12th International Conference on Cochlear Implants and Other Implantable Auditory Technologies

Friday, May 4, 2012
Scientific Session III Oral Abstracts
3:00 PM - 5:00 PM
Learning Objective: Discuss how there is a large variability across centres in the way how the fitting is being performed. The time spent on device fitting varies across centres between one and two and half hours per patient over the initial six months.

Email: joanne.muff@addenbrookes.nhs.uk

Learning Objective: Describe what patient-driven programming is and the advantages it may offer.

Email: ishantsay@gmail.com
**Friday (3:00 PM - 5:00 PM) Marriott Grand Ballroom 1 - 5**

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<th>Presentation 147</th>
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<tr>
<td><strong>Topic:</strong> Alternative Assessment &amp; Programming</td>
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<tr>
<td><strong>Title:</strong> FS4, FS4p, FSP – A crossover study of three fine structure coding strategies</td>
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<td><strong>Author(s):</strong> Dominik Riss, Jafar-Sasan Hamzavi, Clemens Honeder, Michaela Blineder, Isabella Ehrenreich, Christoph Arnoldner</td>
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<td><strong>Presenter:</strong> Dominik Riss</td>
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<td><strong>Abstract:</strong> Background: The newest speech coding strategies are designed to improve the transmission of fine structure to cochlear implant recipients. The aim of the present study was to investigate the influence of two new coding strategies (FS4 and FS4p) on speech perception and subjective hearing impression. Material and Methods: A randomized double blind cross over trial with three conditions (FSP, FS4 and FS4p) was started. 31 Patients were included. Every patient is fitted with every strategy for 4 months in a randomized sequence. After every cycle speech perception in noise is measured using the Oldenburger sentence test. In addition, patients are asked to report on their hearing impression using VAS scales. Results: The study is still ongoing. It has been shown that it is of utmost importance to fit the new coding strategies precisely in order to guarantee a natural hearing sensation. Interestingly large differences between patients have been observed concerning the perception of these changes between speech coding strategies. Conclusion: FS4 and FS4p are promising new additions to FSP. Controlled studies are needed to evaluate their benefit for the patient.</td>
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<td><strong>Learning Objective:</strong> Assess that FS4 and FS4p are two new fine structure coding strategies</td>
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<td><strong>Email:</strong> <a href="mailto:dominik.riss@meduniwien.ac.at">dominik.riss@meduniwien.ac.at</a></td>
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**Friday (3:00 PM - 5:00 PM) Marriott Grand Ballroom 1 - 5**

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<th>Presentation 148</th>
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<tr>
<td><strong>Topic:</strong> Alternative Assessment &amp; Programming</td>
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<tr>
<td><strong>Title:</strong> Improving speech recognition and sound quality with DUET 2 FS4 coding strategy in electric acoustic stimulation</td>
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<tr>
<td><strong>Author(s):</strong> Andrea Kleine Punte, Ellen Cochet, Griet Mertens, Paul Van de Heyning</td>
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<td><strong>Presenter:</strong> Andrea Kleine Punte</td>
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<td><strong>Abstract:</strong> Aim: Electric Acoustic Stimulation (EAS) is an efficient treatment for patients with functional low frequency hearing. The aim of this study was to investigate the effect of the DUET 2 audioprocessor and Fine Structure 4 (FS4) coding strategy for EAS on speech reception in noise and sound quality. Material and methods: 8 EAS patients were upgraded from the Med-El DUET to the second generation DUET 2 audioprocessor. Subjects were subsequently upgraded from envelope based HDCIS strategy to FS4 coding strategy including temporal coding in low frequencies up to 1 kHz. Speech perception in quiet and noise and sound quality for speech and music were assessed with both devices up to 6 months after switch-over. Results: Adaptive speech testing showed a significant improvement of 4,3 dB (p=0.035) in quiet and 6.3 dB (p=0.001) in noise with the DUET 2 compared to the DUET after 6 months. Fixed level speech reception with the DUET 2 significantly improved with 23,2% (p=0.028) in quiet and 17,1% (p=0.031) in noise. Also sound quality of the DUET 2 rated significantly better than the DUET. After upgrade to FS4 coding strategy sound quality improved even further. At 6 months no effect on speech reception was measured with FS4. Conclusions: With the DUET 2 speech perception in quiet and noise improved significantly. Sound quality of music and speech improved with DUET 2 audio processor. Sound quality improved further when using the FS4 coding strategy.</td>
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<td><strong>Learning Objective:</strong> Assess how FS4 coding strategy can improve sound quality perception in EAS users.</td>
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<td><strong>Email:</strong> <a href="mailto:andrea.kleinepunte@gmail.com">andrea.kleinepunte@gmail.com</a></td>
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Presentation 149

**Topic:** Alternative Assessment & Programming  
**Title:** Red Flags: Identifying Barriers To Optimal Auditory Development By Monitoring Performance with Technology  
**Author(s):** Jane Madell, Joan Hewitt, Sylvia Rotfleisch  
**Presenter:** Jane Madell  
**Abstract:** The performance and progress of children with hearing aids and/or cochlear implants can vary greatly. By utilizing specific evaluations of audition and speech perception, audiologists can identify “red flags” indicating less than optimal performance. Red Flags can include, responses to auditory stimuli, speech and language development and other aspects of learning. Techniques audiologists can use to evaluate performance and modify programming based on those performance measures will be discussed. Case studies will be presented to illustrate common issues, the techniques used to identify them, and the performance changes observed with programming changes.

**Learning Objective:** Identify red flags identifying concern about performance of infants and children with cochlear implants  
**Email:** Jane@janemadell.com

Friday (3:00 PM - 5:00 PM) Marriott Grand Ballroom 1 - 5

Presentation 150

**Topic:** Alternative Assessment & Programming  
**Title:** Cochlear Implant Impedance Fluctuations: Origins and Management  
**Author(s):** J Thomas Roland, Jr., William Shapiro, Phil Segel  
**Presenter:** J Thomas Roland, Jr.  
**Abstract:** Objectives: While some degree of electrode impedance variation is common within patients, some recipients may experience clinically significant fluctuations in impedance values, such that the patient percept can be altered prompting the patient to return for clinical management. The objective of this presentation is to review the causes for management of recipients with significant impedance fluctuations. Study Design: The study design included a retrospective review of Cochlear Americas database concerning patients with fluctuating impedances. Analysis of the management options and outcomes including, reprogramming, medical management and revision surgery was made and vetted against the working hypothesis that these impedance changes are likely of biologic origin. Results: A review of Cochlear Ltd’s global complaint database was conducted revealing instances of significant impedance fluctuations in 0.11% of 91,000 devices. Various patterns of fluctuations were observed across patients and even within patients- that is even in bilaterally-implanted recipients fluctuations could be present in one or both ears. Management included reprogramming to keep the map in compliance. Medical control of symptoms included management of infection, the reported use of steroids or cessation of other medications (e.g. HGH). Explantation was noted in 15% of cases. Where the fluctuations were linked to other medical issues (e.g. infection) post revision impedance fluctuations did not recur. However, in cases with no other reported medical issues (7) cases, patients underwent revision surgery with impedance fluctuations recurring with the second device within a short period of time post-activation Conclusion: Based upon successful reprogramming or medical management in most cases as well as the finding that in the revision cases symptoms experienced with the 1st device returned in a relatively short interval the conclusion at this time is that these fluctuations are not uncommonly associated with a biological origin rather than a device origin.

**Learning Objective:** Identify the use of impedance measurements  
**Email:** john.roland@nyumc.org
Compared to monaural cochlear implants (CI), bilateral CIs provide many benefits including improved speech understanding in noise and sound localization. In current clinical practice for bilateral CIs, each CI is fit independently, with minor adjustments to ensure that loudness is balanced between ears. Such fitting procedures cannot account for between-ear mismatches in insertion depth or neural survival, which could lead to a given frequency stimulating different regions of the cochlea in each ear. Such between-ear differences can hinder sound-localization abilities and may also affect speech understanding if patients cannot adapt to the mismatched stimulation. It is possible that adjustments to the frequency table in one or both implants could, however, compensate for between-ear mismatches in site of stimulation. Unfortunately, no tool exists to allow audiologists to determine when adjustments to the frequency table may be necessary, and what adjustments would be appropriate. Thus, we have been developing a tool which allows for adjustment of the frequency table in real time. In using this tool, we assume that a patient may benefit from reprogramming of the frequency table if they select a table in one ear that differs from the standard table used in the contralateral CI, especially when listening with both CIs simultaneously. We are testing this procedure in users of bilateral CIs, and observe that some listeners select a frequency table in one ear which differs from the standard. In addition, the frequency-table selections made by these individuals to maximize intelligibility bilaterally can differ from frequency tables that elicit similar pitch percepts in each ear, suggesting that these listeners may be balancing the desire for pitch-matched percepts with the need for a frequency table that maximizes speech intelligibility. Funding for this work was provided by NIH/NIDCD. Advanced Bionics provided equipment needed to perform the research.

Learning Objective: Describe that current fitting procedures for bilateral cochlear implants may not account for differences in insertion depth or neural survival.

Email: matthew.fitzgerald@nyumc.org
### Presentation 153

**Topic:** Alternative Assessment & Programming  
**Title:** Desktop outcome assessment and programming of cochlear implants  
**Author(s):** Paul Govaerts, Bart Vaerenberg, Haico Van Oosten, Eric Schipperen, Geert De Ceulaer  
**Presenter:** Paul Govaerts  
**Abstract:** The outcome-driven programming of cochlear implants requires the definition of targets and the iterative testing of CI-users. At present targets hardly exist while testing is time-consuming and requires resources and special facilities which are expensive and scarce. A$E is a psycho-acoustical test-suite comprising several clinical tests to assess the perception of sound in its different components, i.e. intensity, spectral content and temporal content. Normative data have been established for all tests and targets have been defined for CI-users. All tests can be run as self-tests allowing experienced patients to perform them without the need of an audiologist. In addition, a desktop test room has been developed which provides ISO-compatible acoustic insulation, calibrated liminal and supraliminal sound presentation and real-time monitoring of the sound delivered in the box. This test box replaces the soundproof booth and the audiometric equipment and allows easy and calibrated auditory testing in CI-users. The combination of A$E and the test box will cause a drastic change in the testing and fitting of CI-users, paving the way for extensive measuring of outcome with a substantial reduction in resources needed. It is anticipated that in combination with FOX (see other presentation), CI-performance will improve in a systematic and measurable way and evidence-based programming strategies will emerge. It is also likely that this approach will be an intermediate step towards remote fitting.  
**Learning Objective:** Perform multiple and iterative testing to improve CI-performance  
**Email:** dr.govaerts@eargroup.net

### Presentation 154

**Topic:** Alternative Assessment & Programming  
**Title:** Computer assisted analysis of speech production; Phonetic accuracy and phonological processes in 60 Australian children using cochlear implants.  
**Author(s):** Shani Dettman, Joanne Bardsley, Leanne Buchanan, Colleen Holt, Gabriella Constantinescu, Richard Dowell, Michelle Moran  
**Presenter:** Michelle Moran  
**Abstract:** Objectives: Systematic analysis of speech production is frequently left in the ‘too hard’ basket due to the time consuming nature of the task. The Computer Aided Speech And Language Analysis (CASALA) was used to analyze the phonetic accuracy of vowels, consonants and clusters and the prevalence of phonological process errors in 60 Australian children using cochlear implants. Methods: Children enrolled in Auditory Verbal (AV; n=12), Auditory Oral (AO; n=39), or Bilingual-Bicultural sign emphasis (BB; n=9) programs completed either the Diagnostic Evaluation of Articulation and Phonology (DEAP) or Goldman-Fristoe Test of Articulation – 2 (GFTA-2) at 5 years of age or at school entry. Results were transcribed using broad phonetic transcription and data were entered into CASALA for analysis. The relationships between child variables (age at hearing-aid fitting, age at cochlear implantation, degree of residual hearing, and mode of communication) and speech production outcomes were examined. Results: Data entry and CASALA analysis of all phonemic errors and phonological processes was completed in less than five minutes for each sample. Patterns of vowel, consonant and cluster acquisition for children using cochlear implants were similar to patterns reported in the literature for children with normal hearing. Typical developmental phonological processes such as cluster errors, stopping, fronting, devoicing, final consonant deletion and gliding were observed in all three groups. There was a significant relationship between speech accuracy and communication mode. More phonetic errors and more atypical phonological processes were observed for the BB group compared to the AV and AO groups. Conclusions: This study supported the use of AV and AO communication approaches for facilitating speech accuracy for children using cochlear implants. Using CASALA to analyze the DEAP and GFTA-2 was a rapid and reliable tool for clinical and research purposes.  
**Learning Objective:** Recognize use of a computer program facilitated rapid, accurate and reliable speech production analysis. CASALA data from multiple samples may be exported to other data analysis programs quickly and effectively.  
**Email:** dettman@unimelb.edu.au
Topic: Medical II
Title: Treatment disparities in cochlear implantation: Do the differences between Germany and the US influence outcomes or complication rates?
Author(s): Lawrence R. Lustig, Magnus Teschner, Thomas Lenarz, Colleen Polite
Presenter: Magnus Teschner
Abstract: Introduction. Throughout the world there exists widespread variation in both the workup and implementation of cochlear implantation. The goals of this investigation are to analyze whether these evaluation and treatment disparities result in differences in complication rates or outcomes and what economic impact such variations engender, in 2 representative cochlear implant centers.

Material and Method. Fifty cochlear implant recipients in each of two representative cochlear implant centers in the United States and Germany were compared with regard to their evaluation and management. Demographics, complication rates (major and minor), and speech language outcomes between these two centers were compared. Relative costs between the 2 centers were also compared.

Results. Many evaluation and treatment disparities were identified between the two centers, reflecting regional norms for treatment. These differences included length of hospitalization and the nature of the pre-operative evaluation process. Despite these differences, only small differences were noted in resulting minor complications between the two centers, and no differences were seen in the major complications. No significant differences were seen in speech language outcome measures. The cost for cochlear implantation per patient at the German center was roughly ½ the cost of implantation at the US center.

Discussion. Despite differing evaluation and management paradigms between these 2 centers, representative of their 2 countries, there were no major differences in complication rates or speech outcome measures. However, the cost of cochlear implantation in Germany was markedly less expensive per patient than similar intervention in the US.

Learning Objective: Compare the differences in the evaluation of patients undergoing cochlear implantation between Germany and the United States
Email: llustig@ohns.ucsf.edu

Friday (3:00 PM - 5:00 PM) Marriott Grand Ballroom 6 - 10
Presentation 156

Topic: Medical II
Title: Complications in cochlear implant surgery according to the approach.
Author(s): Mario Zernotti, Victor Slavutsky, Alejo Suarez, Fernanda Di Gregorio, Luis Nicenboim, Juan Soto
Presenter: Mario Zernotti, Luis Nicenboim
Abstract: Introduction: Complications are a very sensitive indicator of the usefulness of a surgical technique. There are three main approaches, the classical approach uses the facial recess (RF), the suprameatal approach (SMA) does not require mastoidectomy and uses the creation of a tunnel to reach the middle ear, and the endomeatal approach (EMA) based on the completion of a groove in the posterior wall of external auditory canal. Aim: to assess the complications according to the different approaches.

Material and methods: Multicenter review of 208 patients with cochlear implant, comparing the different techniques. The complications were classified into major and minor. Results: Among the 208 implanted patients, 10.5% (22 of 208) had complications, of these 2.88% (6 of 208) were major complications, and 7.69% (16 of 208) were minor complications. Comparing the results obtained by different approaches the RF technique has the least rate of major complications (1.1%) followed by the EMA technique 2.38% and 3.75% in SMA. This group has the lowest number of minor complications 6.25%, followed by those operated by EMA to 7.14% and the group operated by the RF present 10%. The minor problems with the facial nerve, there were independent of the approach used. Conclusions: The three techniques show a very similar rate of complications. Therefore we can conclude that the three techniques are alternative and safe.

Keywords: Complications; cochlear implant surgery; endomeatal approach; recess facial approach; suprameatal approach.

Learning Objective: Assess the different complications
Email: mario.zernotti@gmail.com
**Topic:** Medical II  
**Title:** Major complications in cochlear implant surgery – The Freiburg experience  
**Author(s):** Vanessa Stabenau, Antje Aschendorff, Rainer L. Beck, Susan Arndt, Wolfgang Maier, Roland Laszig  
**Presenter:** Antje Aschendorff

**Abstract:**
Cochlear implant (CI) surgery is well standardized for auditory rehabilitation in children and adults. As with every surgical procedure, complications may occur and surgical developments aim to reduce complication rates. Complications are generally defined as minor (will settle with conservative treatment) or major (require additional surgery). Aim of the evaluation was to determine patterns of complications and treatment outcome.

We performed a retrospective analysis of major complications at a tertiary referral centre and affiliated cochlear implant centre. A total of 1706 CI surgeries between 2003 and 2011 were analyzed. Revision surgeries were reported in 167 cases, resulting in a major complication rate of 9.8%. Out of these, 31% of revisions were caused by implant failures. The remainder of major complications were due to a number of different causes: implant infection (12%), implant dislocation, hematoma, chronic middle ear disease ( tympanic membrane defect or cholesteatoma), facial nerve stimulation and other rare causes. An increasing number (11%) of revision surgeries were reported either prior to magnet resonance imaging (MRI) to remove and then reinsert the internal magnet, or due to a magnet dislocation following MRI. Major complications may result in temporary explantation with additional surgery for re-implantation. This presents a difficult situation for patients and parents as it may result, at least in unilateral CI patients, in a deprivation of acoustic input for several weeks. Surgical procedure in infectious complications must be straightforward including explantation to reduce the number of procedures required until re-implantation can be performed. The rate of device failures is within the responsibility of the manufacturers and has to be improved further to avoid additional surgeries and trauma to soft tissues. As the expected rate for MRIs post CI will increase, precautions for the use of MRI are necessary to reduce the chance of magnet dislocation and consecutive revision surgeries.

**Learning Objective:**
Discuss the amount and type of major complication in a single tertiary care center and mode of treatment

**Email:** vanessa.stabenau@uniklinik-freiburg.de

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**Topic:** Medical II  
**Title:** Cochlear Implant Revision Counseling and Outcomes: The House Clinic Experience  
**Author(s):** William Luxford, Dawna Mills  
**Presenter:** William Luxford

**Abstract:**
Background: The number of cochlear implant recipients has increased significantly over the past few decades in both adults and children. While most of these patients are successful users of their implant, a few unfortunately for a variety of reasons require revision surgery. The clinical management of these unfortunate few within a growing implant program is challenging. Important factors are the timely recognition of clinical symptoms such as changes in performance; and the recognition of device-related problems such as intermittency and static.

Objective: Retrospective review of recent Cochlear™ Nucleus® CI512 (Nucleus 5) cochlear implant failure cases at an individual cochlear implant center. Main outcome measures include: time to revision; cause of failure; performance measures pre- to post-revision; reporting of symptom resolution post revision. Results: Medical and audiological profiles for 15 implant recipients (13 adult; 2 pediatric) in which device failure of the Nucleus 5 cochlear implant were confirmed and analyzed. Conclusion: The recognition of the most common symptoms associated with the Nucleus 5 failures allows appropriate counseling and planning of revision surgery to restore prior cochlear implant benefit.

**Learning Objective:**
Recognize symptoms and identification of atypical outcomes in cochlear implant recipients.

**Email:** wluxford@hei.org
A Retrospective Analysis of Cochlear Implants Explanted for Non-Medical Reasons

William F. Regnault, James K. Kane, Vasant K. Dasika


Study Design: A retrospective analysis was conducted of explant data reported from 2003 through 2010 to FDA’s Manufacturer and User Facility Device Experience (MAUDE) Database. Medical Device Reports (MDRs) associated with device explants during this period were reviewed to determine the reasons for explant (medical vs. non-medical), patient age at time of explant, and implant life. Only unique MDRs with complete implant life information were included in the data summaries. Manufacturer identity is masked for all comparisons.

Results: Analysis of unique non-medical implants (n=3561) showed that the relative proportion of explanted devices varies as a function of patient population. Implant life varied as a function of pediatric age with failures occurring earlier in pediatric patients younger than 9 years of age. The proportion of explanted devices, as a function of time post-implant, differed by manufacturer.

Conclusions: The relative proportion of non-medical explants differs by patient age within the pediatric population. Explants in the adult population do not show a predominant age effect. The majority of non-medical explants occur within the first five years of implant life with the peak in the pediatric population slightly lagging the adult population.

Learning Objective: Discuss that the proportion of devices explanted for non-medical reasons differ among patient population (adult vs. pediatric).

Email: william.regnault@fda.hhs.gov
A Retrospective Analysis of Cochlear Implants Explanted for Medical Reasons

Objectives:
1. Determine the proportion of medical explants reported by CI manufacturers across explant year (2003-2010).
2. Determine if implant life for medical explants in the pediatric population (< age 18 years) differed by patient age across CI manufacturers.
3. Determine if medical reasons for explants differ in rank order among CI manufacturers

Study Design:
The Manufacturer’s and User Facility Device Experience (MAUDE) Database was queried for devices explanted for medical reasons from 2003 through 2010. The Medical Device Reports (MDR) associated with explants during this period were reviewed to determine the reason for explant, patient age, and implant life. Only unique MDRs with complete implant life information were included in the data analysis. Data were grouped by manufacturer, explant year, patient age at time of explant, implant life ≤5 years, and explant reason. Manufacturer identity is masked for all comparisons.

Results:
Review of explanted devices with implant lives of ≤5 years (n = 3311) showed that the proportion of medical explants was consistent across explant year by CI manufacturer but differed among manufacturers. The majority of explants occurred for patients less than age 10 years. Likewise, the proportion of explanted devices as a function of time post-implant differed by patient population and by manufacturer. Explant distribution patterns and ranking of explant reasons differed by CI manufacturer.

Conclusions:
Results suggest that cochlear implant design differences may be reflected in medical explants within the pediatric population, especially for patients younger than ten years of age. The majority of medical explants in the pediatric population occur within two years post-implant but the explant rate does not stabilize until four or five years post-implant.

Learning Objective:
Assess that the proportion of devices explanted annually for medical reasons differ by patient population

A novel method of tracking adverse events in children and adults undergoing cochlear implant surgery

Objectives: The aim of medical care is to improve health-related quality of life in care recipients. Audition by cochlear implantation (CI) renders benefits within quality of life domains in children and adults with significant hearing loss. An adverse event (AE) is avoidable patient harm resulting from medical care. Trends in health care and legislature necessitate tracking of preventable injuries. The aim of this study was to investigate the occurrence of avoidable AEs within 28 days of CI surgery. Study Design: The investigation is a prospective cohort study with inclusion of 120 consecutive in-patient CI surgeries at Sahlgrenska University Hospital, sole tertiary care provider for the Swedish Western Region. Data collection time was December 2007-2010. Adverse events were identified by a structured review of the patient records using the Institute for Healthcare Improvement Global Trigger Tool (GTT). Records, in which criteria for possible harm (“triggers”) were identified, were independently appraised by two physicians to identify possible AEs. The final identification of preventable AE was performed together with a senior physician. Results: Consecutive admissions encompassed 38 children (mean age 3.8±3.3 y) and 82 adults (60.7±16.3 y). Avoidable AEs were identified in 5 of 38 children, and 10 of 82 adult admissions (12.5% of CI surgeries). Fifteen of the 120 consecutive CI-surgery admissions lead to 17 avoidable AEs (14.2%). Eight AEs contributed to or resulted in temporary harm and required intervention (3 postoperative complications, 4 healthcare-associated infections, 1 organ damage); 9 AEs required even initial or prolonged hospitalization (5 postoperative complications, 3 healthcare-associated infections, 1 organ damage). No errors resulted in permanent patient harm, life-sustaining interventions or death. Conclusion: Avoidable adverse events are common in cochlear implantation and lead to increased suffering, temporary harm and intervention. The GTT is a suitable method for identification and quality assurance for improved patient safety.

Learning Objective:
Identify that the Global Trigger Tool is a suitable instrument for identification and follow-up of adverse events in CI surgery.

Email: radoslava.jonsson@vgregion.se
**Friday (3:00 PM - 5:00 PM) Marriott Grand Ballroom 6 - 10**

**Presentation 163**

**Topic:** Medical II  
**Title:** Accuracy study of a Purpose Built Robot System for Minimally Invasive Cochlear Implantation  
**Author(s):** Brett Bell, Nicolas Gerber, Christof Stieger, Marco Domenico Caversaccio, Stefan Weber  
**Presenter:** Marco Domenico Caversaccio  
**Abstract:**

Objectives: Several methods have been introduced to date to reduce the invasiveness of cochlear implantation procedures. The most promising of these techniques utilize image guidance to plan the location of a tunnel through which an electrode can be inserted into the cochlea. Accurate placement of the planned tunnel is paramount, as misplacement could jeopardize the facial nerve or other nearby structures. Study Design: The approach proposed in this paper utilizes a robotic arm developed specifically for surgical applications on the lateral skull base. The aim of this study was to evaluate the accuracy of the proposed robot system and associated surgical workflow on a series of whole head cadaver specimens. The surgical workflow of the image guided procedure consists of the following steps: 1) implantation of bone fixed fiducial screws, 2) Cone beam CT scan and subsequent segmentation of interest structures and reference screw positions, 3) pair-point matching registration using the robot system, 4) drilling the direct access tunnel with the robot, 5) postoperative Cone beam CT scan for numerical validation and 6) a manual mastoidectomy for qualitative verification. Results: The design of the robotic system allows it to be easily integrated into existing OR configurations. Planning of the surgical procedure can be carried out in approximately 15-20 min using a custom software tool which utilizes a combination of manual and automatic segmentation techniques. The surgical procedure time beginning with patient-image registration and ending with completion of the direct access tunnel averaged 25 min. The accuracy at the target point (round window) was 0.56 ± 41 mm with an angular misalignment of 0.88° ± 0.41°. Conclusion: A purpose built lightweight robotic system achieves similar or slightly higher accuracy than similar studies using industrial robotic systems for a minimally invasive access to the inner ear.

**Learning Objective:** Recognize that the design of the robotic system allows it to be easily integrated into existing OR configurations. The insertion of the fiducial screws can easily be performed under local anesthesia with four small incisions surrounding the auditory canal.

**Email:** brett.bell@istb.unibe.ch

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**Friday (3:00 PM - 5:00 PM) Marriott Grand Ballroom 6 - 10**

**Presentation 164**

**Topic:** Medical II  
**Title:** Cochlear implantation in bilateral sporadic vestibular schwannoma: Consideration of hearing and vestibular preservation  
**Author(s):** J. Eric Lupo, Virginia Kitch Lupo, Kristin Uhler, Kathleen Zaccaro, Stephen P. Cass  
**Presenter:** J. Eric Lupo  
**Abstract:**

Bilateral vestibular schwannoma (VS) or VS in an only-hearing ear creates a challenging decision making scenario for the cochlear implant team. Cochlear implantation has been described as a means of rehabilitating hearing loss occurring after bilateral NF2-related VS hearing preservation surgery with variably successful outcomes. Here we present a case of sporadic bilateral (i.e. non-NF2) VS treated with cochlear implantation with preservation of vestibular function as a primary consideration. The initial right VS hearing preservation surgical treatment 20 yrs prior resulted in both right profound hearing loss and a complete right vestibular loss. After left VS treatment with stereotactic radio surgery 5 years prior, hearing loss progressed to a left mild sloping to profound hearing loss meeting cochlear implant audiologic criteria. The right ear was selected for implantation after promontory stimulation and radiographic studies suggested a viable right 8th nerve with intent to minimize risk of potentially disabling bilateral vestibular hypofunction and take advantage of bimodal binaural hearing. After implantation, the patient reported no subjective or objective change in vestibular function (pre CI VNG 100% R canal paresis L WNL, post CI VNG unchanged). From a hearing perspective, the patient demonstrated significant open set speech understanding (AzBio in quiet) improvement in the unilateral (Pre-CI right aided, left unaiderd 0%, 3mo Post-CI right CI, left unaiderd 85%) and bilateral aided performance (Pre CI - 40%, 3mo Post-CI 93%). Bilateral VS, VS in an only hearing ear, or prior VS surgery presents a complex decision process involving considerations of preserving vestibular function and optimizing hearing outcomes.

**Learning Objective:** Identify that by detailing the complex decision making involved in hearing rehabilitation after vestibular schwannoma treatment, we hope to provide an example to future cochlear implant teams to facilitate discussion and selection of appropriate treatment.

**Email:** james.lupo@ucdenver.edu
**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 165**

**Topic:** Unilateral/Bimodal

**Title:** Cochlea implantation in single sided deaf children

**Author(s):** Robert Mlynski, Desiree Ehrmann, Wilma Harnisch, Wafaa Shehata-Dieler, Andreas Radeloff, Heike Kühn, Rudolf Hagen

**Presenter:** Robert Mlynski

**Abstract:**

Objectives: Since a few years, cochlea implants (CI) are successfully used in adults with single sided deafness (SSD) and normal hearing of the contralateral side. Various studies proofed a clear benefit in speech perception in background noise for these patients. Especially, localisation and spatial hearing is substantially improved. There is no experience of CI in SSD children so far.

Methods: A prospective follow-up study with single subject repeated measures design was performed. Three children (2 female, 1 male) between the age of 6 to 9 years and SSD were implanted with a Medel Concerto CI. Implantation followed an unsuccessful conventional CROS hearing aid trial. Speech perception measurements in background noise, localisation tests as well as paedaudiological and psychological observation according to a SSD adapted protocol were performed.

Results: All 3 children accept the CI full day without a break. Children and parents experienced improved spatial hearing immediately after first fitting. A change of behaviour was observed in society as well as in noisy environment. Speech perception measurements showed increased sentence perception and improved signal to noise ratios towards normal hearing subjects.

Conclusion: The experience of CI in SSD children confirms the results with CI in SSD adults. A faster and enhanced compensation of bimodal hearing can be expected due to the higher brain plasticity in children. The use of CI in SSD children can be expected to become standard in rehabilitation of affected children.

**Learning Objective:** Assess the outcome of cochlea implantation in single sided deaf children

**Email:** mlynski_r@klinik.uni-wuerzburg.de

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**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 166**

**Topic:** Unilateral/Bimodal

**Title:** Establishing a new tradition: the paediatric CI candidate with significant residual hearing.

**Author(s):** Yetta Abrahams, Aleisha Davis, Tracy Hopkins

**Presenter:** Yetta Abrahams

**Abstract:**

Objectives: To review the outcomes of children implanted with significant amounts of residual hearing versus more traditional CI candidates with severe-profound levels of hearing.

Study Design: A retrospective review of 2 groups of cochlear implant users was performed: Group 1 with more residual hearing at the time of implantation, and Group 2 with traditional severe-profound hearing levels prior to implantation. Audiological and medical aspects were reviewed as well as outcomes on speech perception and formal speech and language assessments in the longer term.

Results: Children in both groups showed significantly better performance and access to sound after implantation. A variety of factors impacted on the decision to implant children with significant residual hearing, including audiological, medical and psychosocial issues.

Conclusion: Hearing levels may be measurable but unless they facilitate a child’s ability to learn through listening, cochlear implantation in the presence of moderate-severe hearing levels or better may be justified.

**Learning Objective:** Review pre-implant and post-implant factors relevant to these two groups of children

**Email:** yetta.abrahams@shepherdcentre.org.au
Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom

Presentation 167

 Topic: Unilateral/Bimodal
 Title: Cochlear Implants to treat Unilateral Deafness
 Author(s): Joachim Mueller, Thomas Braun, John-Martin Hempel, Stefan Zirn, Stefan Brill
 Presenter: Joachim Mueller

Abstract:
Hearing is one of our basic needs. Especially in a time that is increasingly being dominated by communication technology, special importance is attached to the restoration or amelioration of hearing. Therapy options for single-sided deafness were up to now limited to CROS hearing aids as conventional or bone-conduction devices in the deaf ear. A remarkable improvement in binaural hearing abilities has been known for more than a decade now from bilateral cochlear implantation. Based on earlier studies on bimodal fitting (CI in one ear, hearing aid in the other ear), the question appeared, if patients with normal or near normal hearing in one ear may benefit from a modern CI system, fitted in the deaf ear. At the time of writing 14 patients had been implanted. Fortunately, these patients could match the CI ear and normal hearing in the other ear. Patients so far benefit from increased speech intelligibility in noise (+30%) at different SNR. Also Directional hearing was restored. Patients subjectively report a significant increase in hearing quality. First results from 14 patients who were carefully examined will be presented in detail, as well as a our special test setup used.

Learning Objective: Assess classical and new treatment options for unilateral deafness and their efficacy
Email: joachim.mueller@med.uni-muenchen.de

Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom

Presentation 168

Topic: Unilateral/Bimodal
Title: Cochlear Implantation in Single Sided Deafness
Author(s): William Shapiro, J Thomas Roland Jr, Susan Waltzman
Presenter: William Shapiro

Abstract:
Background: Treatment for unilateral severe-to-profound hearing loss has included CROS fittings and various bone conduction devices, including the BAHA, Oticon Ponto, Sophono, and SoundBite. While these options offer a solution, they do not provide the benefits of binaural hearing since the sound is directed from the poorer ear to the better ear. The purpose of this ongoing study is to determine if cochlear implantation in the poorer ear could provide improved auditory benefits and useful binaural hearing, i.e. can the electric and acoustic inputs fuse, in a larger group of patients, with longer endpoints.
Methods: Four patients (three adults and one child) with unilateral severe-to-profound hearing loss received an implant in the poorer ear. These patients had etiologies ranging from Enlarged Vestibular Aqueduct (EVA) to sudden idiopathic sensorineural hearing loss. Outcome measures performed preoperatively on each ear and binaurally included monosyllabic words and sentences in noise.
Results: Test scores revealed a significant improvement in monosyllabic words and sentences from the preop to most recent postoperative evaluation in the implanted ear with the contralateral ear muffed and plugged. In the sound field binaural condition, the preop and postop monosyllabic scores ranged from 96%-100%. Some patients demonstrated improved speech understanding in noise following implantation when noise was spatially separated from the speech signal (head shadow effect). They are all full-time implant users and describe an improved quality of life.
Conclusions and Learning Outcome: Cochlear implantation can be a viable option in patients with unilateral sensorineural hearing loss. Performance is dependent on numerous factors including but not limited to length and severity of hearing loss, age at implantation and length of device usage.

Learning Objective: Assess the benefit of binaural hearing in bimodal listeners
Email: william.shapiro@nyumc.org
**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 169**

**Topic:** Unilateral/Bimodal

**Title:** Restoration of Binaural Hearing with a Cochlear Implant in Single Sided Deaf Subjects

**Author(s):** Rolf-D. Battmer, Dietmar Basta, Ingo Todt, Alexandra Ludwig, Rudolf Ruebsamen, Arneborg Ernst

**Presenter:** Rolf-D. Battmer

**Abstract:**

Objectives: Recent treatments for restoration of binaural hearing in single sided deaf subjects (SSD) are very limited. If treated at all, acoustic signals are only picked up from the deaf side and routed to the hearing side either as an electrical signal (CROS) or through bone conduction (Baha). For the transmission of auditory signals, both methods only use the contralateral hearing cochlea. They can not utilize the peripheral auditory pathways on both sides and therefore, binaural hearing is not possible. However, through electrical stimulation via a cochlear implant the deaf side could be activated and a true binaural hearing might be possible. The aim of our present study is to demonstrate that this is possible.

Study Design: Ten SSD subjects have been implanted with a Nucleus CP512/Freedom device and all of them are first fitted with a CP810 speech processor. To demonstrate binaural hearing objectively we recorded the binaural interaction component (BIC). For measuring we used the Cochlear fitting system together with Custom Sound EP (CS EP) software (for triggering and stimulating electrically) and a Nicolet Viking system (for stimulating acoustically, recording and averaging). Additionally, we tested speech perception in quiet and in noise and the localization ability in the acoustic free field with a 47 loudspeaker setup.

Results: As result, BIC responses could be recorded in all subjects, speech perception scores especially in noise improved and all subjects were able to localize sounds. Conclusions: The results of the study demonstrate that SSD subjects implanted on their deaf side develop functional binaural hearing. The BIC responses could be recorded in all subjects and may be used in the future preoperatively as a suitable predictor for a successful binaural combination of acoustical and electrical signals. This might not only be important for SSD subjects, but also for bilateral and bimodal patients.

**Learning Objective:** Discuss that cochlear implants in SSD are useful

**Email:** rolf-dieter.battmer@ukb.de

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**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 170**

**Topic:** Unilateral/Bimodal

**Title:** Comparison of performance of a unilateral Cochlear Implant to CROS microphone and Cochlear Implant: A prospective study

**Author(s):** Roochi Arora, Suzanne Stewart, Lendra Friesen, Hosam A. Amoodi

**Presenter:** Suzanne Stewart

**Abstract:**

Comparison of performance of a unilateral Cochlear Implant to CROS microphone and CI: A prospective study

Objectives: The purpose of this study was to investigate the potential benefit of speech understanding in quiet and noise incorporating a Contralateral Routing of Signal (CROS) microphone for unilateral cochlear implant users. Subjective feedback was also collected.

Study Design: A prospective study was undertaken on a group of 21 postlingually deafened adults all implanted with the same multichannel cochlear implant system. Performance with a unilateral cochlear implant was compared with performance using a unilateral cochlear implant and CROS microphone worn on the opposite ear (CI-CROS). Speech understanding in quiet was evaluated using AzBio sentences with speech presented at 0°, and 270° azimuth in the horizontal plane. Speech understanding in noise was evaluated with speech at 0°, and noise at 0°, 90° and 270°. Results: A significant gain in speech understanding using CI-CROS compared to unilateral CI alone was found in quiet, when speech was presented at 270° (average improvement of 8.8%, p<0.01). Participants also demonstrated statistically significant improvement using CI-CROS compared with the unilateral CI alone when noise was presented at 90° and speech at 0° (average improvement of 6.7%, p<0.01).

Conclusion: Adding a contralateral microphone to a unilateral cochlear implant resulted in a significant improvement in different conditions. This method could provide a greater cost/benefit ratio over bilateral CIs and be a potential improvement for those who are not candidates for bilateral CIs.

**Learning Objective:** Recognize the benefits that were observed using the CI-CROS in noise and the benefit for reducing the effects of the head shadow.

**Email:** roochi@ualberta.ca
**Presentation 171**

**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Topic:** Unilateral/Bimodal

**Title:** Comparison of the results of the rehabilitation options after 6 months in patients with unilateral deafness

**Author(s):** Susan Arndt, Roland Laszig, Antje Aschendorff

**Presenter:** Susan Arndt

**Abstract:**

Introduction: The rehabilitation of patients with unilateral deafness can take place with conventional CROS hearing aids, bone-anchored hearing aid (Baha) or with a cochlear implant. Prior to the indication of the type of rehabilitation, a test phase with the conventional devices should be performed.

Material / Methods: In a single-centre study 90 patients with unilateral deafness were examined after a test phase with the conventional devices, as well as six months later speech understanding in noise and localization ability were determined. The subjective assessments of the devices were evaluated with the SSQ questionnaire.

Results: After a 3-week test phase with Baha and CROS hearing aids both showed significant indications of the reason for the decision of the particular device, they differed in the objective measurements and subjective assessment of the (individual) rehabilitation option. The patients who chose a CI after the test phases scored significantly lower in the objective tests compared to patients who chose conventional hearing aids. After 6 months the patients who had a CI implantation showed significantly better localization ability and speech understanding in noise compared to the conventional patients with hearing aids.

Summary: The results of these 90 patients show, that information and testing phases for all rehabilitation options are necessary. The majority of patients with conventional devices is not adequately supplied subjectively and objectively with their devices. With the CI-implantation after 6 months it is possible to reach a significantly better speech understanding and localization.

Conclusion: After 6 months of device use we could demonstrate that the subjective assessment fits with objective results.

**Learning Objective:** Discuss that unilateral deaf patients report difficulties in sound localization and with speech comprehension when the speaker is talking on the deaf side, especially in a noisy environment.

**Email:** susan.arndt@uniklinik-freiburg.de

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**Presentation 172**

**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Topic:** Unilateral/Bimodal

**Title:** The Effect of Contralateral Acoustic Hearing on the Perception of Musical Instruments and Vowel Sounds with Fine Structure Signal Processing or High Definition Continuous Interleaved Sampling

**Author(s):** Christina L. Runge, Keenan Atwood, David R. Friedland

**Presenter:** Christina L. Runge

**Abstract:**

Objectives. The goal was to investigate the effect of contralateral acoustic hearing to the perception of musical sounds and vowel stimuli between fine structure (FSP) and high definition (HDCIS) signal processing strategies.

Study Design. Performance on musical instrument identification and vowel recognition tasks with and without a contralateral hearing aid were performed. Novel 6-channel maps utilizing FSP and HDCIS were used to prevent bias from the subjects’ daily use programs (n=7 FSP; n=3 HDCIS). All subjects were unilaterally implanted with a Med El device and tested with and without their daily fit hearing aid in the contralateral ear. Results. There was a significant improvement in vowel recognition for both FSP and HDCIS in the bimodal condition, although there was no difference in the degree of bimodal improvement between strategies. There was a significant bimodal improvement in instrument identification for the HDCIS program only. Between strategies, a trend was noted toward greater bimodal improvement when using the novel HDCIS map than with the novel FSP map (p=0.056). Those subjects who routinely use FSP as their daily program performed better than daily HDCIS users on both vowel and musical instrument tests in every condition tested (e.g., FSP, HDCIS, bimodal, CI alone). Conclusion. The addition of acoustic information provides significant benefit to cochlear implant patients when listening to abbreviated speech sounds. With complex sounds, e.g., musical instruments, acoustic information was only beneficial in the HDCIS setting. This may indicate that the FSP program provides a closer approximation of complex stimuli and the added acoustic information was redundant. Further, those who regularly use FSP performed better on every test and modality presented. This may indicate that chronic use of FSP supports central processes important for interpreting complex signals or for listening with less than ideal program settings.

**Learning Objective:** Identify effects of bimodal hearing in cochlear implant patients.

**Email:** crunge@mcw.edu
**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 173**

**Topic:** Unilateral/Bimodal

**Title:** Contribution of the non-implanted ear to cochlear implantation outcomes

**Author(s):** Isabelle Boisvert, Catherine M. McMahon, Richard C. Dowell, Björn Lyxell, Elina Mäki-Torkko, Colleen Psarros, Geneviève Tremblay, Eva Karltorp

**Presenter:** Isabelle Boisvert

**Abstract:** Objectives: To identify possible predictors of cochlear implantation outcomes in adults with bilateral hearing loss and long-term monaural sound-deprivation (use of only one hearing aid). Study Design: Retrospective cohort study with data collected in 5 cochlear implant centers. Speech recognition results were examined in 160 adults with bilateral hearing loss and long-term (=15 years) monaural sound-deprivation. 98 received the implant in the sound-deprived ear, of which 72% maintained the use of the hearing aid after implantation, allowing for bimodal hearing. 53 received the implant in the aided ear. 9 had a long-term binaural sound-deprivation before implantation (no hearing aids).

Results: Duration of bilateral significant hearing loss accounted for the majority of the variance in outcomes of implantation in a sound-deprived ear. Use of bimodal hearing, presence of any severity of prelingual hearing loss, and age accounted for a smaller proportion of the variance. Similar speech recognition scores were obtained by individuals using the CI alone, implanted in either ear, which were comparable to outcomes obtained in bimodal condition for individuals using bimodal hearing daily. Individuals with monaural sound-deprivation obtained higher outcomes with the implant placed in either ear, as compared to individuals with a binaural sound-deprivation.

Conclusion: Duration of monaural sound-deprivation is not sufficient to predict low outcomes with the implant placed in that ear. Prognosis of implantation in a sound-deprived ear should consider the hearing in the better ear and the potential impacts of bimodal hearing.

**Learning Objective:** Contrast the physiological and cognitive impacts of binaural deafness to those of monaural deafness.

**Email:** isabelle.boisvert@mq.edu.au

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**Friday (3:00 PM - 5:00 PM) Four Seasons Grand Ballroom**

**Presentation 174**

**Topic:** Unilateral/Bimodal

**Title:** Identification of ‘conflicting-cue’ vowels in listeners with a cochlear implant and a hearing aid

**Author(s):** Mario Svirsky, Elad Sagi, Ben Guo, Chin-Tuan Tan, E. Katelyn Glassman

**Presenter:** Mario Svirsky

**Abstract:** Clinical practice with cochlear implants is undergoing a quiet, but significant change, with the emergence of a quickly expanding group of “bimodal” cochlear implantees who have useful residual acoustic hearing in the contralateral ear. The mechanisms these listeners use to integrate potentially disparate information from the acoustic and electrical ears are still unclear. In this study, we used “conflicting cue” vowels to determine whether bimodal listeners identify vowels responding primarily based on acoustic cues, electrical cues, or one out of many possible combinations of both kinds of cues. Stimuli included three synthetic vowels (/i/, /a/, and /u/), as well as all six possible conflicting cue vowels. There were nine possible responses representing the most common monophthongal English vowels. When presented with conflicting cue vowels, some listeners responded largely based on the acoustic input, other listeners were largely based on the electrical input, and there were also some listeners whose response patterns were more complex, e.g. consistently responding /u/ when the acoustic stimulus was /i/ and the electrical stimulus was /a/. This result is conceptually related to the McGurk effect, obtained when the audio and visual parts of a stimulus encode different phonemes, except in our case it is the electrical and the acoustic stimuli that encode different vowels. These data will help determine how acoustic and electrical information are integrated by individuals with different amounts of residual hearing, and provide insight into the different cognitive strategies they use for electroacoustic speech perception.

**Learning Objective:** Recognize different mechanisms listeners can use to integrate acoustic and electrical information.

**Email:** mario.svirsky@nyumc.org
Observations on Early Intervention and Cochlear Implantation

Abstract:
Newborn hearing screening provides the opportunity for early identification of profound hearing loss. An essential component of early intervention includes the timely provision of information to parents regarding hearing technology options for treatment of a child’s hearing loss. In 2003, we conducted a survey of 148 parents of children who had received cochlear implants to ask them about their experiences with the early intervention process. This survey revealed that most parents did not receive information about cochlear implants from early intervention professionals but instead received such information from a variety of other sources. Most parents indicated they did receive information about communication options for children with hearing loss from these professionals, but judged the information they received to be somewhat or very biased towards one communication methodology. In 2011, we replicated the study using many of the same questions and received 301 completed surveys. While we found that information provided to parents on communication options for deaf children was judged to be more thorough and helpful than in the 2003 survey, the proportion of parents who indicated that they had received cochlear implant information was unchanged. This lack of information about cochlear implants may have an effect on the patients seen in CI clinics today as they report that many families begin the evaluation process after the child’s second birthday, despite early identification. This is supported by implant registration data, which indicates that in 2010, the average age at implant for children who received a cochlear implant prior to their third birthday was 19 months (Cochlear Americas, U.S. estimates). Our study examines several state model programs designed to overcome the above issues associated with early intervention advisement so that parents may access timely information on technology options regardless of their income, education or ethnicity.

Learning Objective:
Describe typical challenges that families face during the early intervention process in learning about and pursuing cochlear implants for a young deaf child.

Email: dsorkin@cochlear.com

Predicting social functioning in children with a cochlear implant and in normal-hearing children: the role of emotion regulation

Abstract:
Aim: The purpose of the present study was to compare children with a cochlear implant and normal hearing children on aspects of emotion regulation (emotion expression and coping strategies) and social functioning (social competence and externalizing behaviors) and the relation between emotion regulation and social functioning. Methods: Parent-report questionnaires on language skills, social functioning and emotion regulation were used, as well as emotion-regulation tasks in children. The study group consisted of 69 cochlear implant children and 67 normal hearing children aged 1.5 to 5 years. Results: Children with a cochlear implant had fewer adequate emotion regulation strategies and were less socially competent than normal hearing children. The parents of cochlear implant children reported externalizing behaviors to the same extent as normal hearing children. While social competence in normal hearing children was strongly related to emotion regulation, cochlear implant children regulated their emotions in ways that were unrelated to social competence. On the other hand, emotion regulation explained externalizing behaviors better in cochlear implant children than in normal hearing children. While better language skills were related to higher social competence in both groups, they were related to fewer externalizing behaviors only in cochlear implant children. Conclusions: Our results indicate that cochlear implant children have less adequate emotion-regulation strategies and less social competence than normal hearing children. Since they had had their implants relatively recently, they might eventually catch up with their hearing peers. Longitudinal studies should further explore the development of emotion regulation and social functioning in cochlear implant children.

Learning Objective:
Discuss the development of emotion regulation and social functioning in children with a cochlear implant.

Email: kwiefferink@nsdsk.nl
**Topic:** Outcomes II

**Title:** The Effect of Electrode Hyper-insertion on Cochlear Implant Outcomes

**Author(s):** Kathy Rehwinkel, Susan Rathgeb, Jacques Herzog

**Presenter:** Kathy Rehwinkel

**Abstract:**
Objective The purpose of this investigation was to examine the pre- and post-revision speech perception abilities of ten adult patients identified as having a hyper-inserted electrode array following concerns of poorer than expected performance. Eight of the patients had the original electrode array repositioned to a more basal location, and two of the patients received a new electrode array as their original device also demonstrated functional anomalies. Study Design Pre- and post-revision word and sentence identification scores (as measured using recorded HINT sentences and CNC word lists), soundfield threshold measurements, and integrity test results were compiled retrospectively for intra- and inter-subject comparison. Each patient received similar auditory training guidance following the initial implantation, and all underwent speech perception testing at 3 months following the initial cochlear implant surgery, as well as at various additional points throughout each patient’s course of care. Results In the presence of similar pre- and post-revision aided threshold levels, an improvement in speech perception abilities on both test measures was observed for all patients following the revision surgeries. A number of the patients demonstrated improvement in speech perception ability, on HINT sentences, the day of their re-activation. Improved sound quality was also reported. Conclusion Electrode placement is critical to speech perception outcomes. Neither programming methods nor auditory training is sufficient to overcome the effects of hyper-inserted electrodes.

**Learning Objective:** Identify the importance of internal device placement on speech perception abilities of cochlear implant recipients.

**Email:** kathyr@stlouisear.com

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**Topic:** Outcomes II

**Title:** 10 Years of Cochlear Implantation in India: Trends and Outcomes

**Author(s):** Asish Lahiri

**Presenter:** Asish Lahiri

**Abstract:**
OBJECTIVES: The growth of cochlear implantation in India has been prodigious, particularly in the last 5 years. In 2010, there were approximately 1000 implant surgeries in the country, with many clinics conducting approximately 100 surgeries per year. This is even more remarkable given that this is a fully private market, with patients paying for all of the costs. Cochlear implantation commenced around 1996, and there are currently over 10000 recipients, with 90-95% of these being children. However, despite the large numbers of recipients, there is little published information about the trends and outcomes for these patients over this time.

STUDY DESIGN This is a retrospective analysis of the data for all the patients whom were implanted at Sir Ganga Ram Hospital & received rehabilitation at Asha Speech & Hearing Clinic in Delhi, India that commenced implantation in 2001. We currently have over 400 patients.

RESULTSThe presentation will show the trends in implantation over the 10-year period for factors such as the age of implantation, the number of surgeries, the age hearing loss was diagnosed, the number of cases seen each year, and staff numbers including audiologist & speech pathologist, rehabilitationist, etc. Further, outcomes for the patients over this time frame will be reported, along with any trends. The results show the tremendous growth in the number of surgeries and children seen per year, particularly in the last 5 years, with over 85% of the patients having been implanted since 2006. Of the 400 patients, 15 were post-lingually deafened adults. The results show that the age of implantation has decreased over this time, with a consistent improvement in outcomes. One other important consideration is that staff numbers have not increased substantially over this time (p value <0.001).

**Learning Objective:** Recognize that despite the tremendous growth of implantation in India in the last 5 years, patient outcomes have not been affected, and are as good as those in many developed countries.

**Email:** lasish@yahoo.co.uk
Topic: Outcomes II  
Title: Is there a right cochlear implant advantage in bilaterally implanted children?  
Author(s): Ricky Kaplan Neeman, Riki Taitelbaum-Swead, Yifaat Yaar-Soffer, Daphne Ari-Even Roth, Lela Migirov, Yael Henkin, Minka Hildesheimer  
Presenter: Ricky Kaplan Neeman  
Abstract: Previously we have shown that speech perception performance of unilaterally implanted children with right cochlear implants (CI) was slightly, yet significantly better than that of children with left CIs. With the continuous increase of bilateral implantations in children, we asked whether the ‘right CI advantage’ found in unilaterally implanted children, is evident in bilaterally implanted children. To answer this question two groups of children with bilateral CI were tested by means of word identification tasks in quiet and in noise. Group 1 consisted of 9 children that were implanted simultaneously at the age of 10-36 months and were using their implants for at least 12 months. Group 2 consisted of 18 children that were implanted sequentially (First CI - 9 right, 9 left). Age at first implantation was 11-52 months, and age at second implantation was 1.8-16 years. Duration of CI use ranged between 20-187 months with the first CI and between 5-77 months with the second CI. Results indicated a significant right CI advantage in the simultaneously implanted group. Performance in a monosyllabic word test in quiet was 66% and 52% while using the right and left CIs, respectively. While data collection from the sequentially implanted group is still in progress, preliminary analysis showed similar performance while using the right and left CIs in the quiet condition. The finding of a right CI advantage in the simultaneously implanted group supports the notion that bilateral stimulation of the impaired auditory system at young age, may lead to lateralization patterns similar to those found in the normal hearing system.

Learning Objective: Assess that children with unilateral CI show right CI advantage.  
Email: kaplann@post.tau.ac.il

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Topic: Outcomes II  
Title: Speech recognition in users of the most recent technologies from the four major cochlear implant manufacturers  
Author(s): Francois Bergeron, Richard Bussières, Mathieu Côté, Julie Lamothe, Isabelle Millette  
Presenter: Francois Bergeron  
Abstract: Objectives. Speech perception in cochlear implant users has been widely studied from the first applications of this technology. While the average performance nowadays appears quite impressive, a large variability in individual results is still present. This variability makes valid comparisons between different devices, inter or intra manufacturer, difficult to obtain; this can even be worse when different tests, different languages or different populations are assessed to attempt such comparisons. This paper presents a unique study of speech recognition in a large cohort of cochlear implants users as the most recent technologies from the four major manufacturers were applied to comparable samples and assessed with the same protocols. Study designThe transversal study involves a hundred adults who received the most recent device from one of the four major manufacturers of cochlear implant in a one-year time frame. All were tested following a minimum of three months experience with their device in identical conditions and with the same speech recognition tests. ResultsDescriptive analysis will specify the average and variance of the scores with each device; these metrics will be compared to the same metrics obtained with other devices. ConclusionAt the end of the study, speech perception from a large cohort of cochlear implant users would have been assessed in a common environment. This will support a valid comparison between the four most advanced devices currently available to clinical teams.

Learning Objective: Recognize the difficulty of comparing different devices  
Email: francois.bergeron@rea.ulaval.ca
Outcomes II
The use of Pre-Processing for Cochlear Implant (CI) users in difficult listening environments
Andreas Buechner, Theo Harpel, Nicole Neben, Thomas Lenarz

Abstract:
The introduction of digital signal processing in hearing aids more than 15 years ago led to significant improvements of speech perception in difficult listening situations. Although this technology has also been available in cochlear implant system for several years now, so far there are no consistent recommendations for selecting the best pre-processing strategies for each listening environment. The goal of this study was to evaluate the impact of different combinations of pre-processing strategies from Cochlear under different listening conditions. In particular, a testing environment with multiple noise sources and different types of noise was used to mimic everyday life situations rather than testing in a clean “laboratory environment”. Ten adult subjects have been recruited for the study so far. The speech performance has been evaluated in acute measurements by comparing speech perception under real life conditions while using different pre-processing recommendations in addition to the patient’s everyday mapping. The test setup consists of five loudspeakers at +/- 70, +/- 135 and 180 degrees for the background noise and one loudspeaker at 0 degrees presenting the test material to be repeated by the subjects. The testing material consists of the Oldenburg sentences with two different noise types, i.e. speech modulated noise (OL-noise) and cafeteria-type multi-talker noise (live recording). The noise is being presented at 65 dB SPL, while the presentation level of the sentences is constantly adapted to reach speech reception threshold (SRT50). Preliminary results indicate that depending on the pre-processing configuration an SNR improvement of up to 6dB can be achieved. The right combination of pre-processing strategies can significantly improve subjective performance in background noise. Further results will be presented at the conference.

Learning Objective: Discuss that pre-processing signal enhancement algorithms can be successfully used in Cochlear Implants.

Email: buechner@hoerzentrum-hannover.de

Study Objective: To describe receptive and expressive language skills in children with CHARGE syndrome and cochlear implants.
Methodology: A multi-site study enrolled 32 children with CHARGE, (ages 11 months to 7 years 1 month) with cochlear implants. Recruitment occurred through state deaf-blind projects, through early intervention, and clinical cochlear implant programs across 15 states within the United States. Children completed evaluations at intervals post-implant. Communication skills were evaluated using a battery of assessments. Only results from the Reynell-Zinkin Developmental Scales for Young Visually Handicapped Children will be presented. Results: 25 children completed post assessments. Age range at implantation was 11 months to 5 years, 2 months. Eighty-eight percent of children were implanted <3 years of age. Participant demographics included: 62.5% of children had physical challenges, 52.1% cognitive challenges, 18.8% behavior challenges, and 93.8% complex health needs. Thirty-two percent of the children had their implant for 4+ years (range 3 months to 6 years 11 months). All children completed the Reynell-Zinkin Scales following implantation. For receptive language categories; 96% of children developed some response to sound, 54% response to words and short phrases, 48% could identify some words, 36% could follow simple directions, and 24% could understand complex directions with spatial/size concepts. For expressive language categories; 100% developed sound production, 44% one word production/jargon, 44% meaningful words, 38% simple sentences, and 16% developed complex sentences. Age at implant was not correlated with receptive (ρ=.205, p=.359) or expressive (ρ=.117, p=.603) language outcomes. Duration with implant was significantly correlated with receptive language (ρ=.693, p=.0001) and expressive language (ρ=.782, p=.0001) outcomes. Cognitive level was significantly correlated with receptive language (ρ=.792, p=.001). Conclusion: While individual outcomes varied considerably, these children with CHARGE, as a group, demonstrated significant improvement in receptive and expressive language over time, after receiving a cochlear implant.

Learning Objective: Describe receptive language outcomes for children with CHARGE who received cochlear implants.

Email: charlotte.ruder@cchmc.org
Outcomes II

Longitudinal Outcomes of Children with Multiple Disabilities Following Cochlear Implantation

Ivette Cruz, Ishabel Vicaria, Nae-Yuh Wang, John K. Niparko, Alexandra L. Quittner

Objectives: The purpose of this longitudinal study was to evaluate language and behavioral outcomes of deaf children who received cochlear implants, comparing children with additional disabilities to deaf children with no additional diagnoses. Study Design: Participants were part of a large, multi-center, longitudinal investigation of the effectiveness of pediatric cochlear implants, the Childhood Development after Cochlear Implantation Study (CDaCI). Participants were categorized into two groups: Deaf or Additional Disability (AD). Children in the Deaf group were developing typically, while children in the AD group were also deaf, but had additional diagnoses, including Attention Deficit Hyperactivity Disorder, Pervasive Developmental Disorder/Autism, and Learning Disability. Data was collected at yearly assessment points, from baseline to 36 months post-implantation. For both groups, receptive and expressive language skills were assessed using the Reynell Developmental Language Scales, and internalizing and externalizing behavior problems were measured by the Child Behavior Checklist. Multilevel modeling was used to predict oral language and behavior problems using time and group as predictors over three years post-implantation. Results: The CDaCI cohort consisted of 188 deaf children. Eighty-five percent of the sample (n=157) had a single diagnosis of severe-to-profound hearing loss (age: M=26.3, SD=14.4), and 16% (n=31) had an additional disability diagnosed following enrollment (age: M=28.0, SD=14.7). Results indicated that deaf children with and without additional disabilities improved significantly in oral language skills post-implantation. However, children with multiple disabilities made slower progress. In terms of specific diagnoses, children with developmental disorders, such as autism, made the slowest progress over time. In addition, behavior problems increased significantly in the AD group, whereas behavior problems decreased over three years in the typically developing deaf sample. Conclusion: Given the improvements in oral language skills documented over three years, these findings support the use of cochlear implants for deaf children with multiple disabilities.

Learning Objective:
Describe the Childhood Development after Cochlear Implantation Study.

Email: icruz@med.miami.edu

Outcomes II

Attitudinal and device preference change whilst adapting to sequential bilateral cochlear implants: Self-reports from adolescents/young adults at 3.5+ years post-switch-on

Karyn L. Galvin, Kathryn C. Hughes, Jennifer F. Holland, Mrs. Alexandra Rousset

Objective: Obtaining self-reports of attitude and device preference change, adaptation, and device use from adolescents/young adults with long-term bilateral implant (BiCI) experience. Study Design: Questionnaire administered to adolescents/young adults who received sequential BiCIs >3.5 years previously. Participants: The clinical population of The University of Melbourne/Eye and Ear Hospital Clinic included 19 recipients first implanted in childhood, now >11 years old and >3.5 years post-sequential BiCIs. Thirteen participated, with median inter-implant interval 8.4 years, median age at second implant (CI-2) 12.3 years, and median time post-switch-on 4.3 years. Results: 92.3% reported a positive attitude towards CI-2, up from 38.5% in the first months post-switch-on. 76.9% reported a preference for BiCIs, up from 61.5% after switch-on. Only 15.4% preferred CI-1 alone, down from 38.5%. 68% reported changing to BiCIs was “fairly easy”. Others experienced varying degrees of difficulty, with adaptation not achieved for one. Respondents’ comments on this process will be shared. At interview, 69% used BiCIs full-time, with an additional 15% using BiCIs 60-90%. One respondent used BiCIs 30-60%, and one was not using CI-2. 92% reported listening improvements with BiCIs. 85% considered CI-2 was worthwhile, with the final two unsure. Conclusion: The proportion of respondents with a positive attitude towards CI-2 and a preference for BiCIs increased with bilateral experience. Adaptation to BiCIs was most often, but not always, easy and relatively quick. At interview, the majority preferred to use BiCIs and did so full-time. Factors that may contribute to CI-2 non-use will be considered, although exact causes for individuals are difficult to isolate. Nearly all reported CI-2 was beneficial and worthwhile obtaining. Older children and young adults should be encouraged to make an informed choice about BiCIs, irrespective of age or inter-implant delay. Post-operative changes in attitude and preference over time, and information about adaptation, have implications for pre- and post-operative management of this group.

Learning Objective:
Discuss the self-reported outcomes of sequential bilateral implantation for adolescents/young adults

Email: kgalvin@unimelb.edu.au