a reduction in clinical time while maintaining profitability and patient and clinician satisfaction. Next steps for the evolution of the model include a redesigned workspace and clinic flow as well as the investigation of the use of a clinical decision support tool for programming which includes self-testing.
Session: S8-2  
Abstract ID: 394  
Title: New CI Delivery Model using Artificial Intelligence: A Case Study.  
Presenting Author: Sara Neumann AuD  
Author Block:  
Sara Neumann, AuD, Jace Wolfe, PhD; Audiology, Hearts for Hearing, Oklahoma City, OK.  
Abstract:  
Introduction: New approaches to cochlear implant (CI) programming seek to reduce the number of post-operative visits while also standardizing programming practices and improving outcomes. Our center is currently involved in a multicenter study evaluating a new clinical decision-assisted CI programming software that utilizes artificial intelligence (AI) and integrated evaluation measures through a direct connect testing system. The evaluation measures are administered and tracked by a software package, which incorporates a psychoacoustic test battery to evaluate the auditory function of cochlear implant recipients. It is used in tandem with artificial intelligence to provide programming parameter recommendations to the clinician based on the outcomes of the evaluation measures. This method is a data-driven approach to programming, and as a result, it can be used with both experienced and newly implanted recipients, and it provides an alternative post-operative programming schedule requiring fewer appointments to achieve outcomes that are comparable to those obtained with traditional programming methods.  
Methods: There are two arms to the study which include 40 newly implanted and 50 existing CI recipients across 10 CI centers in the United States. Test metrics for this within subject, repeated measures design included: CNC Words, AzBio sentences in noise (+10dBSNR), and a psychoacoustic battery (including audiometry, loudness scaling, phoneme discrimination, and speech audiometry) and subjective measures of patient satisfaction. A single, teenage subject from the existing group of participants will be presented. CNC word recognition and AzBio sentence recognition in noise assessments were completed with the participant’s typical/preferred program created by an experienced clinician via traditional CI programming methods (i.e., “expert clinician [EC] MAP”) and repeated at a second visit one month later after using the program created via the novel programming method using AI based on results from the integrated psychophysical test battery (i.e., “AI MAP”). Further adjustments were made to optimize the AI MAP.  
Results: Results from this subject will be shared, including a comparison of the speech perception results from the “EC MAP” and “AI MAPs”. Results suggest equivalency in speech perception obtained with use of the EC MAP and AI MAP after optimization of the MAP with AI techniques.  
Conclusion: Preliminary data shows utilization of a novel CI programming approach that incorporates direct connect testing with AI provides equivalent outcomes to results obtained with traditional programming done by an experienced clinician. This novel approach for programming CIs can substantially reduce the number of visits required to create a satisfactory CI map, and it may allow for standardization of the CI programming process across centers. Additionally, this new approach may facilitate a more interactive role for the patient in the process of CI programming.
**Session:** S8-2  
**Abstract ID:** 263  
**Title:** Disparities in Access to Cochlear Implant Surgery and Related Services  
**Presenting Author:** Simon Angeli MD  
**Author Block:**  
Simon Angeli, MD, Ivette Cejas, PhD, Pryyanka Reddy, MS; Otolaryngology, Univ. of Miami Milner Sch. of Med., Miami, FL.

**Abstract:**

**Introduction:** The long term consequences of delayed access to adequate hearing can lead to setbacks in language acquisition, long-term academic performance, social interaction, employment, and quality of life. An increased proportion of deaf or hard of hearing (DHH) children come from families who live closer to the poverty line, report poorer health status, and are on public (Medicaid) vs private insurance. There have been studies showing that language, income, socioeconomic status (SES), and ethnicity play a role in how quickly children are able to access diagnostic and habilitative services, including cochlear implant (CI) services.

**Methods:** DHH children under the age of 18 who underwent a cochlear implant evaluation and were seen at University of Miami Ear Institute from July 2010 to October 2018. Medical records were queried for demographic data, clinic visit dates, interventions for hearing loss, and diagnoses codes. Data recorded included age, sex, date of birth, race/ethnicity, home zip code, insurance type, primary language, date of diagnosis, date of first evaluation for hearing loss, date of hearing aid fitting, date of cochlear implant evaluation, date of cochlear implant surgery, etiology of hearing loss, co-morbidities of hearing loss, imaging studies, utilization of speech therapy, educational accommodations, and psychology/psychiatry evaluations. Maternal level of education and need for assisted transportation to attend visits were used as surrogate markers of SES. Results of standardized testing of hearing and language outcome were reviewed, including parental questionnaires of children’s hearing proficiency with cochlear implants.

**Results:** Results: Three hundred and sixty pediatric cochlear implants were performed during the study period. The time from diagnosis of hearing loss to first hearing aid fitting and first cochlear implant surgery, and the time from the first cochlear implant evaluation to cochlear implant surgery was longer in children coming from distant areas, with public insurance, and from families with lower maternal education level. Perceptive and language outcome were negatively associated with extent of co-morbidities, type of primary communication, and delayed access to cochlear implant services.

**Conclusion:** Conclusions: Demographic and socioeconomic factors have an important effect on access to cochlear implant services and post-cochlear implantation outcomes. Centers caring for disadvantage populations must make accommodations to facilitate access.
Session: S8-2  
Abstract ID: 179  
**Title:** Early Intervention Enrollment in Children with Hearing Loss: The Impact of Service Delivery Model  
**Presenting Author:** Ursula Findlen PhD  
**Author Block:**  
Ursula M. Findlen, PhD 1, Tabbetha Greco, MA, MS, doctoral candidate, ECMH 2, Gina M. Hounam, PhD 1, Riley Bayer, BA 1, Kayleigh Matesick, MA, EIS 2, Prashant Malhotra, MD 3; 1Clinical Therapies-Audiology Department, Nationwide Children’s Hosp., Columbus, OH, 2Family and Volunteer Services, Nationwide Children’s Hosp., Columbus, OH, 3Pediatric Otology and Hearing Program, Nationwide Children’s Hosp., Columbus, OH.  
**Abstract:**  
**Introduction:** The Joint Commission on Infant Hearing (JCIH) guideline recommends children with permanent hearing loss be enrolled in early intervention (EI) services by six months (JCIH, 2007). On the national level, EI enrollment has increased from 44.9% in 2006 to 67.2% in 2016 (CDC, 2008; CDC, 2018). JCIH (2013) recommends a service delivery model using a service coordinator with specialized knowledge and skills about individuals who are deaf or hard of hearing (D/HH). Despite this recommendation, many state EHDI programs use a primary service coordinator who has limited or no background knowledge of hearing loss and its impact on development. The state EHDI service delivery model for EI enrollment recently changed in our state from using regional service coordinators with specialized D/HH knowledge and skills to a model using a centralized system with service coordinators who have limited or no experience working with children who are D/HH. The purpose of this Quality Improvement (QI) study is to evaluate the influence of service delivery model at the state EHDI level on EI enrollment in a large, multidisciplinary program at a tertiary pediatric hospital.  
**Methods:** A retrospective case review was completed for each child provided services through our Hearing Program between January 2015 and August 2018. The following hearing demographics were collected: date of identification, laterality and degree of hearing loss, hearing devices used, and any comorbid diagnoses. Concurrently, EI demographics about the number of referrals to EI, enrollment in EI (if applicable), quantity of EI provided, and whether goals for communication were included on individual family service plans (IFSP) for the same cohort of children were recorded. Descriptive statistics for children identified during the regional/specialized service coordinator program (2015 through September 2016) were compared with those identified during the centralized/non-specialized service coordinator program (October 2016 to August 2018).  
**Results:** A total of 323 children were identified in our Hearing Program during the study period. The participants are broken down into two groups with 125 children identified during the regional/specialized time period and 168 identified during the centralized/non-specialized time period. Referral from our program to EI services did not appreciably change over the study period (92.6% to 89.4%). Enrollment in EI decreased from 92.0% to 76.8% when the state EHDI program implemented the non-specialized personnel delivery model. Formulation of IFSP’s also decreased from 93.9% to 86.0% for this cohort. Although there was an increase in the percentage of children identified with hearing loss by the recommended three months of age from 45.6% to 60.7%, there was a concurrent decrease in the rate of enrollment by 6 months of age from 63.2% to 53.9%. Lastly, only a minimal decrease was noted for IFSP goals that targeted hearing and/or communication skill development (87.0% to 82.0%).  
**Conclusion:** Service delivery model at the state level for early intervention appears to impact initial early intervention enrollment rate and timing, but not the provision of IFSP goals that target hearing and communication skill development. Implications and the multiple factors that may have contributed to these findings will be discussed. Quality improvement measures implemented will also be reviewed.
Session: S8-2
Abstract ID: 105
Title: Thirty-Five Years of Cochlear Implantation at One of the Nation's Largest Pediatric Centers
Presenting Author: Harold Pillsbury MD
Author Block:
Harold Pillsbury, MD, Lisa Park, AuD, Hannah Eskridge, MS, Elizabeth Preston, AuD, Erika Gagnon, AuD, Jennifer Woodard, AuD, Melissa Auchter, AuD, Carlton Zdanski, MD, Brendan O'Connell, MD, Lauren Kilpatrick, MD, Matthew Dedmon, MD, PhD, Margaret Dillon, AuD, Kevin Brown, MD, PhD; Otolaryngology/Head and Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC.
Abstract:
Introduction: The cochlear implant is a revolutionary technology that has restored the hearing of hundreds of thousands of hearing loss patients - improving their speech understanding and quality of life. The first candidates for cochlear implantation had bilateral profound hearing loss with little to no speech understanding. The success of the cochlear implant in these patients raised the question of who else could benefit from this technology. Multiple clinical trials have investigated and demonstrated the benefit of cochlear implantation under expanded indications, and it is a question we continue to investigate today. One of the nation’s largest pediatric cochlear implant centers includes physicians, audiologists, speech-language pathologists, and researchers who are dedicated to improving the outcomes of children with hearing loss.
Methods: Our pediatric cochlear implant program has implanted over 1,500 cases and has been at the forefront of clinical research investigating expanded indications for cochlear implantation in children. Findings from these studies have and continue to contribute to the expanding indications for cochlear implantation in the US. This report will review the findings from conventional pediatric cochlear implant recipients, and children implanted as part of clinical trials investigating expanded indications (e.g. Electric-Acoustic Stimulation (EAS) and Unilateral Hearing Loss (UHL)).
Results: Pediatric cochlear implant recipients who received their device under current indications or clinical trials investigating expanded indications for cochlear implantation experience significant benefit with device use. The inclusion of advanced mapping techniques and aural rehabilitation tailored to the individual patient improves outcomes.
Conclusion: Cochlear implantation is a beneficial treatment for pediatric patients with bilateral severe-to-profound sensorineural hearing loss. Investigations of cochlear implantation in children with more residual hearing, including cases of normal-to-moderate low-frequency hearing and UHL, also demonstrate a benefit. Collaboration between physicians, audiologists, speech-language pathologists, nurses, and therapists in the treatment of pediatric cochlear implant recipients may support optimal outcomes.
Session: S8-3
Abstract ID: 383
Title: Evaluation of Cochlear Implant Noise Management Technologies
Presenting Author: Sara Neumann AuD
Author Block:
Mila Duke, AuD, Jace Wolfe, PhD, Sara Neumann, AuD; Audiology, Hearts for Hearing, Oklahoma City, OK.
Abstract:
Introduction: Cochlear implant recipients often experience difficulty understanding speech in noise. The objective of this study was to evaluate the potential improvement in speech recognition in noise that recipients obtain with the use of a variety of different cochlear implant (CI) noise management technologies in realistic, noisy environments (e.g., simulated café and classroom settings). Specifically, this study compared hearing performance with use of a variety of different noise management technologies including: 1) channel-specific noise reduction, 2) an automatically-enabled, adaptive directional microphone mode, 3) an enhanced, fixed directional microphone mode that provides significant attenuation to sounds from the rear hemisphere, and 4) a remote microphone system.
Methods: Twenty bilateral CI recipients, ages 7 and older, were evaluated in two different listening configurations including 1) Café: the participants were positioned in the middle of an 8-loudspeaker array (loudspeakers located 4 feet, 3 inches from listener) with the speech signal presented from 0° azimuth and modulated noise presented from 45°, 90°, 135°, 180°, 225°, 270°, and 315° azimuth, and 2) Classroom: the participants were located in the middle of the room with the speech signal presented from a loudspeaker 8 feet, 6 inches away at 0° azimuth and classroom noise presented from four loudspeakers located in the corners of the room. AzBio Sentences were presented in the Café setting at a +10 dB and +5 dB SNR and in the classroom at a +4 dB SNR. In each of the three listening environments, sentence recognition was evaluated in each of the five noise management technology conditions: 1) standard microphone mode without channel-specific noise reduction (NR) (i.e., default), 2) standard microphone mode with channel-specific NR (i.e., NR), 3) automatically-enabled, adaptive directional microphone (ADM) along with channel-specific NR (i.e., ADM-NR), 4) an enhanced directional microphone (EDM) mode that provides significant attenuation to sounds from the rear hemisphere along with channel-specific NR (i.e., EDM-NR), and 5) remote microphone (RM) technology along with channel-specific NR (i.e., RM-NR).
Results: Repeated measures analysis of variance (RM-ANOVA) indicated significant main effects of listening condition and noise management technology with a significant interaction between listening condition and noise management technology. A post-hoc analysis with the Tukey-Kramer Multiple-Comparisons Test indicated that the use of the directional microphone technology improved speech recognition in noise in the café settings but not in the classroom setting. Each of the four different noise management technologies improved speech recognition in noise in the café setting with the less favorable SNR (+5 dB SNR). Use of the RM provided the best sentence recognition in noise in all listening conditions. In the classroom environment, participants performed poorly in all settings except for when the RM was used.
Conclusion: Directional microphone and channel-specific NR technologies can improve speech recognition in noisy environments, especially as noise levels increase. Best performance in noise is achieved with the use of the RM technology, particularly in classroom settings. Clinicians should counsel patients on the potential benefits of using these different technologies in everyday, adverse listening environments.
Session: S8-3
Abstract ID: 1023
Title: Testing Speech Perception with Cochlear Implants Through Direct Audio
Presenting Author: Daniel Zeitler MD
Author Block:
Chen Chen1, Amy Stein1, Michelle L. Hughes2, Haley Morris1, Leonid Litvak1, Daniel M. Zeitler3 1
Advanced Bionics, LLC, Valencia, CA; 2 Purdue University, West Lafayette, IN; 3 Virginia Mason Medical Center, Seattle, WA

Abstract:
Objective: Standard audiometric and speech perception testing requires specialized equipment, which can impose barriers to receiving hearing healthcare for people who live in remote regions or have accessibility issues. For people with cochlear implants (CIs), providing test stimuli directly to the device via wireless direct audio streaming (DAS) or direct audio input allows for testing hearing performance without the need for a sound booth. The goal of this study was to evaluate speech perception for listeners with CIs when stimuli were delivered via DAS versus in a traditional sound booth setting to determine whether differences existed between the two presentation modes.
Design: This study consisted of two experiments. In Experiment 1, speech perception was measured for monosyllabic words in quiet and sentences in quiet and in noise. Scores were obtained in a sound booth and compared to those obtained via DAS for 11 adults (12 ears) with CIs. In Experiment 2, speech perception was measured for sentences in noise, where the speech stimuli were pre-processed to emulate the sound booth environment. Scores were obtained for 11 adults (12 ears) in the sound booth, via DAS with the unprocessed speech, and via DAS with the processed speech. The goal was to determine whether the addition of sound-booth acoustic characteristics would minimize performance differences between the sound booth and DAS.
Results: For Experiment 1, there was no significant difference between the sound-booth and DAS conditions for words or sentences in quiet. However, scores obtained using DAS were significantly better than those obtained in the sound booth for sentences in noise. For Experiment 2, there was no significant difference between scores obtained in the booth and DAS with the processed speech.
Conclusions: By filtering the test materials using an emulated sound booth, we can account for differences in speech perception scores between those obtained via DAS and in a sound booth.
Session: S8-3
Abstract ID: 154
Title: The Effects of the Interphase Gap on Neural Response of the Electrically-Stimulated Auditory Nerve in Children with Cochlear Nerve Deficiency and Children with Normal-Size Cochlear Nerves
Presenting Author: Shuman He MD, PhD
Author Block: Shuman He, MD, PhD 1, Fuh-Cherng Jeng, MD, PhD 2, Xiuhua Chao, MD 3, Lei Xu, MD 3, Angela Pellittieri, AuD 1; 1Otolaryngology - Head and Neck Surgery, The Ohio State Univ., Columbus, OH, 2Communication Sciences and Disorders, Ohio Univ., Athens, OH, 3Otolaryngology - Head and Neck Surgery, Shandong ENT Hosp., Jinan, China.
Abstract:
Background: The sensitivity of the neural response generated by the electrically stimulated auditory nerve (i.e. the electrically evoked compound action potential, eCAP) to changes in the inter-phase gap (IPG) has been shown to be associated with neural survival of the cochlear nerve (CN) in guinea pigs (Prado-Guitierrez et al., 2006; Ramekers et al., 2014). However, studies investigating the effects of the IPG on eCAP results in human cochlear implant (CI) users have shown conflicting findings (Hughes et al., 2018; Schwartz-Leyzac and Pfingst, 2016, 2018), presumably due to the unpredictable CN neural survival pattern in individual CI patients. Compared to children with normal-sized CNs, children with cochlear nerve deficiency (CND) have fewer CN fibers (i.e., poorer CN neural survival). More importantly, the likelihood of measuring the eCAP in children with CND reduces as the stimulating CI electrode site moves from the base to the apex of the cochlea, with many apical CI electrodes showing no measurable eCAP. This unique response-deterioration pattern is not observed in children with normal-sized CNs, and differs from the previously reported CI-electrode-to-modiolus-distance pattern (Long et al., 2014). Therefore, it primarily reflects the unique poor CN survival pattern in children with CND. As a result, comparing the eCAP sensitivity to changes in the IPG between these two subject groups provides an extremely valuable opportunity to confirm these important animal research findings.
Methods: To date, 15 children with CND and 15 children normal-size CNs have been recruited and tested for this study. All study participants used a Cochlear® Nucleus™ CI in the test ear. The eCAP was recorded in each participant at three electrode locations across the electrode array and had relatively equal separation between testing electrodes. IPGs tested in this study included 7, 14, 21, 28, 35 and 42 μs. Slopes of the eCAP Input/Output (I/O) function were estimated using statistical modeling with a sigmoidal regression function. Dependent variables (DV) of interest included eCAP thresholds, slopes of the eCAP I/O functions, and eCAP amplitudes measured at the common maximum comfortable level (C level) at all IPGs. Effects of study group, IPG and electrode location on each DV were evaluated using Generalized Linear effect Mixed Models.
Results: Results of our preliminary data analysis indicated that children with CND had flatter slopes of I/O functions, higher eCAP thresholds and smaller eCAP amplitude at the C level than children with normal-sized CNs. More importantly, children with CND demonstrated reduced eCAP sensitivity to changes in IPGs, with greater reduction observed at more apical electrode locations.
Conclusion: Our preliminary results indicate that the eCAP sensitivity to changes in the IPG is associated with CN neural survival in human CI users.
Session: S8-3
Abstract ID: 284
Title: Investigating Bimodal Solutions for Children with an Advanced Bionics Cochlear Implant
Presenting Author: Julia Reid AuD
Author Block:
Julia Reid, AuD 1, Sydney Bednarz, AuD 1, Nancy Mellon, MA 2, Meredith Ouellette, MS 2, Christine Mitchell, ScM 3; 1Audiology, The River Sch./Chattering Children, Washington, DC, 2The River Sch./Chattering Children, Washington, DC, 3Bloomberg School of Public Health, Johns Hopkins, Baltimore, MD.
Abstract:
Introduction: Individuals with a cochlear implant (CI) in one ear and a hearing aid (HA) in the other require their brain to process two distinct signals simultaneously, which may result in increased cognitive load, fatigue and difficulty hearing in noise. However, binaural benefit outweighs the challenges associated with mismatched inputs. CIs and HAs differ in their sound processing algorithms causing a misalignment of loudness growth, frequency response, and dynamic behavior. Advanced Bionics (AB) and Phonak created a HA that aligns its processing algorithm with a CI: the Naida Link HA with the Adaptive Phonak Digital Bimodal fitting formula (BFF). Preliminary research indicates best bimodal sentence scores in noise were seen with the BFF compared to other formulas and patient preference for aligned AGC to standard AGC (Veugen et al, 2016; Chalupper et al, 2013). There are few studies on children’s performance with the BFF. The pediatric fitting standard has been to use Desired Sensation Level (DSL) formula verified to prescriptive targets with individually measured Real-Ear-to-Coupler-Differences (RECDs). Our study investigates the appropriateness of BFF for children by comparing the new algorithm to the DSL formula and combining settings between formulas to determine whether pediatric audiologists should consider the Naida Link for their bimodal AB patients.
Methods: Five subjects were identified as appropriate from the clinic database. Subjects were evaluated with four programming methods differing based on fitting formula, HA type and/or prescriptive target were investigated. Conditions of interest were as follows with the Naida Link UP: 1) BFF - default manufacturer settings; 2) BFF fit to DSL prescriptive targets; 3) DSL formula fit to DSL targets. A traditional Phonak hearing aid was measured in the following condition: 1) DSL formula fit to DSL targets. HAs were programmed and verified using measured RECDs. In conditions that included verification, overall gain adjustments were made based on DSL prescriptive targets. Single word speech perception and speech-in-noise scores were reported for HA alone and bimodal conditions. Real-world performance was measured through a parent-teacher questionnaire for each fitting condition.
Results: Preliminary results show a trend for poorest speech perception scores in both quiet and noise for BFF at default settings and best performance for the BFF fit to DSL prescriptive targets. No subjects preferred BFF default settings and subjects varied on which fitting formula yielded best outcomes. Further statistical analysis will be provided.
Conclusion: A closer look at the Naida Link HA suggests that the default settings may not be appropriate for children. A mixture of BFF and DSL may be a good alternative to optimize settings. Further analysis is needed with a larger sample size to determine if these results generalize to the greater population and which formula yields best outcomes.
Session: S8-3
Abstract ID: 265
Title: EEG Alpha Activity as an Objective Marker of Listening Effort During Speech in Noise Perception in Cochlear Implant Users
Presenting Author: Andrew Dimitrijevic PhD
Author Block:
Brandon T. Paul, PhD 1, Joseph Chen, MD, FRCSC 2, Vincent Lin, MD, FRCSC 2, Trung Le, MD, FRCSC 2, Andrew Dimitrijevic, PhD 1; 1Evaluative Clinical Sciences Platform, Sunnybrook Res. Inst., Toronto, Canada, 2Department of Otolaryngology - Head & Neck Surgery, Sunnybrook Hlth. Sci. Ctr., Toronto, Canada.
Abstract:
Introduction: Cochlear implant (CI) users commonly report that they must exert a high degree of listening effort (LE) to understand speech in challenging environments, such as in noise or with competing talkers. Over time, chronic LE can lead to exhaustion and sometimes discontinued CI use. Speech-in-noise tests used in the clinic do not capture LE, but LE is critical part of the listening dimension since some CI users may expend far more effort to reach the same performance as a CI user who uses less effort. An objective measure of LE would convey important information to the clinician as to whether a CI user is performing adequately and with as minimal effort as possible. This is especially important for children with CIs, because the concept of effort may be difficult to report for this population, and because chronic LE can impede the development of language skills owing to the increased mental demand that is placed on them during everyday listening. Past research suggests that cortical alpha rhythms (8-12 Hz) recorded by electroencephalography (EEG) are a probable correlate of LE during speech-in-noise perception. The relationship between brain activity and LE has been shown by looking at individual differences in LE across a group of CI users, but there is no individual marker of LE yet established that would uniquely indicate when a CI user is using either high or low effort to listen to speech. The goal of the present study is to determine if EEG alpha activity can reveal correlates of LE during a simple speech-in-noise task on an individual level. Here we report preliminary data in adult CI users, which sets the stage for investigations in to the pediatric CI population.
Methods: While recording the 64-channel EEG, 12 adult CI users using their everyday CI setting were tested on the digit triplet test (DTT) in an 8-speaker free field. The DTT presents trials of three spoken digits (centre speaker) in multi-talker babble noise (peripheral 7 speakers) at different signal-to-noise ratios (SNRs). After each trial, CI users verbally reported the digits that they heard, and rated LE on a 1-10 scale. SNRs were adjusted per individual in a pre-experiment task designed to identify levels corresponding to the highest and lowest LE, while maintaining audibility across all trials.
Results: In twelve CI users collected to date, LE ratings significantly correlated to single-trial alpha power in left lateralized brain regions including Broca’s area, consistent with networks known to be involved in language processing and attention to speech in noise. EEG DTT data from normal hearing pediatric subjects without LE ratings show similar alpha modulations as the adults.
Conclusion: Results suggest that EEG alpha activity may be used as an objective, individual neural marker of listening effort in CI users. Because we have successfully measured the DTT in children as young as 4 years, this design can be easily tested in the pediatric CI population.
Session: S8-3
Abstract ID: 293
Title: Bimodal Speech Perception and Prosody Recognition in CI Recipients with Asymmetric Hearing Loss
Presenting Author: Diego Zanetti MD
Author Block:
Diego Zanetti, MD 1, Federica Di Berardino, MD 1, Umberto Ambrosetti, MD 1, Loredana Todini, Speech Therapist 1, Gabriella Tognola, Biomedical Engineer 2, Luca Del Bo, Engineer 3; 1Audiology Unit, Department of Clinical Sciences and Community Health; University of Milan, Fondazione IRCCS Cà Granda, H. Maggiore Policlinico, Milano, Italy, 2IEIIT-CNR (Inst. of Electronics and Engineering of Information and Telecommunication – Natl. Res. Council), Milano (Italy), Milano, Italy, 3Fondazione Ascolta e Vivi, Milano, Italy.
Abstract:
Introduction: Patients with asymmetric sensorineural hearing loss, i.e. profound in one ear and severe in the other, who fall outside the audiological boundaries of bilateral cochlear implantation (CI), may benefit from a hearing aid. To which extent this occurs, depends, among other factors, on the degree of contralateral residual hearing and on pre-op aided/unaided speech perception in quiet and noise, and is still a subject of debate. The objective of this study is to evaluate the outcomes of bimodal stimulation in terms of speech perception and suprasegmental cues in a strictly selected sample of adults receiving the same CI and HA devices.
Methods: A cohort of 12 adults with asymmetric hearing loss received an Oticon Neuro ZTI® cochlear implant and a Dynamo® hearing aid, respectively. Patients’ age ranged from 16 to 76 years (mean 47.5, SD 24.6). They were tested before implantation (time T0), at month 3, 6 and 12 after CI activation (time 3M, 6M, 12M respectively), by means of: • pure-tone audiogram (PTA) in sound booth and in free-field (FF); • speech perception (dysillabic words recognition scores - WRS) in free-field (FF) in quiet and with cocktail party noise masking; • the 48 items SSQ questionnaire (Tyler, 2009); • the ASSE test. The performances for all tests were checked in the 3 following conditions: bimodal (CI + HA); CI only; HA only.
Results: As expected, the WRS were slightly better in the CI+HA condition than with the CI alone but significantly better than with HA alone in quiet; quite surprisingly though, the differences in noise did not increase significantly in the bimodal condition. The SSQ for the bimodal stimulation showed a constant improvement over 12 months, especially for the “quality of sound” sub-scale. The ASSE test returned the most interesting results: the combined (CI+HA) stimulation provided a statistically significant advantage to CI recipients on all the 7 tasks, with a constant improvement of the JND (just noticeable differences) over time. The greatest advantages were observed with and the PD (phoneme discrimination) and disharmonic intonation (DisInt) subtests.
Conclusion: The preliminary results of this well controlled pilot study confirm certain advantages of the bimodal stimulation, especially in the listening tasks related with the perception of prosodic cues.
Title: What Cues Do Early Implanted and Post-Lingually Deafened Cochlear Implant Users Use to Understand Speech?

Presenting Author: David Landsberger PhD

Abstract:

Introduction: Why do adults implanted as young children perform better on speech understanding tasks than adults implanted after post-lingual deafening? One likely explanation is a difference in the underlying auditory systems between the two groups. Adults implanted as pre-lingual children have auditory systems that develop around the impoverished signal from a cochlear implant. Adults implanted after post-lingual hearing loss have auditory systems that develop in response to a rich acoustic input and then adapts to implantation at a later stage in life. It is therefore plausible that these two groups have developed to use different (or differently weighted) auditory cues when interpreting an auditory signal. To investigate this hypothesis, we compared clinical performance on speech understanding between these two populations. Additionally, we measured spectral and temporal abilities for both groups as spectral and temporal cues have been previously shown to be important for speech understanding.

Methods: Speech understanding on CNC words and AzBio sentences in noise was extracted from clinical records for early-implanted (before age 5) and post-lingually deafened adults. Spectral resolution was measured for early-implanted children and post-lingually implanted adults using the Spectral-temporally Modulated Ripple Test (SMRT). Temporal modulation detection for a 100 Hz broadband noise was measured for early-implanted children and post-lingually implanted adults using a test called the EasyTMT.

Results: Early implanted adults performed better on speech tests than post-lingually deafened adults. Spectral resolution was worse for early implanted children than post-lingually deafened adults, whereas temporal modulation detection was better for early implanted children than post-lingually deafened adults.

Conclusion: Contrary to prior research, poor spectral resolution in the early implanted CI users did not yield poorer speech understanding. This suggests that they may not be relying as much on spectral information for speech understanding as post-lingually deafened CI users. As evidenced by their superior performance on the temporal modulation detection task, early-implanted CI users may be using temporal cues over spectral cues to achieve high levels of speech understanding. Collectively, these results suggest that early-implanted and post-lingually deafened CI users have different access to auditory features and may benefit from different sound coding strategies.
Session: S8-3  
Abstract ID: 301  
Title: Electrophysiological Evidence of Selective Attention in Dichotic Listening in Bilateral Cochlear Implant Users.  
Presenting Author: Andrew Dimitrijevic PhD  
Author Block: Andrew Dimitrijevic, PhD, Brandon Paul, PHD, Joseph Chen, MD, Vincent Lin, MD, Trung Le, MD; Otolaryngology, Sunnybrook Hlth. Sci. Ctr., Toronto, Canada.  
Abstract:  
Introduction: Previous work in normal hearing listeners has shown selective attention to left versus right concurrent auditory streams are associated with specific neural markers: 1) increased “neural tracking” to the attend stream compared to the ignore stream and 2) alpha event-related synchronization (ERS) ipsilateral to the attend side. Neural tracking measures include cross correlation and temporal response functions between the EEG (electroencephalogram) and the speech envelope. The purpose of this study was to examine whether similar relationships exist in bilateral CI users.  
Methods: Two speakers positioned at +/- 45 degrees and at 1.5 meters away from the listeners were used for stimulus presentation. The stimuli consisted of 4 to 7 pairs of digits presented to each speaker. Prior to each trial, a cue indicated which side the participant was instructed to attend to. The number of digits and attend side varied randomly across trials. The task was to recall the last digit presented on the cued side. A 64-channel EEG (electroencephalogram) recorded while subjects performed the task. Temporal response functions between the speech envelope and the EEG were separately performed for attend and ignore stimuli. Time-frequency analysis was also separately performed.  
Results: CI users performed the task at 80-90% behavioural accuracy while normal hearing controls performed at 75-100% accuracy. In both normal hearing and CI users, neural tracking measures indicated that the attend stream evoked larger responses than the ignore stream. Cue-evoked alpha responses showed greater change in the ipsilateral to-be-attended side in both normal hearing and CI users. The change in alpha effect was greater in CI users compared to normal hearing.  
Conclusion: Our results indicate similar neural tracking to attend targets exist in bilateral CI and normal hearing subjects. Greater alpha changes in CI users suggest that more top-down modulation is exerted in CI users compared to normal hearing, likely indicating greater listening effort.
Session: S10-1
Abstract ID: 334
Title: Redefining Success in Cochlear Implant Recipients
Presenting Author: Craig Buchman MD
Author Block:
Craig Buchman, MD 1, Jacques Herzog, MD 1, Jonathan McJunkin, MD 2, Nedim Durakovic, MD 1, Cameron Wick, MD 1, Jill Firszt, PhD 1, Ci Investigative Team ___, ___ 1; 1Otolaryngology, Washington Univ. in St Louis, St. Louis, MO, 2Otolaryngology, Washington Univ. in St. Louis, St. Louis, MO.

Abstract:
Introduction: A holistic viewpoint is critical in the assessment, treatment and outcomes of cochlear implant candidates and recipients. Singular objective clinical metrics such as audiometric levels or speech perception scores, cannot provide an insight to the often profound, immeasurable benefits this sensory restorative treatment option offers a recipient. Subjective reporting and metrics capturing the multi-dimensional benefits an implant provides are critical to the understanding of patient benefit. Quality of life, healthy aging, emotional, cognitive, social and mental well-being are vital aspects that provide more dynamic depth and understanding as to the genuine benefit treatment options offer patients. Data is presented from a prospective study of 100 subjects with severe-to-profound hearing loss implanted with the Slim Modiolar electrode to support the relevance in assessing and quantifying the multi-modality of patient benefit pre-to-post cochlear implant treatment.

Methods: Pre-to-post implant objective and subjective metrics were collected across a large multi-center prospective clinical trial. Audiometric, speech perception outcomes, quality of life and patient satisfaction measures were administered and analyzed comparatively preoperatively to a 6 month postoperative endpoint.

Results: Significant improvements (p<0.001) were observed for all group outcome measures. Using objective metrics, predictably, group mean speech perception improvement (CNC words and AzBio sentences +10 SNR) post-implantation was shown (47% and 31% respectively). More impressively, however, are the significant improvements seen in the quality of life data. Health Utility Index (Mark 3) the mean multi-modality total yielded a marked clinically meaningful improvement. Subjective metrics further yielded significant satisfaction outcomes postoperatively with respect social engagement (i.e. ability to talk on the phone or conversation ability) and music appreciation.

Conclusion: Outcomes following cochlear implantation compellingly support the notable benefit offered by this treatment option as opposed to conventional amplification preimplantation. The additive subjective metrics to include quality of life further enhance an ability to better recognize and appreciate the multi-dimensional benefit implant technology provides a recipient. A patient-centric approach using multi-domain assessment tools, both objective and subjective metrics, will be able to provide a greater understanding and successful management of a sensory treatment option in patients seeking to maintain connectivity to the listening world.
Introduction: The dynamic frequency changes contained in sound contexts provide critical cues for speech perception. Most previous studies examining frequency discrimination in cochlear implant (CI) users have used psychoacoustic tasks in which the target frequency and the reference frequency are presented at 2 or 3 separate time intervals and the participants are required to identify the target frequency relative to the reference frequency by comparing the stimuli across these time intervals. However, perceiving the dynamic frequency changes in speech stimuli requires the detection of within-interval instead of traditional across-interval frequency change. The goal of this study was to explore the relationship between the capability of detecting a within-interval frequency change, or the frequency change embedded in a stimulus, and speech perception performance in CI users.

Methods: Twenty CI adult users and 20 pediatric users were tested with the within-interval frequency change detection task and speech tests. The frequency change detection threshold (FCDT) was measured using a 3-alternative forced-choice (3AFC) procedure. The stimuli were pure tones (base frequencies of 0.25, 1, and 4 kHz, respectively) of 1-sec duration containing frequency changes at 0.5 sec after the tone onset. The frequency change occurred for an integer number of cycles of the base frequency and the change occurred at 0 phase (zero crossing), so that the onset cue was removed and it did not produce audible transient clicks when the frequency change occurred. The speech tests included: 1) Consonant-Nucleus-Consonant (CNC) monosyllabic word recognition, 2) Arizona Biomedical Sentence Recognition (AzBio) in Quiet, 3) AzBio in Noise (+10 dB signal-to-noise/SNR ratio), and 4) Digit-in-Noise (DIN) Test. In addition, a subjective evaluation of hearing with the CI was obtained.

Results: Results from CI adults showed that the correlations between FCDTs and speech perception outcomes were statistically significant (p<0.05). The results of the DIN test were significantly correlated to the results of AzBio in noise (p<0.05). Data from CI children are ongoing.

Conclusion: The current findings suggest that the ability to detect within-interval frequency changes plays an important role in speech perception performance of CI users. Moreover, the FCDT and DIN tests can serve as simple and fast tests that require no or minimal linguistic background for the prediction of CI speech outcomes.
Session: S10-1
Abstract ID: 237
Title: Conditions for Successful Application of EAS in Children with Useful Residual Hearing.
Presenting Author: Young-Myoung Chun MD, PhD
Author Block:
Young-Myoung Chun, MD, PhD Soree Ear Clinic, Seoul, Korea, Republic of.
Abstract:
Introduction: The combined electric acoustic stimulation (EAS) of one ear is a topic that has received considerable attention over the last 10 years. Its development has followed several parallel strands, including the modification of existing surgical approaches and the use of different CI devices, as well as having been applied to various groups of patients. Despite the outstanding results achieved by the application of EAS in adults, there has been little confidence whether EAS can be applied to children who have significant amount of residual hearing in the ear selected for implantation.
Methods: Out of 21 ears of EAS candidates with preserved useful residual hearing, 15 ears were chosen as the subject to study after disregarding ears with inner ear deformity or multiple handicaps. All children were compared in two different conditions, EAS mode and CI only mode, for speech understanding in quiet/noise environment, directionality, ability to listen to music, and subjective satisfaction. And the analysis was divided into groups with or without the EAS benefit. The use of hearing aid prior to surgery, the stability of hearing preservation, mapping strategy, and family support, etc., were evaluated on how the benefits of EAS were influenced.
Results: 12 out of 15 ears of the subjects preferred to use amplified acoustic sound, in which EAS mode was better than CI only mode in one or more parameters in speech, directionality, and music. All three ears that did not benefit from EAS in all parameters were rarely experienced with hearing aids before CI surgery. It is clear that the amount of residual hearing preserved is an important factor in benefiting from EAS, but it was not always the case. In other words, the uses of EAS was prefered also in the case of children with relatively small residual hearing among users who have experienced hearing aid prior to the surgery. In addition, the optimal fitting strategy and family support seemed to be important factors for successful use of EAS.
Conclusion: Our experiences of pediatric EAS trials showed that EAS could give a significant benefit to congenital deaf children with residual hearing at lower frequencies just like to adult EAS. Especially, early hearing rehabilitation through hearing aids prior to CI is also essential for successful EAS use.
Session: S10-1
Abstract ID: 254
Title: Incidental Residual Hearing and Speech Perception Outcomes Following Pediatric Cochlear Implantation
Presenting Author: Alecia Jayne AuD
Author Block:
Alecia Jayne, AuD, Cynthia Warner, AuD, Michelle Shannon, AuD, Ursula Findlen, PhD, Prashant Malhotra, MD, Oliver Adunka, MD; Audiology, Nationwide Children’s Hosp., Columbus, OH.
Abstract:
Introduction: Cochlear implantation has been recommended for children with hearing thresholds in the moderate to moderately-severe hearing loss range who do not benefit from traditional amplification. Modern cochlear implant devices have evolved to decrease the likelihood of cochlear insult during implantation, which has been shown to correlate with better post-operative speech perception outcomes in the adult population. However, little is known regarding incidental hearing preservation in the pediatric population and there is limited published data examining whether incidental residual hearing is correlated with improved speech perception outcomes in children. The present study seeks to: 1) characterize incidental hearing preservation in the pediatric population, and 2) evaluate whether degree of residual hearing correlates with perceptual outcomes.
Methods: A retrospective chart review of pediatric patients implanted between 2012-2018 at a pediatric hospital was completed. Inclusion criteria included (1) implantation with a standard length electrode array, (2) pre-operative audiological low frequency pure tone average (LFPTA) of 75 dB HL or better, (3) at least one post-operative unaided pure-tone evaluation, and (4) recorded speech perception testing with the cochlear implant. The Skarzynski classification was used to calculate incidental hearing preservation. Differences between each patient’s pre-implantation LFPTA and two post-measurements were assessed using a mixed effects model to determine whether the rate of change over time was impacted by independent predictors (age, gender, type of surgery, surgery side, and pre-operative LFPTA severity). A subset of speech perception scores were assessed using two-sample t-tests or Wilcoxon rank sum tests comparing categorical predictors and Spearman correlations for continuous predictors.
Results: Forty-three ears in 39 patients with a mean age of 11.93 years met the inclusion criteria. The patient population included 3 cochlear implant manufacturers and 10 different electrode arrays. A wide range of etiologies were noted including; idiopathic (n=11), suspected heredity (n =10), EVA (n=8), and ANSD (n=5). Regardless of pre-operative LFPTA, patients lost residual hearing at the same rate with the same average loss of 31.1 dB. Skarzynski categorization revealed 18% of patients had complete HP, 67% had partial HP, 10% had minimal HP, and 5% of patients experienced no hearing preservation. After adjusting for adjusting for severity, duration of time between visits and type of surgery, pre-op LFPTA scores were significantly lower than the first post-op score (p<0.0001) but subsequent post-op scores were not significantly different (p=0.65). There were no significant differences in the Skarzynski score between the categorical predictors. There was a small-moderate positive association between the Skarzynski and CNC score but it was not statistically significant (r=0.29, p=0.23). Age at implant was small-moderately negatively associated with the CNC score but not statistically significant (r=-0.37, p=0.13).
Conclusion: Incidental hearing preservation is possible when using a standard electrode array in the pediatric population. Understanding incidental hearing preservation and its impact on speech perception outcomes will be beneficial in determining candidacy for children and for counseling regarding expectations after cochlear implantation.
Session: S10-1
Abstract ID: 140
Title: The Outcome of Cochlear Implant in Teenage Recipients with Steeply Sloping Hearing Loss
Presenting Author: Ying Guo MA
Author Block:
Abstract:
Introduction: Cochlear Implant systems that combine electric and acoustic stimulation (EAS) have been introduced for recipients with steeply sloping hearing loss in recent years. More and more studies about EAS cochlear implants in adults have proved that speech perception scores for EAS recipients (unilateral and bilateral) are significantly improved with the cochlear implant compared to pre-operative performance with traditional amplification systems. In general hearing preservation techniques show long-term benefits in adults with both conventional and EAS cochlear implants. Furthermore, a recently published paper (Jones et al 2018) showed good hearing preservation in bilateral paediatric cochlear implantation (86% overall). The hearing preservation surgical techniques have been used for children with steeply sloping hearing loss in recent years. The objective of this study was to measure the outcome of cochlear implants in teenage recipients with steeply sloping hearing loss who had cochlear implant surgery by using hearing preservation techniques.
Methods: Retrospective case review in a tertiary implant centre. All 8 children eligible for inclusion in this study have steeply sloping hearing loss. Outcome measures included: 1) Pre and post-operative pure tone thresholds, and hearing thresholds in their regular follow ups; 2) Speech perception scores (Bamford- Kowal- Bench (BKB) sentence testing) in quiet (presented at 70dB SPL) and/or in noise situations (a signal-to-noise ratio of +10dB SPL); 3) Questionnaires (Speech, Spatial and Qualities of Hearing Scale (SSQ) and the Categories of Auditory Performance (CAP) ) were collected pre-and post-operatively, where possible; 4) Listening effect during their appointment measurements and daily life situations.
Results: Hearing preservation percentages were calculated using the HEARING group formula (Skarzynski et al 2013). The residual hearing of all 8 teenage implant recipients are well-preserved. The speech performances in different situations have improved significantly, in the different questionnaires, all participants reported that they are more confident in social situations, they could hear better with their family and friends, they tend to engage in more conversations with other people, and their environmental sounds awareness increased significantly. They also reported less listening effort to hear speech in clinical environmental testing and daily life conversations.
Conclusion: Although the sample size was small, it would appear to suggest that the use of cochlear implant EAS systems and hearing preservation surgical techniques provide a good management option for teenage recipients who have steeply sloping hearing loss. The hearing preservation surgical techniques might reduce their concerns about losing their residual hearing. They also have better hearing performance than before with less listening effort. Further studies with a larger cohort of recipients would be recommended.
Session: S10-1
Abstract ID: 114
Title: Pediatric Case Studies of Congenital CMV and Cochlear Implants
Presenting Author: Heidi Leonard AuD
Author Block:
Heidi J. Leonard, AuD, Cheryl K. Glovsky, AuD; Audiology, Massachusetts Eye and Ear, Boston, MA.
Abstract:
Introduction: Given the variability in hearing outcomes for pediatric patients diagnosed with congenital CMV, we sought to define the natural progression of hearing loss, and the effects of earlier cochlear implantation, in this patient population through a series of case studies.
Methods: We present the progression of hearing loss with longitudinal data for various pediatric patients both with and without antiviral treatment, and with and without early cochlear implantation.
Results: Knowledge gained from outcomes of our current population of pediatric patients diagnosed with congenital CMV has contributed to the evolution of our audiological recommendations for intervention, the primary goal of which is to help our pediatric patients develop normal speech and language. These case studies highlight the need for early identification of congenital CMV, and more aggressive intervention with cochlear implants.
Conclusions: We conclude with a proposal for changes to clinical protocols and family counseling to improve outcomes for this patient population. 1. Aggressive intervention should be considered in cases of unilateral hearing loss. Earlier implantation of poorer ear should be considered to lessen or prevent a disruptive period of poor hearing and speech understanding. 2. Excellent benefit from cochlear implants is noted for this population.
Session: S10-2
Abstract ID: 1011
Title: Managing Bilingual Cochlear Implant Candidates: An Audiological Perspective
Presenting Author: Sandra Velandia AuD
Author Block:
Abstract:
Invited Presentation
Session: S10-2
Abstract ID: 1012
Title: Adapting Auditory-Verbal Therapy: Culturally and Linguistically Relevant Intervention for Spanish-Speaking Families
Presenting Author: Sarah Radlinski MS LSLS Cert AVT
Author Block:
Abstract:
Invited Presentation
Session: S10-2
Abstract ID: 437
Title: Development and Validation of the Spanish AzBio Sentence Lists
Presenting Author: Alejandro Rivas MD
Author Block:
Alejandro Rivas, MD 1, Michael F. Dorman, PhD 2, Luz A. Rincon, Audiology Specialist 3, Tony Spahr, PhD 2, Adriana S. Rivas, MD, Aud 3, Rene H. Gifford, PhD 4; 1Otolaryngology- Head and Neck Surgery, Vanderbilt Univ. Med. Ctr., Nashville, TN, 2Speech and Hearing Science, Arizona State University, Tempe, AZ, 3Clinica Rivas, Bogota, Colombia, 4Hearing and Speech Sciences, Vanderbilt Univ. Med. Ctr., Nashville, TN.
Abstract:
Introduction: The AzBio sentence test is a well established instrument to evaluate the speech perception abilities of hearing impaired listeners and cochlear implant users. With the increasing Spanish speaking population in the United States, the need for a Spanish speech perception test comparable to the AzBio is warranted. The goal of this study was to create and validate a new set of sentence lists that could be used for Spanish speakers. Our intention was to generate a large number of sentence lists with an equivalent level of difficulty for the evaluation of performance over time and across conditions.
Methods: The AzBio sentence corpus includes 2000 sentences recorded from two female and two male talkers. The mean intelligibility of each sentence was estimated by processing each sentence through a five-channel CI simulation and calculating the mean percent correct score achieved by 15 normal-hearing listeners. Sentences from each talker were sorted by percent correct score, and assigned to 46 lists, each containing 20 sentences (5 sentences from each talker). List equivalency was validated by presenting all lists, in random order, to 10 CI users.
Results: Using sentence scores from the CI simulation study produced 46 lists of sentences with a mean score of 85% correct. The results of the validation study with CI users revealed no significant differences in percent correct scores for 38 of the 46 sentence lists. However, individual listeners demonstrated considerable variability in performance on the 38 lists. The binomial distribution model was used to account for the inherent variability observed in the lists. This model was also used to generate 95% confidence intervals for one and two list comparisons.
Conclusion: The use of a five-channel CI simulation to estimate the intelligibility of individual sentences allowed for the creation of a large number of sentence lists in Spanish with an equivalent level of difficulty. The results of the validation procedure with CI users found that 38 of 46 lists allowed scores that were not statistically different. However, individual listeners demonstrated considerable variability in performance across lists. This variability was accurately described by the binomial distribution model and was used to estimate the magnitude of change required to achieve statistical significance when comparing scores from one and two lists per condition. Fifteen sentence lists have been included in the Spanish AzBio Sentence Test for use in the clinical evaluation of hearing-impaired listeners and CI users.
Session: S10-2  
Abstract ID: 132  
Title: Does Family Language Impact Young Implanted Children's Likelihood of Achieving Oral-Only Communication?  
Presenting Author: Stephen Hoff MD  
Author Block:  
Stephen R. Hoff, MD 1, Denise Thomas, AuD 2, Elizabeth Tournis, AuD 2, Nancy M. Young, MD 1;  
1Pediatric Otolaryngology, Northwestern Univ., Ann & Robert H. Lurie Children's Hosp. of Chicago, Chicago, IL, 2Pediatric Audiology, Ann & Robert H. Lurie Children's Hosp. of Chicago, Chicago, IL.  
Abstract:  
Introduction: Cochlear Implant programs in the United States serve many children whose parents are not exclusively English speaking. There is limited information available about the outcomes in young implanted children from these families.  
Methods: Retrospective study of 176 children implanted before age 37 months, with a mean age at first implantation of 20.8 months (6.7-36.8). Mean length of follow-up was 5.8 years (1.1-10.4), and mean age at last follow-up was 7.5 years (2.7-12.8). Primary outcome measures were: 1. Development of and time to achieve measurable open-set skills by implanted ear and 2. Communication modes at last follow up. Factors considered in the analysis included family language (exclusively English; bilingual not requiring an interpreter; at least one parent requiring an interpreter), parent choice of communication approach, Medicaid eligibility at time of implant, and age of implantation(s).  
Results: Age at first and second implant was younger for English-only families. Measurable open-set was achieved by most children, and there was no difference in rate of measurable open-set developed by parental language category alone. Oral-only communication was achieved by more English-only families (76.8%) than bilingual families and families requiring interpreters (37.9% and 37.3% respectively, p≤.001). However, children with English-only speaking parents were less likely to be funded by Medicaid. All categories of parental language in Medicaid-funded patients, including English-only, had similar low rates of oral-only communication ranging from 23.8% to 37.8%. Regression analysis revealed that Medicaid eligibility at implantation accounted for the most variance in whether oral-only communication was achieved, followed by age of first implant. However, together these accounted for only 36% of variance. Parental language did not significantly contribute to prediction of oral-only communication after Medicaid eligibility and age at first implant were taken into account.  
Conclusion: Children in the United Stated from bilingual or non-English speaking families implanted below age 3 years are less likely to achieve oral-only communication than those from English-only families. This difference appears to be influenced in part by lower socioeconomic status and older age of implantation, and not to exposure to languages other than English in the home.
Session: S10-2
Abstract ID: 1013
Title: Literacy in Iberoamerica: Status and Intervention Strategies
Presenting Author: Lilian Flores PhD  LSLS Cert AVT
Author Block:
Abstract:
Invited Presentation
Session: S10-3
Abstract ID: 367
Title: Behavioral and Subjective Outcomes with the Non-Invasive Bone Conduction Hearing System, Adhear in Pediatric Patients with Conductive Hearing Loss
Presenting Author: Hillary Snapp PhD
Author Block:
Hillary Snapp, PhD, Chrisanda Sanchez, AuD, Alyssa Whinna, AuD, Kari Morgenstein, AuD; Univ. of Miami, Miami, FL.
Abstract:
Introduction: The aim of this investigation is to prospectively evaluate the benefit of non-invasive bone conduction hearing devices (BCDs) in children with conductive hearing loss (CHL). Despite established effectiveness of implantable BCDs in CHL, adoption and acceptance rates for implantable BCDs are low (Andersen et al, 2006; Desmet et al, 2012; Farber et al, 2012; Kompis et al 2001; Siau et al 2015). This has been attributed to aesthetics (Farber et al, 2012) and the need for surgery (Farber et al, 2012; Desmet et al, 2012; Siau, 2015). In lieu of implantation, BCDs can be anchored to a headband. Non-invasive bone conduction hearing technology is a promising alternative, although issues related to comfort and increased visibility of headband devices have limited the acceptance and use of such systems. The Adhear (MEDEL, Corp) BCD provides non-invasive transcutaneous stimulation of the cochlea without the need for a headband. The audio processor attaches to a long wear adhesive adapter allowing for optimal placement of the processor where cochlear stimulation is expected to be maximal. The aim of this study was to evaluate the effectiveness of the Adhear BCD treatment solution when compared to BCDs worn on a headband.
Methods: Prospective randomized controlled study. Children between the ages of 5 and 15 years of age with irresolvable conductive hearing loss and their guardians were enrolled for study. Subjects were evaluated in two phases consisting of random assignment to trial with either a traditional BCD on a headband or an Adhear BCD system for 3 weeks. Pediatric subjective questionnaires were administered prior to and at the end of each phase. A matched guardian proxy was administered to the pediatric subject’s guardian at the beginning and end of each phase. Outcome measures included soundfield aided narrowband signal thresholds, aided speech reception thresholds, aided word recognition ability in quiet and in speech shaped noise at +5dB SNR for soft at 35, 45, and 55 dB. All soundfield testing was administered at 0º azimuth and noise was co-located.
Results: Preliminary results suggest no significant difference between devices in the primary endpoints of aided threshold and speech perception. Subjective data indicates parent-child agreement may be low in certain domains. Data collection is ongoing. Current enrollment is at 70% of the target sample with anticipated completed by February 2019. Hearing and subjective outcome results will be reviewed, the study design will be detailed in the presentation.
Conclusions: Non-invasive BCDs provide children with conductive hearing loss options for early intervention and access to amplification. Hearing outcomes are improved with use of these devices. Effectiveness of the Adhear BCD appears to be comparable to that of a device worn on a headband. Subjective reports indicate that participants ranked the adhear highly in the aesthetic and use domain, although parent-child agreement varies in other hearing and psychosocial aspects.
Session: S10-3
Abstract ID: 121
Title: Bone Conduction Implants vs. Cochlear Implants in Single-Sided Deafness
Presenting Author: Thomas Keintzel Dr med
Author Block:
Thomas Keintzel, Dr medENT Department, Klinikum Wels Grieskirchen, Wels, Austria.
Abstract:
Introduction: There is a wide range of disappointment in individuals suffering from an acquired single sided deafness. Some individuals even do not realize their impairment and others feel a great discomfort. For many SSD patients increased hearing effort as well as the fear that deafness can occur the second ear are a reason to look for a restoration of the deaf ear. Our study intended to compare restoration of binaural hearing with two different semiimplantable hearing devices.
Methods: 39 patients with single sided deafness and contralateral normal hearing participated in the study. 18 patients were implanted with an CI and 21 with the active bone anchored hearing device Bone Bridge. The implant experience in the CI group was 1 - 9 years and in the BB group 6 month up to 5 years. Speech reception thresholds (SRT) were obtained with the OLSA sentence test and Spatial release from masking (SRM) was evaluated. In addition, localization ability in the frontal horizontal plane was assessed using an array of seven loudspeakers. The SSQ and Bern Benefit in SSD questionnaire was used to outline the change in quality of life.
Results: The data show that binaural hearing can be restored using an cochlea implant in single sided deafness. No binaural effects could be achieved using the bone conducted CROS amplification
Conclusion:
**Session:** S10-3  
**Abstract ID:** 146  
**Title:** First Results of a New Coupling Device for Precise Round Window Coupling of the Vibrant Soundbridge  
**Presenting Author:** Magnus Teschner MD, PhD, MBA  
**Author Block:**  
Hannes Maier, PhD, Magnus J. Teschner, MD, PhD, MBA, Nina Wardenga, B.Sc., Thomas Lenarz, MD, PhD.; Department of Otolaryngology, Hannover Med. Sch., Hannover, Germany.  
**Abstract:**  
**Introduction:** For more than 20 years the Vibrant Soundbridge (VSB) is successfully used to treat patients. The Floating Mass Transducer (FMT) can be coupled to different parts of the ossicular chain and also round window coupling, shows favorable results. To place the FMT in front of the round window membrane (RWM) biological as well as artificial materials have been used to improve the vibratory transmission into the cochlea. To overcome the undefined contact forces and standardize the procedure, a special coupler had been designed. The new design allows precise and standardized RWM-coupling and exerts a constant and controllable preload of the FMT to the RWM. Laser Doppler vibration experiments were performed in human temporal bones before first patients were treated.  
**Methods:** By now, n=7 patients have been implanted with a Custom Made Device (CMD) of the new RW coupler at the Hannover Medical School. To assess the audiological outcomes pre- and post-operative hearing thresholds, Freiburg Monosyllables (FBM) 65 dB and the Oldenburg sentence test (OLSA) in noise were performed up to 6 months after first activation.  
**Results:** It could be shown, that the bone conduction thresholds had not been affected by the surgical intervention (n=7). The speech perception outcomes in quiet measured with the FBM improved in average from 7% (n=6) in the preoperative unaided situation to 79% (n=6) at 3 months and 84% (n=4) at 6 months. Speech in noise outcomes measured with the OLSA were in average -2.8 dB SNR (n=4) at 6 months.  
**Conclusion:** The new coupler is a reliable and safe method for round window coupling. Precise and standardized placement of the FMT was possible during the surgical intervention. The inner ear function has not been affected and first results show good speech perception outcomes in quiet and noise up to 6 months postoperatively.
Session: S10-3
Abstract ID: 409
Title: Surgical Considerations for Implantation of a New Active Bone Conduction Aid in Children
Presenting Author: Sharon Cushing MD MSc FRCSC
Author Block:
Sharon L. Cushing, MD MSc FRCSC 1, Karen A. Gordon, PhD Aud 2, Mary Lynn Feness, MSc Aud 2, Blake C. Papsin, MD MSc FRCSC 3; 1Hosp. for Sick Children, Toronto, Canada, 2Communication disorders, Hosp. for Sick Children, Toronto, Canada, 3Otolaryngology, Head and Neck Surgery, Hosp. for Sick Children, Toronto, Canada.
Abstract:
Introduction: Bone conduction devices (BCDs) play an important role in the rehabilitation of children with hearing loss who are unable to wear or fail to gain benefit from conventional hearing aids. BCDs can be held in place by bands, adhesives or involve surgically placed osseointegrated components which are connected to external equipment percutaneously or transcutaneously. Surgical BCDs provide excellent access to sound but soft tissue complications are frequent. The current study examines surgical considerations of a new active bone conduction aid called the Osseointegrated Steady State Implant (OSIA) (Cochlear Corporation, Sydney) as it applies to the pediatric population.
Methods: A retrospective review of surgical considerations over the first 12 children provided with the OSIA.
Results: A total of 12 children with a mean age of 14.7 years (SD 1.7; Range 10.3-17.7 years) underwent surgical placement of 13 OSIA devices under general anaesthesia. The indication for device placement included bilateral aural atresia (n=2), acquired canal stenosis (n=2), unilateral conductive hearing loss due to unilateral aural atresia (n=4) as well as single sided deafness (n=4) due to cochlear nerve aplasia (n=3), and enlarged vestibular aqueduct (n=1). Eleven children received unilateral devices and 1 child received bilateral devices sequentially. Surgical technique evolved across the 12 cases with progressively more device recessing in an effort to decrease the profile of the device, particularly in children with underdeveloped mastoids (i.e. aural atresia) and younger children. Five children had previously received a percutaneous BCD; 3 had had there abutments removed prior to evaluation for OSIA and the other 2 were removed prior to OSIA implantation. In 3 children, the OSIA was placed on the same side as the previous percutaneous abutment. One child who had previously undergone implantation using the dermatome technique, had the device placed on the ipsilateral side as the previous percutaneous device. In this child great care was taken in device and incision placement. There were no wound complications. One child required a second procedure for soft tissue reduction at the magnet site and continues to struggle with magnet retention.
Conclusion: The OSIA implant offers a new option for an active BCD in children with varying etiology of hearing loss. Special consideration for the etiology of the hearing loss is required, particularly in children with microtia and aural atresia.
Session: S10-3
Abstract ID: 402
Title: A Comparison of Language and Articulation Scores Between Students with Single-Sided Deafness and Unilateral Microtia Atresia
Presenting Author: Monica Dorman MS
Author Block:
Monica Dorman, MS, Jessie Ritter, MA, Stacy Adams, MS; Speech Language Pathology, Sunshine Cottage Sch. for Deaf Children, San Antonio, TX.
Abstract:
Unilateral hearing loss (UHL) in children affects 0.4 to 34 per 1000 newborns, and 1 to 50 per 1000 school aged children (Lieu, et. al, 2010). Many do not meet eligibility requirements for their state to receive early intervention (EI) services (Holstrum, et. al, 2008). Bess and Tharpe (1984) reported that 35% of children with a UHL fail at least one grade in school compared to 3.5% of their typically hearing, school-aged peers. In 2010, Lieu et. al, reported that children diagnosed with a UHL were more than four times as likely to have an Individual Educational Plan and twice as likely to have received speech therapy than their typically hearing peers (Vila and Lieu, 2015). Historically, research discussing UHL has included both students with single-sided deafness (SSD) and unilateral microtia/atresia (UMA) within the same sample group. Research is not readily available analyzing the performance of students with SSD to students with UMA. It is important to distinguish between the two populations as SSD is a sensorineural hearing loss and microtia/atresia is typically a conductive hearing loss. Gathering formalized data on each population individually may have implications for intervention services. This study analyzes the difference in language and articulation scores between students with SSD and students with UMA. Data from 2010 to 2018 were reviewed to evaluate preschool students’ language and articulation skills during their first year in a listening and spoken language program. Students’ language and articulation skills were formally assessed utilizing standardized tests during their initial year of preschool (three to five years of age). The data were separated to compare the performance of students with SSD to students with UMA. Standardized language assessments administered included the Preschool Language Scales – 4 th Edition, Preschool Language Scales – 5 th Edition, Clinical Evaluation of Language Fundamentals Preschool - 2 nd Edition, Test of Early Language Development – 3 rd Edition, Clinical Evaluation of Language Fundamentals Preschool – 2 Spanish, or the Preschool Language Scales - Fifth Edition Spanish. Articulation was assessed using the Goldman-Fristoe Test of Articulation – 2 nd Edition, Goldman-Fristoe Test of Articulation – 3 rd Edition, Diagnostic Evaluation of Articulation and Phonology, Clinical Assessment of Articulation and Phonology, or the Goldman-Fristoe Test of Articulation – 3 rd Edition, Spanish. Data show that students with SSD performed better for overall language and expressive language than students with UMA. Students with SSD and students with UMA performed similarly for receptive language. In terms of articulation performance, a greater percentage of students with SSD scored within average range compared to students with UMA; however, students with UMA demonstrated more variance in severity for articulation than those with SSD who only performed within average range or with a severe delay. Due to a limited sample size, no statistical difference was observed. Results of this study revealed that both students with SSD and students with UMA demonstrate the need for aggressive audiological management and speech and language therapy services due to a large number of the students in this study exhibiting speech and language deficits compared to their typically hearing peers. Further research should be conducted to determine if a statistically significant difference between language and articulation in children with SSD and UMA exists.
Session: S11-1  
Abstract ID: 195  
Title: A Comparison of Family Engagement in Two Early Intervention Settings: Telepractice and In-Person  
Presenting Author: Melissa McCarthy MEd, LSLS Cert AVT  
Author Block:  
Melissa McCarthy, MEd, LSLS Cert AVT 1, Greg Leigh, AO, PhD 1, Michael Arthur-Kelly, PhD 2; 1RIDBC Renwick Centre, RIDBC, North Rocks, Australia, 2Education, Univ. of Newcastle, Callaghan, Australia.  
Abstract:  
Introduction: This presentation will report results from a recent study examining family engagement in early intervention for children who are deaf or hard of hearing. The study was conducted within one organization that operated two discretely administered early intervention programs that differed only by delivery mode. One program provided services ‘in-person’ where all participants were physically present in the same room whereas the other program provided services through ‘telepractice’ where participants at different locations were connected through technology. This study sought to explore whether there were any differences in perceived or actual levels of family engagement between the two different delivery modes.  
Methods: This two-stage comparison study focused on a cohort of primary caregivers whose children were deaf or hard of hearing and had been receiving early intervention services from one of the nominated programs for at least two months. All eligible caregivers were invited to complete The Scale of Parental Involvement and Self-Efficacy (SPISE), a self-report questionnaire examining their own perceptions of self-efficacy and parental involvement in early intervention sessions. Subsequently, a subset of the larger cohort was videorecorded during their usual early intervention sessions for four weeks. A representative video sample from each family was selected and caregiver participation behaviours were coded using methods described in the literature. Statistical analysis was used to characterize the overall data set and determine the similarity of the two groups (‘in-person’ and “telepractice”) on potentially confounding variables (e.g., degree of hearing loss, device use, etc.). Survey and video data were then analysed to determine if there were any significant differences between the two delivery modes in regard to parental self-efficacy, involvement, and participation.  
Results: A total of 141 survey responses were returned: 100 from caregivers who received early intervention in-person and 41 from caregivers who received early intervention through telepractice. Mean scores for four different SPISE subscales were calculated for both groups and statistical comparison of means found no significant differences between groups. A subset of 29 survey respondents (16 in-person, 13 telepractice) consented to the collection of video data. A total of 105 videos were reviewed and 29 sample segments selected for analysis. Data analysis of caregiver behaviours, including mean scores for parental level of engagement, will be presented.  
Conclusion: Survey results indicate that caregivers feel involved and self-efficacious regardless of whether services are delivered in-person or through telepractice. The frequency and variety of caregiver participation behaviors in each setting will be examined as well as any observable associations between caregiver perceptions and observed behaviors. The preliminary evidence from this study suggests that there is no difference between early intervention services delivered in-person or through telepractice when considering the nature of family engagement.
Session: S11-1  
Abstract ID: 373  
Title: Effectiveness of Teletherapy at Facilitating Language Development in At-Risk Children with Hearing Loss  
Presenting Author: Matthew Fitzgerald PhD  
Author Block: Matthew Fitzgerald, PhD 1, Joy Kearns, MS 2, Jannine Larky, AuD 1, William Doyle, MBA 2, Arturo Manriquez, 1, Meg Farqhar, MSW 1, Gerald Popelka, PhD 1, Nikolas Blevins, MD 1; 1Otolaryngology - Head and Neck Surgery, Stanford Univ., Palo Alto, CA, 2Weingarten Children's Ctr., Redwood City, CA.  
Abstract:  
Introduction: The BabyTalk program has provided intervention using teletherapy to children with hearing loss in California since 2012. This program uses a parent-coaching model to focus on development of listening and spoken language skills. In 2017 we showed that overall, this intervention appeared to facilitate language development in children with hearing loss. Here, we determine if the magnitude of these improvements differs between children with known ‘at-risk’ variables of low levels of socioeconomic status (SES) and parental education, and children not classified as ‘at-risk.’ Additional analyses investigated the extent to which changes in language development were influenced by the amount of teletherapy, and other key demographic and therapy variables.  
Methods: As of July 2018, 112 children received intervention through BabyTalk. Children were categorized as ‘at-risk’ if they met either of two criteria: 1) low socioeconomic status (primary insurance being California Childrens’ Services, (e.g., Medicaid)) and 2) low education level of the primary caregiver (< 12 years) vs > 12 years. 80% of children enrolled in BabyTalk were classified as ‘at-risk’ using these criteria. We examined auditory and language development outcomes with the Little Ears Questionnaire (LEQ), the Preschool Language Scales, 5th edition (PLS-5), and the MacArthur Bates Communication Development Index (CDI). We also measured parenting stress through the Parental Stress Index. We first analyzed the overall extent of change for ‘at-risk’ and ‘not at-risk’ children, and then conducted regression analyses to determine the extent to which improvement on any of these measures was related to key variables of the amount of teletherapy received, education level of the primary caregiver, and (SES).  
Results: On average, significant improvements were observed on all auditory and language outcome measures. However, children defined as ‘at-risk’ had considerably greater variability in their auditory and language outcome scores. Further analysis suggested that the magnitude of improvement was related to SES category. Notably, there was not a linear relationship between the amount of teletherapy and the magnitude of improvement. However, an odds ratio analysis indicated that children who completed less than ~ 20 hours of teletherapy were approximately four times more likely to fall behind their normal-hearing peers on the PLS.  
Conclusion: Both ‘at-risk’ and ‘not at-risk’ children with hearing loss benefit from a parent-coaching model delivered via teletherapy. However, auditory and language outcome scores were more variable in ‘at-risk’ children. Benefits were not directly related to the amount of teletherapy received once a threshold number of hours was achieved. This information may be useful for further refinement and improvements of teletherapy programs, and may help establish expectations for resource allocation as such programs become increasingly common.
Session: S11-1
Abstract ID: 355
Title: The Next Step in Pediatric Remote Cochlear Implant Programming in Australia
Presenting Author: Paula Berkley BA Dip Aud, MAud SA (CCP)
Author Block:
Paula Berkley, BA Dip Aud, MAud SA (CCP), Kylie Chisholm, LSLS Cert AVT, Rachelle Hassarati, BEng, Wai Kong Lai, PhD;SCIC Cochlear Implant Program, Royal Inst. for Deaf and Blind Children, Gladesville NSW, Australia.
Abstract:
Introduction: With close to 100 cochlear implant (CI) recipients living over 200 km (straight-line distance) from their nearest CI audiologist/clinic, a need for a strategy to ensure continual programming and ongoing support for remote paediatric patients has arisen. State of the art telecommunication technologies has bridged vast distances to connect remote Australians with life changing clinical hearing services. This paper details one such novel tele-audio strategy which has successfully allowed for the continual programming of children with CIs living in remote areas across Australia.
Method: A total of 10 children aged between 1-10 years and their families living at distances of up to 2500 km from their nearest centre where programmed remotely. The remote programming system consists of a tablet computer connected wirelessly to the speech processor via Bluetooth. Remote desktop applications were utilised by the audiologist to control the tablet computer at the client’s end. Data logging records, functional questionnaires and verification tests were used to monitor the quality of the sound processor fitting.
Results: Initial experience with the system suggests a robust data connection is vital to the success of the programming session. This allows the audiologist controlling the tablet computer to confidently program the child’s cochlear implant speech processor and effectively communicate with the parent assisting the child in the appointment, despite the very large distances. Clients found the session easier with the wireless connection between tablet computer and sound processor as it allowed for a more natural interaction for them and their child during the programming appointment.
Conclusion: Remote cochlear implant programming has worked reliably for a wide age range of clients including young children. This greatly benefits clients and their families living in regional and remote areas of Australia, reducing the need to travel to clinic centres whilst still having access to expert clinical support. In order to provide this service to a wider range of clients, there is a need for further work in the area of appropriate reimbursement for telepractice services.
Session: S11-1
Abstract ID: 210
Title: Cochlear Implants and Telemedicine - Rehabilitating the Tone Deaf Surgeon
Presenting Author: Douglas Hildrew MD
Author Block:
Douglas M. Hildrew, MD 1, Jacob I. Tower, MD 1, Jessica Preston, Au.D 2, Adam Burkland, Au.D 2, Cyndi E. Trueheart, Au.D 2; 1Otolaryngology, Yale Univ. - Sch. of Med., New Haven, CT, 2Audiology, VA Connecticut Healthcare System, West Haven, CT.
Abstract:
Introduction: Currents estimates state that cochlear implants are an underutilized resource, with a penetration of only 6-10% of eligible adults. While the reason for this dramatic underutilization is not fully understood, it is likely a combination of a lack of awareness, inefficient referral networks, limited community resources, financial constraints, geographic constraints, and health-related constraints. While these factors may have created an insurmountable barrier for some of our prospective patients in the past, they can be overcome with the creation of an organized telemedicine network. Integrating telemedicine into the identification, evaluation, treatment, and programming of our potential cochlear implant candidates will become the new paradigm.
Methods: A telemedicine service focusing on cochlear implantation was created within a regional healthcare system, consisting of a cohesive network of audiologists and a cochlear implant surgeon. This consisted of a centralized cochlear implant center with several satellite audiology clinics. Patients underwent preoperative evaluation, implantation, and activation at the cochlear implant center; those identified as having potential issues with access to care were offered enrollment in the telemedicine program to assist in their evaluation, treatment, and post-implantation cochlear implant programming needs.
Results: Over fifty patients have been enrolled in the telemedicine program to assist with their evaluation, treatment, and post-implantation cochlear implant programming needs. The mean age at first telemedicine encounter was 74 years (±7.67 years). There are fifteen satellite audiology clinics within our telemedicine network, with the furthest one located 283 miles away from the centralized cochlear implant center. Approximately 58% of the patients enrolled in the telemedicine program were from out of state. Patient surveys indicate a high level of patient satisfaction in the program, and there has been no statistically significant difference seen for the performance measures of our patients programmed in-person versus remotely.
Conclusion: While there are many reasons that cochlear implants are underutilized within the United States, it is thought that the most common are a generalized lack of awareness, inefficient referral networks, limited community resources, financial constraints, geographic constraints, and health-related constraints. Such real and/or perceived barriers can result in significant healthcare disparities for our most at risk populations. Patients who wish to seek implantation may be dissuaded by the necessary evaluation and follow-up required to achieve their full potential. Providers may also be reluctant to recommend such patients for implantation given the preconceived notion that the surgery is too involved, and that the rehabilitation would be infeasible for those with limited local resources. A telemedicine service focusing on cochlear implantation can be an ideal way to interface with this at risk population, bringing a highly specialized care team directly into the patient’s community.
Session: S11-1
Abstract ID: 298
Title: Improving Access to Care Through Offsite Cochlear Implant Mapping Services in Pediatric Patients with Additional Disabilities
Presenting Author: Elizabeth O'Neill AuD
Author Block:
Elizabeth E. O'Neill, AuD, CI Program, Boston Children's Hosp., Waltham, MA.
Abstract:
Introduction: Cochlear implantation is routinely recommended for pediatric patients who have bilateral, severe to profound sensorineural hearing loss. For children with additional disabilities, however, the decision to proceed with cochlear implantation can be more challenging. Given the neurological and medical complexities, persons with additional disabilities are not considered typical candidates. However, successful implantation in children with additional disabilities, such as CHARGE syndrome, dual sensory impairments, and Autism, is possible. Although the literature is limited, positive outcomes in this population have been reported and include benefits such as sound awareness, increased communication and socialization. Providing individualized and most appropriate care to this population to maximize benefit can be additionally challenging. Owing to complex and unique needs, anxiety in the medical environment, and need for additional support staff, successful mapping of these patients is complicated. This study examines the need for flexible and individualized cochlear implant mapping sessions for pediatric patients with additional disabilities.
Methods: The following challenges were identified as barriers to successful cochlear implant mapping in this population: increased anxiety and perceived lack of safety in the medical and unfamiliar environment, difficulty transitioning to mapping room, resistance to entering mapping room or booth, eloping, and need for increased staffing, such as teachers or security, to safely complete the visit. A pilot program for offsite mapping services was subsequently implemented to address these barriers.
Results: To date, five unilaterally implanted patients have been successfully mapped in their school environments. Four patients were seen in a sound-treated audiometric booth located at a residential school for the Deaf and Blind. One patient was seen in a therapy room at a day school for Autism. All five patients have difficulty completing mapping services in the medical environment. The following are key factors for successful mapping: familiar environment and perceived safety, familiar educational and behavioral support providers, ability for patients to move around the environment with a wireless programming system, and transportation not required of the patient or educational team. All families and providers report complete satisfaction with off-site mapping.
Conclusion: Providing cochlear implant mapping services to children with additional disabilities in the least restrictive environment can be more successful than in the medical environment, proving to be more time efficient, less stressful for patients and family and cost-effective for the family and provider.
Session: S11-2  
Abstract ID: 122  
Title: Equipment Setup for Therapy with Children with a Unilateral Hearing Loss Who Receive a Cochlear Implant  
Presenting Author: Sandra Hancock MS, LSLS Cert AVT  
Author Block: 
Sandra Hancock, MS, LSLS Cert AVT, Maegan Evans, PhD, CCC-SLP, LSLS Cert AVEd, Lisa Park, AuD, CCC-A, Margaret Dillon, AuD, CCC-A, Kevin Brown, MD, PhD; Department of Otolaryngology/Head and Neck Surgery, Univ. of North Carolina Chapel Hill, Chapel Hill, NC.  
Abstract:  
Introduction: Listening and Spoken Language therapy is widely accepted as an effective treatment option for children with bilateral hearing loss. A new patient population is now emerging. Children who have unilateral hearing loss are being considered candidates for a cochlear implant. Therapy for children with unilateral hearing loss who receive a cochlear implant is unique compared to therapy with children who have bilateral hearing loss. In order to build auditory skills in the implanted ear, it is critical to isolate the ear in order to prevent the child from using the normal hearing ear to perform auditory tasks. The purpose of this presentation is to explain how to set up technology to isolate the implanted ear, give examples of therapy activities, describe in-clinic and remote therapy sessions, and provide tips for setting up and conducting home carry over activities.  
Methods: The present report reviews the intervention program created for children with substantial unilateral hearing loss who underwent cochlear implantation of the affected ear as part of an Investigational Device Exemption. The participants were between 3.5 and 6.5 years of age at the time of surgery, and presented with normal hearing in the contralateral ear, normal cognition, and age-appropriate speech and language skills. The therapy program was created utilizing a developmentally appropriate auditory skills hierarchy. Input was isolated to the cochlear implant processor to focus on cultivating and integrating sound in the implanted ear.  
Results: The therapy program was successful in allowing practice of auditory skills by isolating the CI ear using accessories to direct connect the CI to a computer, tablet, or smartphone during video conferencing, or for pre-recorded auditory stimuli. Subjects made significant improvements in their ability to perform both closed set and open set tasks using their CI ear only, within 12 months. The therapy can be performed in the clinic or at home, with the child and parent connecting with the clinician through video conferencing. Parents have demonstrated the ability to replicate this set up for home carryover practice between therapy sessions. Because this form of therapy is completely dependent on technology, the ability to troubleshoot issues with the equipment is crucial.  
Conclusion: It is important to provide a way for children with UHL, who have received a, cochlear implant, to develop the ability to integrate sound from the CI to benefit from the device. Setting up technology and utilizing the accessories has proven to be an effective way for clinicians, family members and school support staff to isolate the CI ear and build auditory skills.
**Session:** S11-2  
**Abstract ID:** 427  
**Title:** Cochlear Implantation in Acquired Single Sided Deafness  
**Presenting Author:** Paul Van de Heyning MD PhD  
**Author Block:** Paul Van de Heyning, MD PhD Antwerp Univ. Hosp., Antwerp-Edegem, Belgium.  
**Abstract:**  
**Introduction:** Aim: to evaluate the long-term (LT) auditory outcomes up to 15 years of Cochlear Implantation (CI) in acquired Single-Sided Deaf Group (SSD) and an Asymmetric Hearing Loss Group (AHL).  
**Methods:** Structured interview evaluated CI use. Adaptive Speech perception in noise and sound localization were assessed in two listening conditions, i.e. Cloff and Clon condition and summation effect (S0N0), squelch effect (S0NCI) and a combined head shadow effect (SCIN0) were obtained. Sound localization used a frontal 9 speakers semicircle with CCITT noise bursts of 300 ms duration. QOL test included the 12-item Speech, Spatial and other Qualities (SSQ12) and the Hearing Implant Sound Quality Index (HISQUI19). Tinnitus assessment is judged with VAS for loudness and the Tinnitus Questionnaire (TQ) for QOL.  
**Results:** All the patients (23/23) wore their CI seven days a week, eight (3-10) years after cochlear implantation. SSQ12 improved from pre-operative score (2.63) to LT score (5.29). In the SSD group a significant combined head shadow effect of 2.67 dB HL was found. In the AHL group the summation effect (3.50 dB HL), the squelch effect (4.17 dB HL) and the combined head shadow effect (7.67 dB HL) turned out to be significant at LT testing (Ear Hear 2016). Significant benefit was found for sound localization in the SSD group (47°) as well as in the AHL group (45°) (Clin Otolaryngol 2016). The tinnitus loudness decreased from 8/10 (7-10) to 3/10 (0-7) and the TQ dropped from 55 (27-78) to 31 (5-59) (Hear Res 2016).  
**Conclusion:** This is the first study to report on 15 years results in a large number of single sided deaf or asymmetrical deaf CI users, up to 15 years. Structured interviews shows that 100% of the subjects wears their CI seven days a week. The presence of binaural effects could be demonstrated with speech in noise testing, sound localization and subjective evaluation and a significant decrease in tinnitus was achieved.
Session: S11-2
Abstract ID: 131
Title: Preliminary Results of Auditory Skill Development in Children with Unilateral Hearing Loss Who Receive a Cochlear Implant
Presenting Author: Maegan Evans PhD, LSLS AVEd
Author Block:
Maegan Evans, PhD, LSLS AVEd 1, Sandra Hancock, MS, CCC-SLP, LSLS AVT 1, Lisa Park, Aud, CCC-A 2, Margaret Dillon, Aud, CCC-A 2, Kevin Brown, MD, PhD 2; 1Department of Otolaryngology/Head and Neck Surgery, Univ. of North Carolina Chapel Hill Sch. of Med., Durham, NC, 2Department of Otolaryngology/Head and Neck Surgery, Univ. of North Carolina Chapel Hill Sch. of Med., Chapel Hill, NC.
Abstract:
Introduction: Children with a unilateral hearing loss (UHL) demonstrate speech recognition and localization difficulties, speech and language delays, academic difficulties and behavioral issues. Historically, treatment options for children with UHL included a CROS hearing aid, a bone conduction aid, or no treatment. More recently, cochlear implantation of the poorer hearing ear has been investigated for children with UHL and outcomes are promising. Part of the postoperative follow-up included assessment of auditory skills. A computer-based protocol was developed to track auditory skills progress and to develop goals for children with UHL that receive a CI. The auditory stimuli are based on a hierarchy of listening skills. The aim of this report is to discuss the computer-based program and present the preliminary results for children with a UHL that receive a CI.
Methods: Twenty children with UHL underwent cochlear implantation as part of an Investigational Device Exemption clinical trial. Subjects were 3.5 - 6.5 years of age at implantation and presented with normal cognition and age-appropriate speech and language skills. A computer-based tool was developed and used to gather baseline data from the normal hearing ear and track auditory skills progress for the implanted side. Subjects were evaluated at initial activation of the CI processor, and 2 weeks, 5 weeks, 3 months, 6 months, 9 months and 12 months post activation.
Results: Subjects experienced a trend in improved auditory skills from baseline through the 12-month interval. The tasks that showed to be the most difficult include the identification of environmental sounds, imitation of speech babble (syllables), and answering questions about a story with the topic undisclosed.
Conclusion: Children with UHL who receive a CI are able to show improvements in auditory skills in the implanted ear. A computer-based model is an effective way to measure incremental changes in audition during the therapy process.
Introduction: Cochlear implantation (CI) is a recognized treatment for select adults with single-sided deafness (SSD). More recently, this indication has been extended to some children with SSD. This study aims to describe our institutional experience with such children.

Methods: We performed a retrospective review of all patients under the age of 18 with SSD undergoing cochlear implantation between 2011-2018 at a single academic medical center. Demographic data, history, pre- and post-operative audiometry, speech perception tests, and data logs were recorded.

Results: Eleven children underwent implantation for SSD. The mean age at implantation was 4.5 years (range: 15 months-9 years). Etiology of hearing loss was varied. Both prelingual (n=7) and postlingual (n=4) children were represented. All patients had severe-to-profound SNHL in their candidate ear at time of implantation. Two children had contralateral hearing loss, while three possessed an “at-risk” contralateral ear. One patient implanted at an outside institution presented for consultation for failure to demonstrate benefit and was found to have an absent cochlear nerve on preoperative imaging. Eight patients demonstrated significant improvements with hearing in noise testing as early as 3-month follow-up and continue to improve over extended period of follow-up. Two additional patients recently implanted have not yet had evaluations. Mean device use was 8.7 hours/day (range 2-12 hours).

Conclusions: Children with SSD who underwent CI demonstrated objective audiometric benefit as well as subjective benefit based on monitoring device use and family reported outcomes. Based on limited experience, counseling in children with SSD may include consideration of cochlear implantation, especially in patients with a contralateral “at risk” ear. Word Count: 258 Character count: 2058
Reduced Fatigue and Improved Quality of Hearing after Cochlear Implantation in Children with Unilateral Sensory Hearing Loss

Presenting Author: Kevin Brown MD, PhD

Author Block: Kevin D. Brown, MD, PhD, Lisa Park, AuD, Margaret Dillon, AuD, Brendan P. O’Connell, MD; Otolaryngology - Head and Neck Surgery, Univ. of North Carolina Sch. of Med., Chapel Hill, NC.

Abstract:

Introduction: Unilateral sensory hearing loss (UHL) negatively effects speech understanding in noise and localization. For children, there are also more insidious consequences including problems with speech and language development, behavioral problems, and academic and cognitive issues. Fatigue has been suggested to contribute to poor academic performance. Children with bilateral sensory hearing loss have much higher levels of fatigue in comparison to normal hearing children, potentially contributing to academic or cognitive issues. We wished to determine if children with UHL have similar problems with fatigue. We then evaluated the effect of cochlear implantation in these children on fatigue as well as quality of hearing.

Methods: This was a prospective, investigator initiated, FDA-approved clinical trial evaluating the benefits of cochlear implantation in 20 children with UHL. Children between 3.5-6.5 years with moderate to profound UHL were enrolled and received a cochlear implant. Children were evaluated before surgery and at 3, 6, 9, 12 and 18 months after surgery with a validated scale of pediatric fatigue (Peds-QL). Children were also evaluated for quality of hearing by the Speech, Spatial and Qualities of Hearing Scale (SSQ) and the modified Bern Benefit Inventory.

Results: Children with UHL demonstrate similar levels of fatigue as a historic cohort of children with bilateral sensory hearing loss, especially in the cognitive fatigue subscale. There was substantial improvement after implantation in all 3 subscales (General, Sleep and Cognitive), most notably after 6 months. There was also concurrent improvements in the quality of hearing as measured by the SSQ, most notably for spatial hearing (p< 0.001). The Bern Benefit Inventory demonstrated marked improvement in the cochlear implant condition as compared to before implantation with a hearing aid alone.

Conclusion: These data together demonstrate that the quality of hearing is markedly improved with cochlear implant use for children with moderate to profound UHL. This results in decreased fatigue, possibly by reducing the amount of auditory effort expended over the child’s day. The implications for this are that children with UHL now have a viable option to rehabilitate their hearing loss, reduce fatigue in the classroom, and enable them to better reach their academic potential. This merits expansion of cochlear implant candidacy to children with unilateral sensory hearing loss.
Title: Hearing and Cochlear Implant Outcomes in Children with Absent/Abnormal Cochleovestibular Nerves

Presenting Author: Elina Kari MD

Author Block:
Elina Kari, MD 1, Danielle Gillard, MS 2, John Go, MD 3, Nathaniel Chuang, MD 4, Janice Loggins, MA 5; 1Otolaryngology/Surgery, Univ. of California, San Diego, La Jolla, CA, 2Univ. of California, San Diego, La Jolla, CA, 3Radiology, Univ. of Southern California, Los Angeles, CA, 4Radiology, Rady's Children Hosp., San Diego, CA, 5Otolaryngology, Univ. of Southern California, Los Angeles, CA.

Abstract:
Introduction: Abnormal cochleovestibular nerves in children with profound sensorineural hearing loss (SNHL) have traditionally been a contraindication to cochlear implantation. Some centers advocate for immediate consideration of auditory brainstem implantation (ABI). The data, however, indicate that some children with abnormal cochleovestibular nerves (CVNs) do derive hearing benefit from hearing aids and/or cochlear implants (CIs) despite not having distinct cochlear nerves. The benefit from a CI in these children is extremely variable and comparable to the outcomes reported for ABIs. In this review, we characterize the cochleovestibular anatomy and present the outcomes in children with abnormal CVNs who received CIs.

Methods: Retrospective review of pediatric patients with SNHL and abnormal cochleovestibular nerves in an academic quaternary referral center. Outcome measures: Computed tomography and/or magnetic resonance imaging was reviewed in each patient and correlated with their hearing assessments and postoperative outcomes with their cochlear implants, if implanted.

Results: A total of 41 pediatric subjects (82 ears) were included. The bony labyrinth was abnormal in the vast majority of subjects and the most common abnormality was an abnormal cochlear aperture. Four percent of ears had zero nerves visualized in the IAC, 11% had one, 25% had 2, 16% had 3, 18% had 4, and 25% had insufficient fluid in the IAC to determine the contents. Of those with 4 nerves in the IAC, 8/14 (10% total, 57.1% of those with 4) ears had a hypoplastic appearing cochlear nerve. The hearing status and language outcomes were extremely variable- ranging from no responses with hearing aids and/or cochlear implant(s) to open-set speech recognition. There was a trend towards having better hearing outcomes with 3 or 4 nerves in the IAC.

Conclusion: Cochlear implantation should be considered in patients with abnormal cochleovestibular nerves. While the hearing outcomes are extremely variable, the outcomes parallel those of ABI in many cases. Furthermore, the imaging results cannot accurately predict the hearing status or the potential benefit from a cochlear implant. Expectations in these situations are more guarded and families need to be counseled accordingly.
Session: S11-3
Abstract ID: 78
Title: Cochlear Implant Outcomes in Cochlear Nerve Dysplasia- What Can We Tell Parents?
Presenting Author: Catherine Birman MBBS PhD FRACS
Author Block:
Catherine Birman, MBBS PhD FRACS 1, William Gibson, MD FRACS FRCS 1, Elizabeth Elliott, MD MPhil FRACP FRCPCH FRCP 2; 1SCIC, Sydney, Australia, 2Children's Hospital at Westmead, Sydney Univ., Sydney, Australia.
Abstract:
Introduction: Parents with profoundly deaf children are understandably hopeful of excellent outcomes with cochlear implants (CI). MRI findings of cochlear nerve dysplasia (CND) can be devastating for parents, as they are unsure of the likelihood of verbal language outcomes. We need more information on the outcomes in these cases to be able to guide CI consent, and early intervention options.
Methods: Our program's data base was reviewed for children with CND. Records were reviewed regarding: MRI, transtympanic auditory brainstem testing, intraoperative CI evoked auditory brainstem responses, NRT, categories of auditory perception (CAP), and main mode of communication.
Results: Fifty CI recipients were identified, including 21 bilateral recipients. Twenty seven children had developmental delay. MRI showed cochlea nerve (CN) aplasia in 64 ears, hypoplasia in 25 ears, and a normal nerve in 11 ears. Main mode of communication was analyzed for 41 children with 12 months or more CI experience: 21 (51%) used verbal language (15 speech alone, 5 speech plus some sign, 1 bilingual in speech and sign), and 20 (49%) used sign language (10 sign alone, 9 sign plus some speech, 1 tactile sign). Seventy-three percent of children used some verbal language. Cochlear nerve aplasia/hypoplasia and developmental delay were both significant factors affecting main mode of communication. Categories of Auditory Performance scores were available for 59 CI ears; 47% with CN Aplasia and 89% with CN hypoplasia achieved Categories of Auditory Performance scores of 5 to 7 (some verbal understanding) (p = 0.003). A novel grading system is proposed for nerves in the IAM.
Conclusion: Our results are very encouraging and useful when counselling families regarding the likelihood of language outcomes and auditory understanding.
Session: S11-3
Abstract ID: 310
Title: Auditory Brainstem Implant Array Position and Auditory Outcomes in Pediatric Patients
Presenting Author: Isabeau van Beurden BS

Author Block:
Isabeau van Beurden, BS 1, Dana Egra-Dagan, MA 1, Barbara S. Herrmann, PhD 1, Mary E. C. Cunnane, MD 2, Christian M. Brown, PhD 1, Daniel J. Lee, MD 1; 1Otolaryngology, Mass. Eye and Ear, Boston, MA, 2Radiology, Mass. Eye and Ear, Boston, MA.

Abstract:
Introduction: The auditory brainstem implant (ABI) provides varying degrees of sound perception to deaf pediatric patients who are ineligible for cochlear implantation. Perception outcomes range from sound detection only to limited closed-set word identification (Noij, K. et al., 2015, Otolaryngol Head Neck Surg. 153(3):e739-e750). The main goal of this study is to document the ABI electrode array position in pediatric patients and compare to perceptual outcomes. In addition, cases with changes in perception outcomes were examined for changes in electrode array position.

Methods: We performed a retrospective review of nontumor pediatric ABI subjects with postoperative computed tomography (CT) of the head. Electrode array position was classified using the posterior and left lateral views from three-dimensional (3D) reconstructions (Barber, S. et al.,2017, Ear and Hear. 38(6):e343-e351). Array angles were measured with respect to a horizontal line, and array distances were the vertical (D1) and horizontal distances (D2) between the proximal array tip and the basion. Electrodes were activated in the processor program if no side effects were observed with direct electrode stimulation or were suspected to be auditory sensations from eABR morphology done during a prior sedated session (Herrmann et al. Ear Hear. 2015; 36(3): 368-376). Electrodes were disabled if side effects were observed (e.g. gagging, extreme eye blinking, facial twitching, etc.), or if eABR morphology had suggested nonauditory sensation, or if there were no behavioral responses at highest current level during programming sessions. Performance testing in awake subjects included sound detection (pure tones and warble tones), speech perception (Ling 6-Sound Test and the Early Speech Perception Test), and the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS).

Results: A total of 15 CT scans from 9 pediatric ABI subjects were analyzed, including three subjects with a total of 4 revisions. All arrays except one were tilted posteriorly when seen from lateral view, and most (12/15) of the arrays were tilted medially from posterior view. The position of the electrode array varied among subjects, with D1 ranging between 0.7 and 2.3 cm (mean = 1.37, 2 Stnd. Dev. (SD) = 0.76), and D2 ranging between 0.1 and 1.3 cm (mean = 0.9, 2 SD = 0.58) in posterior view, and between 0.3 and 3.0 cm (mean = 0.8, 2 SD = 1.0) in lateral view. The number of activated electrodes was between 6 and 21 (out of 21 electrodes), of which 5 subjects had consistent responses on 3-11 electrodes, with the remainder being disabled electrodes. Overall, most of the patients had sound detection (8/9). The array position of the subject with no sound detection was tilted medially from posterior view and anteriorly from lateral view, with array distances beyond 2 SD. In contrast, the array position of the best performer, with closed-set speech recognition of monosyllables and IT-MAIS 40/40, was tilted medially from posterior view and posteriorly from lateral view, with array distances close to the mean. In two subjects with a history of minor head trauma, after a change in perception, the pre-change CT-scan and post-change CT-scan showed that the electrode array had changed position.

Conclusion: ABI array position based on postoperative 3D CT reconstruction varies and may contribute to the range and change of auditory outcomes seen in this specialized patient cohort.
Session: S11-3
Abstract ID: 285
Title: Long-Term Use of Device and Outcomes in Non-NF2 Children with Auditory Brainstem Implant
Presenting Author: RANJITH RAJESWARAN MASLP
Author Block:
Ranjith Rajeswaran, MASLP 1, Mohan Kameswaran, Prof, MS, FRCS, MAMS, DSc, 2; 1MERF-Institute of Speech and Hearing, Chennai, India, 2Madras ENT Res. Fndn. (P) Ltd.,, Chennai, India.
Abstract:
Introduction: More and more children are identified as candidates for Auditory Brainstem Implant (ABI), however there is no clear evidence to predict outcomes in these children. Though there are few articles that describe the outcomes in children with ABI, only very few studies have documented the long-term results in these children. This study will shed some light about the long-term outcomes and use of device in children with ABI. The aim is to profile the long term outcomes and use of device in children with ABI
Methods: Ten children with bilateral auditory nerve aplasia using Auditory Brainstem Implant were monitored for a period of three years. Their listening, Speech and Language outcomes were measured periodically from surgery to 36 month. The outcomes were measured using CAP, SIR, MAIS, MUSS, Little ears Test Battery etc. The performance of the device and the adverse events were documented periodically and as and when need arises
Results: All children with ABI use the device consistently. Performance of auditory and communication skills developed after ABI, but showed very slow progress. Audition skills are better than speech production skills. Though the scores are not comparable to children with Cochlear Implant, few children have shown comparable performance to children with Cochlear Implant. The long-term outcomes in these children shows slow improvement in the communication skills and all the children are very much dependent on the device. The mode of communication changed from total communication to oral and sign language, from pre-operative to two years post-operative respectively. There were adverse events related to procedure and device which were resolved later. Among children who had adverse event, two children had severe adverse event compared to others. Non auditory sensation was perceived in two children during the initial stimulation. Non-auditory sensation was resolved in one child in the consecutive session, but in one child the non-auditory side effect was persistent.
Conclusion: ABI is option to restore hearing in children who are contra indicated for Cochlear Implant. Outcomes in children with ABI are variable and cannot be compared to children with CI. Unlike children with CI, children with ABI show very slow progress with diverse trend. Since there are no single factor that influence outcome in children with ABI, it is very difficult to predict the outcome prior to surgery or even immediately after switch-on. So it is recommended that children with ABI need a very long term close monitoring and follow-up. However all the children with ABI use the device consistently and show some auditory benefits that supplement their communication mode some form. Adverse events can be expected, but can be managed with good team. Though ABI is an option to restore hearing, parental expectations should be very realistic and the family should be willing to support the rehabilitation for a longer duration than for children with CI.
**Title:** Evaluation of the Functionality of the Cochlear Nerve: Deciding Between Cochlear Implant and ABI

**Presenting Author:** Luis Lassaletta Head Section of Otology

**Author Block:**
Luis Lassaletta, Head Section of Otology 1, Rubén Polo, Otolaryngologist 2, Maria del Mar Medina, Otolaryngologist 2, Emilio Amilibia, Otolaryngologist 3, Javier Gavilán, Head of the Department 1; 1Otolaryngology, La Paz Univ. Hosp., Madrid, Spain, 2Otolaryngology, Ramón y Cajal Univ. Hosp., Madrid, Spain, 3Otolaryngology, Trias i Pujol Univ. Hosp., Madrid, Spain.

**Abstract:**

**Introduction:** Cochlear implantation is a challenging indication for children with severe inner ear malformations as well as for those with a vestibular schwannoma, especially NF2 patients. In these complex cases, it may be necessary to assess the viability of the cochlear nerve in order to predict the outcome of a cochlear implant (CI). If the cochlear nerve is not viable, the only alternative is an auditory brainstem implant (ABI). The aim of this talk is: (1) To assess the functionality of the auditory nerve in standard cochlear implantees by using an intracochlear test electrode, comparing electrical auditory brainstem responses (eABR) via the test electrode with the eABR responses with the CI. (2) To assess the usefulness of this intraoperative electrode in complex patients, both with malformations and NF2.

**Methods:** Main outcome measures were the quality of an eABR waveform, scoring criteria from Walton et al. and postimplantation audiometric scores

**Results:** (1) Of the 10 postlingually deaf patients, it was possible to evoke electrical stimulation responses along with both the test electrode and the CI in all subjects. No significant differences in latencies or amplitudes after stimulation were found between the test electrode and the CI. All subjects obtained useful hearing with their CI and use their implants daily (2) Of the 21 patients, 16 were implanted, 14 of them achieving auditory perception. According to the test electrode there was one false positive and one false negative cases.

**Conclusion:** The intracochlear test electrode may be a suitable method to test the integrity of the auditory nerve by recording eABR signals. This allows for further research on the status of the auditory nerve in cochlear malformations of after tumor removal in NF2 patients, and correlation with auditory performance. In selected patients, this may allow for cochlear implantation as an alternative to ABI.
Session: S12-1
Abstract ID: 217
Title: Simultaneous Electrocochleography and High-Resolution Fluoroscopy During Electrode Array Insertion with Two Types of Electrode Arrays
Presenting Author: Torquil Sørensen PhD
Author Block:
Torquil M. Sørensen, PhD 1, Ralf Greisiger, PhD 1, Hilde Korslund, BSc 2, Marie Bunne, PhD 1, Greg Jablonski, PhD 3; 1Department of Otolaryngology, Oslo Univ. Hosp., Oslo, Norway, 2Intervention Centre, Oslo Univ. Hosp., Oslo, Norway, 3Institute of Clinical Medicine, Univ. of Oslo, Oslo, Norway.
Abstract:
Introduction: Indications for cochlear implantation are expanding to include patients with more residual hearing. Less traumatic electrode arrays and implantation techniques are therefore needed so as not to cause additional trauma. We use implant-based electrocochleography (ECoG) for monitoring cochlear function during array insertion. To identify the causes of trauma or mechanical obstruction, we monitor the electrode array using high-resolution fluoroscopy. Also, intracochlear ECoG measurements can potentially lead us to new insights regarding progressive postoperative loss of residual hearing. We want to identify trauma or mechanical obstructions during electrode array insertion, and better understand different types of ECoG responses. This could improve ECoG interpretation during surgeries without visual electrode array feedback. We compare the electrode array movements and ECoG characteristics of a mid-scalar and a recent lateral wall electrode array.
Methods: During cochlear implant surgery, we monitor the cochlea using ECoG on recipients with residual hearing, and monitor the electrode array using fluoroscopy. The ECoG responses and visual observations from the fluoroscopy and microscope are compared with the pre-op and post-op audiograms. Post-op CT is performed to study the electrode array placement. We also perform post-op ECoG measurements as well as pure-tone audiometry.
Results: We have successfully monitored the electrode array insertion on more than 15 patients involving a mid-scalar and a recent lateral wall electrode array. By comparing the ECoG responses with the electrode array movements, we are able to identify some causes of cochlear trauma, and differences between the two electrode array types.
Conclusion: ECoG and fluoroscopy gives very valuable feedback during surgery, and information regarding causes of trauma. Fluoroscopy allows us to study the connection between ECoG behaviour and electrode array movements as well as post-insertion surgical manipulations such as round window packing and lead coiling. In time, perhaps ECoG can become a standard technique for CI surgeries when the residual hearing is significant.
**Session:** S12-1  
**Abstract ID:** 245  
**Title:** Clinical Experience with the Atraumatic SlimJ Electrode and Intra-operative ECochG Measurements  
**Presenting Author:** Thomas Lenarz Prof, Prof HC, Dr Med  
**Author Block:**  
Thomas Lenarz, Prof, Prof HC, Dr Med, Rolf Salcher, Dr, Michael Bardt, B Eng, Andreas Buechner, Prof Dr; ENT Department, Med. Univ. of Hannover, Hannover, Germany.  
**Abstract:**  
**Introduction:** Nowadays, Cochlear Implantation (CI) is performed in candidates with significant residual hearing. Demands to electrode design as well as surgical techniques are increasing. The SlimJ electrode array by Advanced Bionics was developed to meet requirements like atraumatic design, easy handling and preservation of hearing. To improve the surgical techniques and reduce the trauma of the electrode insertion electro-cochleography (ECochG) measurements are used. The recordings of ECochG provide real-time feedback elicited by acoustic stimulation while the electrode array is being inserted.  
**Methods:** So far 92 CI candidates have been implanted with the HiRes Advantage/Ultra implant and SlimJ electrode. In 47 CI candidates, showing residual hearing pre-operatively, ECochG has been measured intra-operatively. All CI users underwent post-operative follow-up including hearing threshold as well as speech perception measures for at least 4 months post-op.  
**Results:** The SlimJ electrode was inserted in all cases via the round window. At one month post-op in 43% of the CI users hearing loss of less than 30dB was measured, in another 40% less than 15dB. Based on the ECochG signal, used as a real-time warning system, the insertion of the electrode was halted or the electrode withdrawn until the ECochG signal was recovered. Changes in ECochG amplitude during electrode array insertion were in line with surgical feedback and surgical video review. Intra- as well as post-operative ECochG measures were correlated to low-frequency hearing preservation. Subjects were grouped according to their intra-operative curve progression: 1) final amplitude at least 80% of maximal amplitude, 2) final amplitude between 20% and 80%, 3) complete loss (<20%). Hearing loss 4 weeks after surgery (expressed as LF PTA) in group 1 was 10 dB and significantly lower than in group 2 (32 dB). Only 3 subjects were assigned to group 3, preventing a comparison.  
**Conclusion:** The SlimJ electrode array is easy to handle for atraumatic insertion through the round window and adjusted insertion depth controlled by ECochG measurements. Both electrode design as well as surgical technique are important for reliable hearing preservation.
Session: S12-1
Abstract ID: 175
Title: Electrocochleography in Pediatric Cochlear Implant Recipients Correlations with Behavioral Audiometry and Auditory Outcomes
Presenting Author: Joseph Attias PhD
Author Block:
Joseph Attias, PhD 1, Ohad Hilly, MD 2, Suhail Habiballah, BA, Eng 1, Eyal Raveh, MD 3; 1Communication Sciences and Disorders, Univ. of Haifa, Haifa, Israel, 2ENT, Schneider Children Med. Ctr., Petach Tikva, Israel, 3ENT, Schneider Children Med. Ctr., Petach-Tikva, Israel.

Abstract:
Introduction: Preservation of the cochlear structures and residual hearing are a challenging target in cochlear implantation (CI), especially in children with congenital hearing loss. Children with more sensory and neuronal remnants had lower electrical thresholds, better speech in noise and music perception. Electrocochleography (ECochG) recorded directly from the CI may serve as an excellent tool both for monitoring the changes during the implantation and assessing the residual hearing post implantation. Thus, the objectives of this study were: to correlate the Cochlear Microphonics (CM) ECochG Audiograms with the behavioral audiograms obtained in pediatric CI recipients. In addition, to compare CI outcomes in children with or without residual hearing.

Methods: Post-implantation Intra-cochlear CM thresholds as well as behavioral audiometry were measured at test frequencies 125 to 2000 Hz in 102 ears of 64 children implanted with Advanced Bionics CI. Most of them were implanted below age of 3 year and the rest up to 5 years old. Of the all children, 11% diagnosed with AN. CI outcomes measures were assessed using the Speech, Spatial and Qualities (SSQ) of hearing scale, the categories auditory performance (CAP) and CI audiograms.

Results: Post implantation CM-ECochG audiograms revealed "Auditory Neuropathy" (AN) and "Sensory" patterns. In the AN group, CM thresholds were better than the audiometric across all frequencies, while in the SNHL cases they were similar. In the SNHL group the ECochG thresholds across all frequencies strongly correlated (r² = 0.87, n = 185) with the behavioral audiometry. The mean difference between CM thresholds and the behavioral was -2.8 ±10 dB. Children with residual hearing loss performed significantly better in the SSQ of hearing scale as well as in the CAP scales. Behavioral CI audiograms were similar between the groups.

Conclusion: Intra-cochlear CM-ECochG is a valuable metric objective tool for predicting the audiometric thresholds both for very low (125 Hz) and high frequencies (2000 Hz) in pediatric cochlear implant recipients. Currently, there is no other neurophysiological tool for assessing low frequencies residual hearing. The presence of acoustic residual hearing in the children was associated with better electrically auditory performance with the cochlear implant as compared to absence of residual hearing. Practically, the test is very quick, does not need a close cooperation, easy to implement in pediatric population, and provide a valuable data for better mapping, treating and rehabilitating children with CI. However, regarding the children with AN, since ears with AN are 5-15% of all SNHL cases, it is necessary to develop and add a neuronal measure to the CM, as for instance, compound action potential (CAP) which may more appropriately reflect the audiometric thresholds in children with AN.
Session: S12-1
Abstract ID: 316
Title: Angular Insertion Depth and Electrocochleography Predict Speech Perception Outcomes with Lateral Wall Arrays
Presenting Author: Michael Canfarotta MD
Author Block:
Michael W. Canfarotta, MD, Christopher K. Giardina, PhD, Brendan P. O’Connell, MD, Douglas C. Fitzpatrick, PhD; Otolaryngology/Head and Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC.
Abstract:
Introduction: There remains a high variability in outcomes amongst cochlear implant (CI) recipients. Electrocochleography (ECochG) can assess residual cochlear function to auditory stimulation at the time of implantation and has been previously shown to account for up to 40-50% of variability in postoperative speech perception outcomes in adults. Surgical factors, such as angular insertion depth (AID) with lateral wall arrays have a modest correlation with outcomes and it is postulated that these will account for part of the remaining variability. The present study seeks to determine additional variance in speech outcomes accounted for by AID.
Methods: ECochG was performed in adult subjects undergoing CI with lateral wall arrays. Measurement of residual cochlear function was determined by the total response (TR), the sum of magnitudes of spectral components in response to tones of different stimulus frequencies. AID was determined by intraoperative x-ray using a rotating cochlear model. Multiple linear regression was used to compare AID and the TR with consonant-nucleus-consonant (CNC) scores at 6 months post-initial activation.
Results: Of 42 patients implanted with lateral wall arrays, AID ranged from 394 o to 735 o and showed a positive correlation with CNC scores accounting for 18% of variability ($r^2 = 0.18$, $p = 0.005$). The TR measured by ECochG accounted for 38% ($r^2 = 0.38$, $p < 0.005$). TR and AID accounted for 65% of variability in speech perception outcomes by multivariate regression ($r^2 = 0.65$, $p < 0.005$).
Conclusion: AID and TR account for a significant portion of variability in speech perception outcomes in CI recipients with lateral wall arrays. Future prospective studies will evaluate additional variables known to affect speech perception outcomes, such as other array types, distance to the modiolus and scala location. Additionally, further research will focus on the applicability of this relationship within the pediatric population.
Session: S12-1
Abstract ID: 218
Title: Trauma detection during CI surgery using objective measures and imaging
Presenting Author: Ralf Greisiger PhD
Author Block:
Trauma detection during CI surgery using objective measures and imaging
Ralf Greisiger 1, Torquil Macdonald Sørensen 1, Hilde Korslund 2, Marie Bunne 1, Greg Eigner Jablonski 1,3
1Department of Otolaryngology, Oslo University Hospital, Norway
2Intervention Centre, Oslo University Hospital, Norway
3University of Oslo, Institute of Clinical Medicine, Norway
Abstract:
Introduction: During the last years, indications for cochlear implantation are expanding, including patients with residual hearing. Several factors have been identified, that reduce the residual hearing after CI surgery. This study investigated trauma during insertion of the electrode array, reflected by hearing loss. We used implant-based electrocochleography (ECochG) for monitoring the cochlear responses during electrode array insertion while performing per-operative fluoroscopy at the same time to observe the movement of the array inside the cochlea. In addition, video recording of the surgeon’s microscope view was done to capture the surgeon’s actions. Objectives of this study are to identify trauma or mechanical obstruction during electrode array insertion, and better understand the different types of ECochG responses. This could improve ECochG interpretation during surgeries without visual electrode array movement feedback. We compared the movements and different ECochG characteristics with the maneuver done by the surgeon. Ideally, the gained understanding of what happens during the electrode array placement will lead to better preservation of residual hearing.
Methods: For 12 adult patients the Electrocochleography (ECochG) responses were measured during insertion of the electrode array of a Cochlear™ Nucleus® Profile with Slim Modiolar Electrode (CI532). At the same time fluoroscopy was performed to analyze the movement of the array and to synchronize the movement with the measurements. As third observation microscope video was recorded to track the surgeon’s insertion technique and surgical procedure. Finally, a postop CT scan was performed to analyze the electrode array placement in the cochlea. For all patients pre- and post-op audiograms were taken up to one year after CI surgery to record the loss of residual hearing.
Results: We have successfully monitored the electrode array insertion for 20 patients and were able to identify some causes of cochlear trauma. There seems to be a strong correlation between loss of ECochG response and loss of residual hearing. In some cases, the loss happened during electrode insertion. In other cases, the loss may have happened already before insertion, while not measuring a response during insertion and losing residual hearing. In addition, every movement of the electrode array even after insertion has been identified to be critical. For some cases the loss of ECochG response happened after full insertion just before or while packing the electrode array at the round window. Even coiling of the electrode array after sealing of the round window with the muscle has an effect on ECochG response amplitude.
Conclusions: The combination of per-operative ECochG measurements, microscope video, fluoroscopy and post-operative CT scan gives us a valuable information about which steps during the electrode array placement may cause a reduction of residual hearing. These findings will be used to improve the surgical procedure in future. Nevertheless, further investigations are necessary to increase the success rate of preserved hearing.
Session: S12-1
Abstract ID: 1024
Title: Relationship of Intra-cochlear electocochleography to long term speech perception scores in conventional cochlear implant recipients
Presenting Author: Carla Valenzuela MD
Author Block:
Abstract:
Invited Presentation
Session: S12-2
Abstract ID: 359
Title: Interprofessional Practice and Intensive Listening and Spoken Language Intervention Support Pediatric Cochlear Implant Users Keep Up, Catch Up, Move Up
Presenting Author: Uma Soman PhD, LSLS Cert AVEd
Author Block: Uma Soman, PhD, LSLS Cert AVEd, Danielle Chalfant, MA, CCC-A, Jean Thomas, MS, CCC-A, Michael Novak, MD; Expanding Children’s Hearing Opportunities, Carle Fndn. Hosp., Urbana, IL.

Abstract:
Introduction: Childhood hearing loss impacts development of communication skills, which impacts development of literacy, academic, and social-emotional skills. Children who are deaf or hard of hearing (DHH) and their families can reach their desired outcomes through early diagnosis and intervention. This presentation will feature how one comprehensive program that includes otology, audiology, speech-language pathology, and education services under one roof, is leveraging interprofessional practice and intensive listening and spoken language (LSL) intervention, to help children who are DHH reach their potential. In this comprehensive program, families receive audiological evaluations, learn about communication options, and receive early intervention. Hearing aid selection, fitting, as well as cochlear implant surgery and mapping is available in the same program. Children who have deficits in listening, language, and speech, at three years can enroll in the school program. The school program meets each child and family where they are to support their growth trajectory - Keep Up, Catch Up, or Move Up. Evidence-based LSL instruction is provided in small group settings by highly qualified professionals. Through interprofessional practice, audiologists, speech-language pathologists, and educators of DHH students collaborate to develop intervention plans, implement it, monitor progress, and modify the plan if the student isn’t making adequate progress. Spontaneous language samples, observations, and annual assessments using standardized measures ensure data-driven intervention. When students achieve at or near age-appropriate skills, families seek placement in public or private school.

Methods: A retrospective study of 40 children who are DHH (4-11 years), who attended the school program for two or more years was conducted. All participants used hearing technology, and were learning to listen and speak. Participants graduated from the school program in 2008 - 2018. Standard scores from annual assessments in domains of speech, vocabulary, and connected language were analyzed. Demographics, audiological history, and factors that might impact outcomes, such as presence of additional disabilities and adverse childhood events (ACEs) were documented. Twenty-five of 40 participants, demonstrated below average scores in three or more domains at time of enrollment. Outcomes in speech, receptive & expressive vocabulary, and language, at time of “graduation” from the school program are characterized in this study.

Results: At time of “graduation”, 23 of 40 participants demonstrated age-appropriate scores in all four domains, with 11 of them “catching up”, i.e., making more than a year’s progress in a year’s time. Of the remaining participants, 6 had below average standard scores in one domain, 3 participants had below average scores in two domains, and 8 participants had below average scores in more than two domains. Conclusion: Approximately 75% of children who have attended the school program, many of them with below average scores in three or more domains at time of enrollment demonstrated age-appropriate scores at time of “graduation”. Several participants whose learning was impacted by additional factors, and are often excluded from such studies, demonstrated age appropriate scores in more than two domains indicating that interprofessional practice and intensive LSL interventions can help pediatric CI users keep up, catch up, and move up.
Session: S12-2
Abstract ID: 408
Title: Pre-Lingually Deaf Children After Cochlear Implantation: The Developmental Regularity of Language Ability During Long-Term Follow-Up
Presenting Author: Wei Wei PhD
Author Block:
Wei Wei, PhD, Xiulan Ma, MD; Otology, Shengjing Hosp. of China Med. Univ., Shenyang, Liaoning Province, China.
Abstract:
Introduction: Some children who born profoundly deaf fall significantly behind their normal-hearing peers in their mastery of the surrounding oral language in its written, read, spoken and signed forms. Until the early 1980s, a cochlear implant was invented as a device that could stimulate the auditory nerve electrically to produce hearing percepts. And now the use of cochlear implant (CI) has been clearly known to rehabilitate the auditory and language ability of the patients with severe to profound sensorineural hearing loss. However, several studies demonstrated the regularity of auditory and language ability of pre-lingually deafness children after CI. While our study was to investigate the developmental regularity of language ability of pre-lingually deafness children with cochlear implantation (CI) during 3-year follow-up.
Methods: Language articulation, grammatical competence, comprehension competence, expressive competence and communicative competence were used to evaluate the language ability at 0 (the start of rehabilitation training), 6, 12, 18, 24, 30, 36 months after rehabilitation training of 371 CI pre-lingually deaf children with a mean age of 3.02 yr. Categories of auditory performance (CAP) and Speech intelligibility rating (SIR) were also used to evaluate the data.
Results: ① All the language abilities were developed gradually with the time of rehabilitation training, and the speed of language ability development was fastest in the first 12 months (P<0.05). Further, the developmental order was comprehension competence, grammatical competence, language articulation, communicative competence, expressive competence. Among them, comprehension competence was significantly faster than the other four language abilities (P<0.05). ② The speed of the language abilities develop gradually slow down, and language articulation, expressive competence, communicative competence have significant difference between each two time point before 30 th month (P<0.05), respectively. Grammatical competence and comprehensive competence have significant difference between each two time point before 24 th month (P<0.05), respectively. ③ Total language ability has positive correlation with both CAP and SIR (P<0.05).
Conclusion: Pre-lingually deaf children rehabilitated their hearing and language ability gradually after CI. According to the different time points of 5 language abilities rehabilitation to reach their plateau, it was suggested that at least 30 months should be taken to rehabilitate language abilities for the pre-lingually deaf children after CI.
**Session:** S12-2  
**Abstract ID:** 326  
**Title:** Do the Children with Cochlear Implants Comprehend Verbal Irony?  
**Presenting Author:** Sara Cavicchiolo Speech Therapist  
**Author Block:**  
Francesca Panzeri, Neuropsychologist 1, Sara Cavicchiolo, Speech Therapist 2, Beatrice Giustolisi, Neuropsychologist 1, Paola Ajmone, MD 3, Paola Viziello, MD 4, Veronica Donnini, Psychologist 4, Umberto Ambrosetti, MD 2; 1Department of Psychology, Univ. of Milan - Bicocca, Italy, Milano, Italy, 2Audiology Unit, Department of Clinical Sciences and Community Health;, Fondazione IRCCS Ca’ Granda, Ospedale Maggiore Policlinico, Univ. of Milan,, Milano, Italy, 3U.O.C. Neuropsichiatria dell’Infanzia e dell’Adolescenza, Fondazione IRCCS Ca’ Granda - Ospedale Maggiore Policlinico, Milano, Italy, 4U.O.C. Neuropsichiatria dell’Infanzia e dell’Adolescenza, Fondazione IRCCS Ca’ Granda, Ospedale Maggiore Policlinico, Univ. of Milan,., Milano, Italy.  
**Abstract:**  
**Introduction:** Despite great variability, many children with cochlear implants (CI) reach a linguistic competence comparable to normal hearing (NH) peers, even if prosody recognition remains a weakness. CI children have nonverbal mental age (NVMA) in line with normal hearing (NH) peers, but their Theory of Mind (ToM) abilities, such as irony comprehension are reported to be delayed. Their pragmatic abilities are understudied, and irony comprehension is a particularly interesting topic because it is not yet clear what are the factors that better predict the development of this ability in NH children: however, some scholars highlighted the role played by 2nd order ToM abilities. Among ToM abilities, aim of this study was to assess irony comprehension in a group of children with CI and in two control groups of NH children. Primary goal was to evaluate their pragmatic abilities and identifying the factors that predict irony understanding.  
**Methods:** We tested a group of 28 children with CI (mean age 8 y and 5 months; range 3-12 years); 13 children had received the cochlear implant within 18 months of age (early CI), 15 after 24 months of age (late CI). We had also two control groups of NH children, one matched for chronological age (CA-NH, p = .905); and one for hearing age (HA-NH, p.=892). Children were administered Raven CPM for their NVMA; a morphosyntactic task for linguistic abilities; six tasks for ToM abilities (up to 2 ndorder ToM); a task for prosody recognition; a new irony comprehension task that included 6 ironic and 4 literal remarks.  
**Results:** All the CI children had lower linguistic abilities compared to the CA-NH (p=.027), but not with HA-NH (p=.614). The same level of ToM was reached by the CI and HA-NH groups, whereas a statistically significant difference was observed between CI and CA-NH in 2ndorder ToM scores (p=.026). Prosody recognition was also significantly worse (p<.01) in all the CI recipients with regard to both NH controls. On the irony comprehension task, CI children had a lower accuracy in ironic remarks not only compared to CA-NH (CI: 52% vs CA-NH: 82; p<.001), but also with regards to HA-NH (CI: 52% vs CA-NH: 73%; p=.011), while literal comments were at ceiling for all groups. The comprehension of ironic criticisms strongly correlated with hearing age, and with ToM skills. Children with early CI had higher level of accuracy in irony comprehension than those in the late CI.  
**Conclusion:** Irony comprehension in children with CI is delayed compared to that observed in the NH peers, also in the younger ones matched for hearing age. This deficit does not seem to depend on their difficulty in prosody recognition, but on their delayed ToM skills.
Session: S12-2  
Abstract ID: 151  
Title: Relation Between Mothers’ Linguistic Input and Children’s Language Development: Before the Surgery and Three Months After Cochlear Implant Activation  
Presenting Author: Letizia Guerzoni Speech and language Therapist  
Author Block:  
Giovanni Bianchin, MD, Patrizia Formigoni, MD, Valeria Polizzi, MD, Pasquale Brizzi, Audiologist, Silvia Delmonte, Audiologist, Ilaria Crovi, Speech Pathologist; Azienda Usl di Reggio Emilia - IRCCS, Reggio emilia, Italy.  
Abstract:  
Introduction: In recent decades, early access to Cochlear Implants (CIs) has given an increasing number of deaf children access to speech cues and, consequently, the chance to learn oral language and improve their communication skills (Tomblin, Peng, Spencer, & Lu, 2008; Uhler, Yoshinaga-Itano, Gabbard, Rothpletz, & Jenkins, 2011). In particular, some studies have highlighted that the mother’s communication changes according to the child’s language level (Lederberg & Everhart, 2000) and adapt their language communication to the linguistic limitations of their children. The aim of the present research is to assess the relationship between children’s language development and mother’s linguistic input, also considering the age of the children at the moment of CI activation, before the surgery and at three and six months after CI activation.  
Methods: Method: Eleven dyads mother-child with deafness were recruited from hospital. All the children had profound congenital sensorineural hearing loss, the mean age at CI activation was 20.5 months (SD +/- 3.8; range 13-33). The mother-CI child dyads were observed at the hospital the day before surgery and three months after CI activation. Twenty minutes of video-observations of mother-child interaction during semi-structured play were conducted (Olswang, Stoel-Gammon, Coggins, & Carpenter, 1987). All video-observations were transcribed and codified using CHILDES (MacWhinney, 2000). Specifically, the following were coded the communication function of mothers and children. The total number of utterances, the number of different words and the function of the mothers and children input were analyzed, in line with other studies (Braddock & Iverson, 2003; Majorano et al., 2018).  
Results: Results: The preliminary data analysis has shown positive correlations, before the surgery, between mothers’ numbers of words and children’s frequency of different types of words (r=.680; p=.021); number of mothers’ answers and children’s: communicative initiative (r=.905; p=.000) and answer (r=.839; p=.001). Three months after cochlear implants activation, data analysis has shown a positive correlation between children’s turns of words and mothers’ number of utterances (r=.841; p=.001) and words (r=.618; .043); mothers’ answers and children’s communicative initiative (r=.741; r=.009).  
Conclusion: Conclusion: The preliminary data shown a strong correlation between mothers ‘linguistic input and children’s language development. These preliminary findings could have implication for clinical practice and the implementation of supportive intervention programmes for mothers after CIs activation, focused on the direct observation of the mother-child interaction.
Session: S12-3
Abstract ID: 361
Title: Two is Better than One and One is Better than Two: The Impact of Pediatric Cochlear Implants on Language Acquisition
Presenting Author: Shani Dettman PhD, MEd, Speech Pathology
Author Block:
Shani Dettman, PhD, MEd, Speech Pathology 1, Dawn Choo, Master of Speech Pathology 1, Jaime Leigh, PhD 2, Richard Dowell, PhD 1, Robert Cowan, PhD 3; 1Dept Audiology and Speech Pathology, The Univ. of Melbourne, Parkville, Australia, 2The Royal Victorian Eye and Ear Hosp., East Melbourne, Australia, 3The HEARing CRC & HearWorks, Carlton, Australia.
Abstract:
Introduction: Congenital and early onset hearing loss can have significant effects on a child’s access to spoken language and subsequent language acquisition. As cochlear implants (CIs) have been available as a paediatric intervention to manage profound hearing loss for 30 years, we can examine the impact of CIs on language over this time course. Using a long-term paediatric database which includes communication outcomes, family and device characteristics for 1000 children, this retrospective study aims to examine language outcomes for the first 100 children to receive CIs, compared with each successive cohort of 100 children, up to and including the most recent 100 children to receive CIs at this centre. This study aims to examine the mediating influences of receiving two versus one CI (i.e. bilateral versus unilateral CIs) and the effects of receiving the first CI younger than one year of age versus receiving the first CI at an older age.
Methods: All children completed language assessments post-implant at five years of age (school entry). These language data were entered into a paediatric database at the time of the assessment along with relevant child factors (e.g., gender, aetiology, cognitive skills, age at device fitting, communication approach), family factors (e.g., relative socio-economic advantage, language used/English interpreter required, maternal education) and device factors (e.g. unilateral/bilateral CI, number of electrodes, implant device, speech processor type). Retrospective analysis of all available language standard scores was conducted (e.g., PPVT, PLS, CELF). To include both standardised tests, criterion reference tools and language scales (e.g. CDI and RI-TLS), data were also coded using the Categories of Language Performance (CLIP; e.g., 0=greater than 4 SD below the mean to 7=2 SD above the mean).
Results: Preliminary analysis of the first and last cohorts of 100 children reveal reductions in mean age at hearing aid from 1.4 years to 0.68 years, mean age at CI from 5.6 to 1.95 years, prevalence of sequential bilateral CIs from 25% (75% unilateral, no simultaneous bilateral) to 17% sequential bilateral (34% unilateral, 49% simultaneous bilateral). ANOVA results indicated significantly poorer language outcomes for unilateral CI users compared to sequential and simultaneous bilateral CI users (and no differences between sequential and simultaneous groups). The confounding effects of age at CI, however, warrants further discussion; those presently receiving simultaneous bilateral CIs tend to be younger. Comparing the first and last cohorts of 100 children using CIs, the mean receptive standard scores improved from 66.9 to 79.2%. Median CLIP improved from 2 to 3, but this still indicates language that is one to two standard deviations below the mean.
Conclusion: Large data sets enable us to examine changes over time, and factors affecting child language outcomes. These data may be used to encourage health care providers to facilitate earlier access to bilateral CIs.
Session: S12-3
Abstract ID: 65
Title: Age at Full Time Use is More Predictive of Language Outcomes than Age at Cochlear Implant Surgery
Presenting Author: Erin Thompson MS, LSLS Cert AVT
Author Block:
Erin M. Thompson, MS, LSLS Cert AVT 1, Lisa R. Park, AuD 1, Kevin D. Brown, MD, PhD 2; 1Department of Otolaryngology - Head and Neck Surgery, The Univ. of North Carolina at Chapel Hill, Durham, NC, 2Department of Otolaryngology - Head and Neck Surgery and Neurosurgery, The Univ. of North Carolina at Chapel Hill, Durham, NC.
Abstract:
Introduction: The greatest challenge for children who are deaf or hard of hearing is the ability to acquire age appropriate language to communicate. Age of implantation is a critical factor for the development of speech and language, however, receiving an implant does not always equate to full time input of sound. The purpose of this study is to compare the correlation between age of cochlear implantation versus age at full time device use on receptive and expressive language outcomes one year post implantation.
Methods: All children included in this retrospective analysis were congenitally deaf and received their first implant at a single center. Children must have had otherwise typical development, no cochlear nerve deficiency or major inner ear malformations, have a language test point at one year post implantation, and to have started cochlear implant use with a processor that supported data logging. The date of full time use was recorded as the point where device lock reached >7 hours per day on average. A series of regression analyses were run to test the influence of age at implantation and age at full time use on receptive and expressive language outcomes.
Results: Age at implant predicted receptive language outcomes, F(1,36) = 15.949, p < 0.001, adj. R 2 = 0.29. Age at full time use was also highly predictive, but with a larger size effect, F(1,36) = 50.457, p < 0.001, adj. R 2 = 0.57. Findings were similar for expressive language outcomes, with age at implant being predictive, F(1,36) = 42.002, p < 0.001, adj. R 2 = 0.53, and age at full time use having a larger size effect, F(1,36) = 95.864, p < 0.001, adj. R 2 = 0.72.
Conclusion: Age of full-time use appears to be a better predictor of language outcomes after one year of implantation than age of implantation. Part-time use of a cochlear implant device appears to be a significant predictor of poorer outcomes. Although early implantation is important, but continued counseling on the importance of full-time device use after implantation is also critical.
**Session:** S12-3  
**Abstract ID:** 89  
**Title:** Bilateral Cochlear Implants in Children  
**Presenting Author:** Angelika Illg PhD  
**Author Block:**  
Angelika Illg, PhD, Doris Adams, MSc, Alexandros Giourgas, MSc, Andreas Büchner, Professor, Anke Lesinski-Schiedat, Professor, Thomas Lenarz, Professor; ENT, Med. Univ. of Medicin, Hannover, Germany.  
**Abstract:**  
**Introduction:** Since 1986 deaf children are treated with cochlear implants at Medical University Hannover, Germany. In the beginning of cochlear implantation history they got one cochlear implant (CI) and the implantation age was very high. These children received a contralateral CI beyond the age of 4 years. Later a new generation of children got two cochlear implants early in their age. We evaluated in different patient groups the optimal inter implant interval in sequential implanted children, the passive vocabulary and memory for sentences in early implanted bilateral children.  
**Methods:** Speech comprehension results of 250 children who underwent sequential bilateral cochlear implantation were evaluated to investigate the optimal inter implant interval. All individuals underwent periodic speech perception testing in quiet and noise. Additional we present the results of 165 children tested with the subtest “Passive Vocabulary” from the “Marburger Sprachverständnistest für Kinder” and results in 98 children tested with the subtest “Sentence Memory” from the “Language Acquisition Test for three to five year old children” (SETK 3-5). Group A included data of children implanted under the age of one year, group B included children between one and two years.  
**Results:** The evaluation of the inter-implant interval and age groups at first implantation showed a preferred interval of up to four years in children under the age of 4 at first implantation. The group comparison shows that on average the children implanted after their second year of life reached significantly poorer results in the passive vocabulary test. The evaluation of the “Sentence Memory” is carried out in the percentile rank, which allows the comparison to hearing peers. Group A achieves a mean percentile rank of 41 and group B a mean percentile rank of 18. The group of earlier implanted children shows significantly better results, almost comparable to the hearing peers. Speech comprehension in noise is better in children with bilateral implantation than in unilateral implanted children.  
**Conclusion:** We conclude that in sequential implanted children the age of second implantation is such important as in the first side. We found a positive correlation between the old age at first implantation and short inter implant interval. Congenitally deaf children, provided with two CI within the first year of life, can build up age-appropriate linguistic abilities until school enrolment, while there are lower chances for bilaterally congenitally deaf children, provided with CI on both sides in their second year of life.
Session: S12-3  
Abstract ID: 378  
Title: Cochlear Implantation in Pediatric Auditory Neuropathy Spectrum Disorder  
Presenting Author: Cedric Pritchett MD, MPH  
Author Block:  
Cedric V. Pritchett, MD, MPH 1, Syed H. Sagheer, BS 2, Nathan Vandjelovic, MD 3, Nicole Becker, AuD 4, William Parkes, MD 3, Thierry Morlet, PhD 3; 1Division Otolaryngology, Nemours Children’s Hosp., Orlando, FL, 2College of Medicine, Univ. of Central Florida, Orlando, FL, 3Division Otolaryngology, Alfred I DuPont Children’s Hosp., Wilmington, DE, 4Division Audiology, Nemours Children’s Hosp., Orlando, FL.  
Abstract:  
Introduction: Auditory neuropathy spectrum disorder (ANSD) represents a family of hearing disorders with a continuum of behavioral presentations, ranging from mild difficulty processing speech to profound hearing loss. Predicting the appropriate course of intervention in ANSD can be challenging. In carefully selected patients, cochlear implantation (CI) is indicated. However, the decision to move forward with CI often requires an expansion of traditional candidacy criteria and the optimal timing of the intervention can be difficult to discern. Here we report on the outcomes of a heterogeneous population of 67 implanted children diagnosed with ANSD.  
Methods: A retrospective study was conducted on 67 children with ANSD who were implanted over the past 11 years. Children were diagnosed using the established diagnostic indicators of ANSD that include absent or abnormal middle ear muscle reflexes, absent or abnormal auditory brainstem responses along with a present cochlear microphonic and/or otoacoustic emissions. Audiometric and operative data were recorded, along with the medical histories and imaging results.  
Results: The diagnosis of ANSD was achieved between the age of 6 weeks and 13 years, with 34% of the children diagnosed before 1 year of age and 70% during the first 3 years of age. Of the 67 patients, 60 had visualized nerves bilaterally; one each had either poorly visualized nerves or hypoplastic nerves; five patients had missing data. The degrees of hearing loss based on pure tone audiograms obtained before CI varied from mild to profound. A hearing trial was conducted in 86% of the children and was unsuccessful in terms of speech language development for all of them. Eight children presented with a progressive type of ANSD that decreased the benefit of hearing aids over the years. Twenty-four children were implanted unilaterally (median age at implantation: 3 years and 9 months) and 43 received bilateral implants, 13 sequentially (median age: 2 years and 6 months at first implantation) and 30 simultaneously (median age at implantation: 1 year and 8 months). CI was performed between 6 weeks and 4 years after the diagnosis of ANSD with 50% of the population being implanted during the first year. More simultaneous bilateral implantation was performed in this population over the past four years than during the previous seven years.  
Conclusion: The majority of these implanted children, although it is too early to tell for recently implanted ones, reached normal outcomes in terms of pure tone thresholds and word recognition scores.. The cochlear implant candidacy and timing of CI in children with ANSD often differ from those of more traditional candidates. Management decisions should be based on speech and language development skills and not only on hearing thresholds to achieve the best outcomes. With more experience caring for this population, the benefit of earlier and bilateral implantation in children with poor speech and language development has become increasingly clear.
Title: The Impact of Cochlear Implantation on Speech and Language Outcomes in Children with Asymmetric Sensorineural Hearing Loss

Presenting Author: Prashant Malhotra MD

Abstract:

Introduction: Cochlear implantation is considered in children outside of traditional candidacy guidelines. The benefits of a cochlear implant (CI) in these non-traditional candidates are less well known. This study investigated the impact of unilateral CI on speech and language outcomes in pediatric patients with asymmetric sensorineural hearing loss (severe to profound sensorineural hearing loss in one ear, and better hearing contralaterally).

METHODS: A retrospective chart review of pediatric patients who underwent cochlear implantation for asymmetric sensorineural hearing loss was completed. Children with single sided deafness or auditory neuropathy spectrum disorder were excluded. Children underwent cochlear implantation in the poorer ear, and maintained a hearing aid in the better ear. Preoperative and postoperative, ear-specific audiometry was recorded. Developmentally appropriate speech recognition tasks, including questionnaires, closed-set, and open-set measures, were also reviewed. When available, measures of speech articulation, expressive and receptive language, and vocabulary were recorded for: Goldman-Fristoe Test of Articulation (GFTA-3), Clinical Evaluation of Language Fundamentals (CELF-P or CELF-5), Receptive-Expressive Emergent Language Test-Third Edition (REEL-3) battery, Receptive One-Word Picture Vocabulary Test (ROWPVT) and Expressive One Word Picture Vocabulary Test (EOWPVT). Speech and language data was recorded for preoperative evaluations, and every 6 months postoperatively as available.

RESULTS: Twenty-six children with asymmetric sensorineural hearing loss were included in the analysis, with 11 (42%) having bilateral enlarged vestibular aqueducts (EVA). At time of CI, unaided mean Pure Tone Average-4 (PTA4) for the better ear was 62dB HL, and worse ear was 92dB HL. There was an improvement in speech recognition in the implanted ear as expected. All preoperative speech and language evaluations were conducted within 7 months of cochlear implantation. Twenty-three patients had at least 1 postoperative re-evaluation. Fourteen children had preoperative and postoperative assessments with the same tool, with 13 patients (93%) showing improvement in at least 1 domain. For patients with repeated assessment within 12 months of surgery, we observed an average improvement in standard scores of: CELF-5 Core Language (+6.2), CELF-P2 Core Language (+7.3), GFTA (+11), ROWPVT (+3) and Expressive EOWPVT (+7). Individual results are described.

Conclusion: Improvement in speech and language measures can be demonstrated in children undergoing unilateral cochlear implantation for asymmetric sensorineural hearing losses. These children, who are not typical CI candidates, can benefit from a CI in the poorer ear.