SELECTED ABSTRACTS

ORAL PRESENTATIONS

IN ORDER OF PRESENTATION

AOS | AMERICAN OTOLOGICAL SOCIETY

159th Annual Meeting
AMERICAN OTOLOGICAL SOCIETY

April 24-25, 2026
Sheraton Phoenix Hotel
Phoenix Convention Center
Phoenix, AZ

Influence of Cochlear Microanatomy on Hearing Preservation in Cochlear Implant Recipients

Elena Quinonez Del Cid, BS; Ashley Micuda, BSc; Margaret T. Dillon, AuD, PhD
Sumit Agrawal, MD; Hanif M. Ladak, PhD; Kevin D. Brown, MD, PhD

Objective: Identify cochlear microanatomic variables that influence hearing preservation in adult cochlear implant (CI) recipients

Study Design: Retrospective review

Setting: Tertiary academic referral center

Patients: 42 adult CI recipients with preoperative unaided thresholds ≤45 dB hearing level (dB HL) at 250 Hz

Interventions: Cochlear implantation with 24-, 28-, or 31.5-mm straight electrode arrays

Main Outcome Measures: Preoperative computed tomography (CT) scans were automatically segmented using deep learning to extract scala tympani (ST) volume, cochlear duct length (CDL), and cross-sectional measurements (height, width, area, diameter) at 15° increments. Pre- and post-operative CTs were aligned to determine cross-sectional measures at the most apical electrode (E1) and angular insertion depth (AID). Low frequency pure tone average (LFPTA) was calculated from unaided thresholds at 125, 250, and 500 Hz. Change in LFPTA was computed for each subject at activation and at 6 months.

Results: A linear mixed effects model analyzed the effects of cochlear microanatomy (i.e., ST volume, CDL, AID), cross-sectional measurements at E1 (height, width, area, and diameter), as well as interval, age at surgery, and biological sex on the postoperative shift in LFPTA. This model demonstrated significant effects of non-anatomic variables including age ($p=0.05$) and sex ($p=0.01$). Interval ($p=0.26$) did not affect LFPTA change. Of the anatomic variables, only ST volume demonstrated a significant effect ($p=0.005$). CDL ($p=0.80$) and AID ($p=0.40$) did not affect hearing preservation. Metrics computed at the apical electrode including ST height ($p=0.71$), width ($p=0.65$), diameter ($p=0.56$) and cross-sectional area ($p=0.14$), did not significantly affect change in LFPTA.

Conclusions: ST volume is significantly predictive of hearing preservation. Together, these data suggest that hearing preservation may be less affected by interactions of the electrode with the local environment of the walls of the cochlea and may instead be more affected by the overall volume of the cochlea. This finding implies that indirect mechanisms of trauma, such as hydraulic pressure as the electrode is inserted, may predominate.

Learning Objective: Understand the role of cochlear microanatomy in hearing preservation outcomes

Desired Result: Attendees will enhance their understanding of which features of cochlear morphology most impact hearing preservation

Level of Evidence - III

Indicate IRB or IACUC: IRB#09-2328, University of North Carolina

Hearing Preservation Across Different Electrode Arrays:
Robotic Versus Manual Insertion

Carlos A. Perez-Heydrich, MD; Elena Quinonez Del Cid, BS; Margaret T. Dillon, AuD, PhD
A. Morgan Selleck, MD; Matthew M. Dedmon MD, PhD
Kevin D. Brown MD, PhD; Nicholas J. Thompson, MD

Objective: Robotic-assisted cochlear implantation using a controlled and slow insertion of the electrode array may preserve hearing function compared to manual insertion. This study aimed to determine if there is a benefit in early hearing preservation outcomes for robotic insertion with iotaSoft Insertion System from iotaMotion as compared to manual insertion and assess whether outcomes differed as a function of electrode array length.

Study Design: Retrospective study

Setting: Tertiary Care Center

Patients: Adults who underwent cochlear implantation with a straight electrode array from January 2024 to October 2025.

Main Outcome Measures: Unaided thresholds were measured preoperatively and at device activation. A low-frequency pure-tone average (LFPTA; 125, 250, and 500 Hz) was calculated for each visit.

Results:
Data were available for 79 cases at the time of review. Robotic insertion was used for 21 cases (mean age= 69.3 yrs ±11.7) and manual insertion was used for 58 cases (mean age=66 yrs ±15.0). Patients were recipients of an Advanced Bionics SlimJ (20 mm; robotic=3, manual=8), or MED-EL Flex24 (24 mm, robotic=11, manual=17), Flex26 (26 mm; robotic=2, manual=4), or Flex28 (28 mm; robotic=5, manual=29) electrode array. The groups did not differ significantly in preoperative LFPTA (p=0.336; robotic = 41.6±12.9 dB HL, manual = 45.0 dB HL ±15.6). At CI activation, the LFPTA for the robotic insertion group was significantly lower (67.5 dB HL ±24.8) compared to the manual insertion group (82.3 dB HL ± 24.6; p=0.024). When stratified by electrode array, significantly better hearing preservation was observed for recipients of the longer array (28 mm) with the use of robotic insertion (mean LFPTA shift: 23.3 dB HL ±12.5) as compared to manual insertion (mean LFTPA shift: 43.4 dB HL ±20.7; p=0.016). This difference was not observed for shorter arrays (p≥0.471).

Conclusions: Robotic-assisted cochlear implantation may support better hearing preservation at initial CI activation compared to manual insertion with greater benefit observed for longer electrode arrays.

Learning Objective: To describe the difference in early hearing preservation for CI recipients of straight electrode arrays using a manual versus robotic insertion and the discuss the differences in observed outcomes by electrode array length.

Desired Result: To determine early hearing outcomes based on robotic assisted insertion of CI electrodes compared to manual insertion of electrodes.

Level of Evidence – Level IV; Retrospective Cohort Study

Indicate IRB or IACUC: IRB 09-2328 from UNC Medical Center

Iowa CI Trauma Tool: A Deep Learning Approach to Cochlear Implant Trauma Assessment from CT scans

Aseem Jain, MD, MSE; Nicholas George-Jones, MD; Rachel Scheperle, AuD, PhD
Joshua Pinzour, BS; Marlan Hansen, MD; Alexander Claussen, MD

Hypothesis/Aim: To develop a tool that captures electrode array position relative to intracochlear structures and quantifies distances between these structures for cochlear implant (CI) trauma assessment from CT scans.

Background: Recent studies have shown the impact of CI position on post-operative hearing outcomes. We present a fully automated tool that segments the CI and cochlea within post-operative CT scans (poCT), individually labelling the scala-tympani (ST), scala vestibuli/media (SVM), lateral wall (LW), modiolus, and basilar membrane (BM). Segmentations are used to compute electrode array position relative to the intracochlear structures outlined above.

Methods: The tool utilizes two pipelines that generate: 1) Cochlea and CI segmentations derived from poCT; 2) Intracochlear segmentations derived from pre-operative CT. Pipeline 1 was created by training a neural network (nnUNet) on 50 labeled poCTs. Pipeline 2 was developed using five co-registered micro-CT and CT pairs of the cochlea, augmented synthetically to train a separate nnUNet. The result of pipeline 2 is registered to pipeline 1 for CI position analysis. For both pipelines, using cross validation, 20% of the training data was randomly isolated to create a testing dataset.

Results: Accuracy was assessed on the testing dataset using Dice similarity coefficients (DSC), which measure overlap between predicted and ground-truth labels (1 = perfect overlap). Pipeline 1 achieved DSCs of 0.94 (cochlea) and 0.87 (electrode). Pipeline 2 had DSC scores of 0.96, 0.95, 0.83, 0.86, 0.91 for ST, SVM, BM, modiolus, and LW, respectively.

Conclusion: Using neural networks and image registration techniques, we created an accurate, open-source CI trauma assessment tool that is manufacturer and electrode-agnostic. This platform enables large-scale CI analysis and aids in surgical planning and postoperative hearing evaluation.

Learning Objective:

- To understand the importance of key quantitative metrics such as electrode-to- intracochlear structure distances and electrode location in CI trauma assessment.
- Demonstrate how neural networks and image registration techniques can be leveraged to automatically extract features such as intracochlear regions and electrode position from CT scans
- Discuss how open-source automation can facilitate large-scale, standardized cochlear implant outcome analysis and improve surgical planning and post-surgical audiological management.

Desired Result: To create and validate an accurate, open-source tool that automatically segments cochlear and electrode structures from CT imaging and generates quantitative metrics for cochlear implant position and potential trauma assessment. Ultimately, this tool will be integrated to support large-scale CI research that enhance understanding of electrode placement effects on hearing outcomes and informs data-driven surgical decision-making and audiological management.

Level of Evidence – Level III

Indicate IRB or IACUC: IRB P50 VIII 202210440 Approved: 3/13/2023; IRB P50 VII 201805740 Approved: 6/22/2018

Comparing Low-Frequency Threshold Functions of Intracochlear Electrocochleography and Perioperative Pure Tone Audiometry

Jordan J. Varghese, MD, MSCI; Amit Walia, MD, MSCI; Matthew A. Shew, MD; Amanda J. Ortmann, PhD
Nedim Durakovic, MD; Jacques A. Herzog, MD; Craig A. Buchman, MD

Objective: To evaluate the relationship between minimal stimulation levels for intracochlear electrocochleography during implantation and pure tone audiometric thresholds at both cochlear implant (CI) candidacy and residual hearing testing.

Study Design: Prospective case series

Setting: Tertiary referral center

Patients: 41 post-lingual adult CI recipients undergoing intraoperative monitoring with electrocochleography threshold function testing

Interventions: Intracochlear electrocochleography responses to 250 and 500 Hz tone bursts during implantation of the slim modiolar electrode array. Recordings were from the best responding internal electrode for each frequency. Stimulus intensity was incrementally decreased to identify the threshold for minimal electrocochleography response observable above the noise floor.

Main Outcome Measures: Pure tone audiometry tested at CI candidacy evaluation and 1-month post-implantation.

Results: Electrocochleography thresholds were higher than pre-operative pure tone thresholds (mean difference in dB HL [SD]; 250 Hz: 25.7 [16.5]; 500 Hz: 21.4 [14.4]) and lower than post-operative pure tone thresholds (250 Hz: -10.4 [27.4]; 500 Hz: -16.1 [25.0]). When evaluating a combined low-frequency (LF) average of 250 and 500 Hz, there was a strong positive correlation between LF-electrocochleography thresholds and candidacy LF-PTA ($r = 0.53$, 95% CI [0.35 to 0.76]), and a weak positive correlation to residual hearing LF-PTA ($r = 0.23$, 95% CI [-0.09 to 0.50]). There were similar relationships seen when independently evaluating 250 and 500 Hz electrocochleography thresholds.

Conclusions: Intraoperative electrocochleography thresholds correlate well with candidacy pure tone thresholds but are less predictive of residual acoustic hearing. This may further support the mechanism that residual hearing loss is less related to the immediate electroacoustic alterations of the inner ear from CI implantation and more driven by delayed fibrotic changes. Candidacy LF-PTA could guide selection of optimal stimulus intensity levels to improve signal quality during intracochlear electrocochleography monitoring.

Learning Objective: 1) To recognize the utility of electrocochleography for evaluating clinical and audiometric outcomes for CI recipients. 2) To consider the potential for intracochlear electrocochleography as an electrophysiologic model to better characterize properties of the inner ear.

Desired Result: Clinicians and researchers will appreciate the relationship between intracochlear electrocochleography and perioperative pure tone thresholds for CI recipients. This knowledge can support the utility of incorporating electrophysiologic measurements into routine clinical care for CI recipients and provide insight into future research investigation on the complexities of the CI neural interface.

Level of Evidence - V

Indicate IRB or IACUC: Washington University in St. Louis IRB #202007087 (04/30/2024)

Whole Genome Sequencing of Archival Human Temporal Bones –
Identification and Characterization of the DFNA17 Mutation

Adam Y. Xiao, MD, PhD; Achilles Kanaris, BS; Shin-ya Nishio, MD; Shin-ichi Usami, MD
Ivan A. Lopez, PhD; Gail Ishiyama, MD; Akira Ishiyama, MD

Hypothesis: Whole genome sequencing (WGS) technology can be successfully applied to archival human temporal bones (HTB) to identify pathogenic genetic variants.

Background: WGS has enhanced the detection of mutations underlying genetic hearing loss. However, correlating genetic findings with otopathology remains difficult due to the inaccessibility of inner ear tissues. Archival HTBs offer a unique opportunity to link genotype with histopathologic phenotype, but their harsh processing conditions impede genomic analysis. DFNA17, characterized by cochleosaccular degeneration, is associated with a known myosin 9 (MYH9) mutation.

Methods: Genomic DNA was extracted from a celloidin-embedded HTB with DFNA17 and processed using a FFPE DNA Library Prep Kit. WGS was performed on the NovaSeq X Plus 10B platform. Secondary analysis utilized the DRAGEN pipeline, and variant annotation was performed with wANNOVAR. MYH9 expression was evaluated by immunofluorescence in histologic sections.

Results: Extracted DNA was highly fragmented (<100 bp). WGS generated 848 million unique reads (43.16%), with a mean coverage of 6.12x. Genome coverage was 87.13% at ≥1x and 15.16% at ≥10x. A total of 9,824 single-nucleotide variants were identified at >10x depth. The known MYH9 G→A mutation at nucleotide 2114 was confirmed with 25x read depth, minimal strand bias (FS = 4.632), and high mapping quality (MQ = 235.34). MYH9-immunofluorescence localized to atrophic vessels of the saccular macula, spiral ganglion, stria vascularis, and spiral ligament.

Conclusions: This study demonstrates the first successful application of WGS to a celloidin-embedded archival HTB by confirming the MYH9 mutation in a DFNA17 specimen. Although sequencing depth and library complexity remain limited, these findings establish proof of concept for performing WGS on archival HTBs, enabling future genotype–phenotype correlations in otopathology and advancing understanding of molecular mechanisms of hearing loss.

Learning Objective: To understand the application of WGS to archival temporal bones as well as the histopathology of DFNA17.

Desired Result: Participants should better appreciate the potential use of WGS on archival temporal bones and the expression pattern of MYH9.

Level of Evidence – Not applicable

Indicate IRB or IACUC: UCLA IRB # 22-001587

Macrophage and Schwann Cell Alterations in Sudden Sensorineural Hearing Loss: Insights from Human Temporal Bones

Drew J. Montigny, BS; Soomin Myoung, BS; Andrew M. Jung, BS; Alex J. Lim
Diana Correa, MD; Jennifer O'Malley, BA; Andreas Eckhard, MD
Alicia Quesnel, MD; Judith S. Kempfle, MD

Hypothesis: Sudden sensorineural hearing loss (SSNHL) is associated with alterations in non-neuronal cells—specifically Schwann cells and macrophages—compared with normal-hearing human temporal bones.

Background: The etiology of SSNHL remains poorly defined. Current treatments focus on suppressing inflammation with corticosteroids. IBA1 (ionized calcium-binding adaptor molecule 1) labels tissue-resident and monocyte-derived macrophages, whose morphology can indicate pro-inflammatory states. SOX2 (SRY-box transcription factor 2) marks Schwann cells and is upregulated in Schwann cells after injury. Characterizing these cell populations may help to clarify additional non-neural mechanisms underlying SSNHL.

Methods: Immunohistochemistry was performed on celloidin-embedded archival human temporal bones from four individuals with short- or long-standing SSNHL and three normal-hearing controls, using antibodies against SOX2 and IBA1. Quantification of $SOX2^+$ Schwann cells and $IBA1^+$ macrophage ramification indices were compared between SSNHL and control samples.

Results: $SOX2^+$ Schwann cells were significantly increased in SSNHL compared with controls (0.103 ± 0.105 vs. 0.008 ± 0.005 $SOX2^+/100\ \mu m^2$/DAPI; $p = 0.00026$). One SSNHL case, corresponding to death within one year of onset, exhibited reduced $IBA1^+$ macrophage ramification (3.76 ± 1.12 vs. 4.23 ± 1.27; $p = 0.0017$), indicating more acute immune activation. Cases with longer SSNHL-death intervals (19-48 years) showed no difference from controls, suggesting only transient macrophage response early after onset, but persistent $SOX2^+$ Schwann cell activation.

Conclusions: SSNHL is associated with sustained activation of Schwann cells after damage and transient macrophage reactivity during the acute phase. These findings highlight dynamic non-neuronal responses and plasticity to cochlear injury in SSNHL pathology.

Learning Objective: To recognize macrophage and Schwann cell responses in human temporal bone samples with sudden sensorineural hearing loss, specifically increased SOX2 expression and macrophage activation.

Desired Result: Learners will gain improved knowledge of the cellular mechanisms underlying SSNHL, enhancing discourse regarding future therapeutic approaches targeting Schwann cells and macrophages.

Level of Evidence: III (Cohort and case-control studies)

Indicate IRB or IACUC: Massachusetts Eye and Ear Infirmary, IRB#2021P000332, Exempt

Histopathological Considerations for Indication of Cochlear Implant for Patients with Vestibular Schwannoma

Shinya Ohira, MD, PhD; Ivan Lopez, PhD; Maya Harary, MD; Maureen Laufer, AuD
Gail Ishiyama, MD; Gregory P. Lekovic, MD, PhD; Akira Ishiyama, MD

Objective: To conduct clinicopathological correlations of audiological data and histopathology in archival human temporal bones of vestibular schwannoma (VS) for potential auditory rehabilitation with cochlear implant (CI).

Study Design Clinicopathological study

Setting: National archival human temporal bone bank

Patients: 34 temporal bones from 28 patients with a history of VS. Five patients had neurofibromatosis.

Interventions: Clinical data included: surgical history and audiometry of pure tone average (PTA) and speech discrimination score (SDS). Residual tumor, tumor invasion into the fundus, cochlear ossification, and spiral ganglion cells (SGCs) and cochlear hair cells.

Main Outcome Measures: Correlation between pathological findings and audiometric data.

Results: Of the 28 patients, seven were managed non-operatively; the remaining underwent VS resection: middle fossa approach (MFA = 4), retrosigmoid/retrolabyrinthine approach (RSA/RLA = 5) or translabyrinthine approach (TLA = 15) approach. SGCs were sometimes preserved despite severe hearing loss on PTA and low SDSs were associated with significant SGC loss. TLA surgery was associated with cochlear ossification and severe loss of hair cells and SGCs. All cases with tumor invasion into the fundus demonstrated marked SGC degeneration. Post-surgical cases without residual tumor at the fundus exhibited preservation of SGCs corresponding with hearing preservation.

Conclusions: High SDSs reflected the preservation of SGCs in VS patients, likely indicating CI candidacy. Fundal invasion was associated with SGC and neural degeneration. TLA was associated with cochlear ossification, loss of hair cells and SGN, and should be avoided in hearing rehabilitation. Early intervention may be indicated when the tumor invades near the fundus using a non-TLA and aiming for eradication of fundal tumor.

Learning Objective: To better understand factors related to hearing in VS patients.

Desired Result: Improved treatments for VS patients.

Level of Evidence - Level V

Indicate IRB or IACUC: Approval was obtained from the Institutional Review Board (IRB #22 001587).

Histopathologic Diversity in Idiopathic Sudden Sensorineural Hearing Loss: A Multi-Institutional Temporal Bone Study

Diana M. Correa, MD; Michael S. Castle, MD; Rafael da Costa Monsanto, MD, PhD
Abbie K. Hall, BS; Ivan A. López, PhD; William H. Slattery, MD; Sebahattin Cureoglu, MD
Meredith E. Adams, MD, MS; Akira Ishiyama, MD; Alicia M. Quesnel, MD

Hypothesis: Idiopathic sudden sensorineural hearing loss (iSSNHL) represents a heterogeneous disorder characterized by multiple patterns of cochlear degeneration.

Background: iSSNHL is a medical emergency with over 66,000 new cases annually in the United States. Its etiology remains poorly understood, limiting the development of targeted therapies. Human temporal bone (hTB) studies are essential for clarifying pathological consequences, generating mechanistic hypotheses, and guiding candidacy for emerging treatments.

Methods: Postmortem hTBs from donors diagnosed with iSSNHL during life were identified through a systematic review of clinical records across three institutional collections. Inner and outer hair cell survival was evaluated using 100× DIC microscopy of every hair cell on H&E sections in a subset of cases. Supporting cell survival, tectorial membrane abnormalities, and endolymphatic hydrops were assessed using semi-quantitative digital scoring. Spiral ganglion neuron (SGN) quantification and spatial distribution were analyzed with a machine-learning algorithm.

Results: hTBs from 43 donors with iSSNHL were examined histopathologically. Preliminary analysis showed 26% of cases exhibited an encapsulated tectorial membrane (vs. 0% in age-matched controls) and 22.2% demonstrated endolymphatic hydrops. Among hydrops cases, 66.7% also showed tectorial membrane encapsulation, suggesting a potential association. Fractional hair cell survival correlated with focal audiometric threshold elevations in cases with deafness >7 months. Supporting cell survival negatively correlated with duration of deafness, suggesting progressive degeneration. SGN counts did not correlate with the duration of deafness (preliminary 13% of cases counted).

Conclusions: This study represents the largest hTB series of iSSNHL to date. iSSNHL demonstrates diverse cochlear pathologies, supporting a heterogeneous etiology. A subset showed concurrent hydrops and tectorial membrane encapsulation. Progressive supporting cell loss over time suggests that early intervention may be critical for successful regenerative therapies.

Learning Objective: Describe the key cellular and structural patterns of cochlear degeneration identified in the largest temporal bone study of iSSNHL cases.

Desired Result: We aim to characterize the spectrum of cochlear pathology in iSSNHL. We expect to identify correlations between these cellular and structural changes and clinical features such as duration of deafness, providing insights into disease heterogeneity and potential windows for future regenerative interventions.

Level of Evidence – Level III.

Indicate IRB or IACUC: IRB #2021P001358, IRB #2019P00375, IRB # 22-001587

Peri-Insertional Cochlear Implant Electrode Forces for Manual Versus Rigidly-Fixed and Handheld Robotic Insertion

Maxwell Bergman, MD; Nathan Kemper, MD; Constantinos Nikou; Zachary Urdang, MD, PhD
Alexander Claussen, MD; Bruce J. Gantz, MD; Marlan R. Hansen, MD

Objective: To compare cochlear implant (CI) electrode insertion forces across manual, rigidly fixed robotic, and handheld robotic methods and to evaluate whether handheld robotic insertion maintains the low forces achieved with rigid fixation.

Study Design: Controlled laboratory experiment using 3D-printed human temporal bone models.

Setting: Temporal bone laboratory, University of Iowa.

Patients: Not applicable (benchtop experimental model)

Interventions: Six surgeons performed 43 interpretable CI insertions into 3-D-printed temporal-bone models using three techniques—manual, rigidly fixed-robotic, and handheld-robotic using the iotaMotion iotaSOFT system

Main Outcome Measures: Axial insertion forces were captured with a millinewton-resolution load cell. Mean peak, variability, and release forces were then compared

Results: Both robotic methods generated smaller and more consistent forces than manual insertion. Rigid and handheld robotic CI electrode insertion generated smaller peak insertion forces (57 mN and 58 mN, respectively) versus manual (226 mN, $p<0.0001$). Rigid (34 mN) and handheld (44 mN) robotic electrode array insertion demonstrated less force variation compared to manual (265 $\pm$167 mN, $p<0.001$). Finally, release forces were smaller with the robotic systems—about 67 mN for rigid and 87 mN for handheld—while manual insertions reached roughly 160 mN ($p = 0.18$)

Conclusions: Handheld robotic insertion achieved force profiles nearly identical to rigid fixation. Handheld robotic use could help the device feel more intuitive for some surgeons and while dampening insertion forces seen with manual placement. These results support handheld robotic insertion as a practical, less-traumatic bridge between traditional manual and fully fixed robotic CI techniques.

Learning Objective: To understand how handheld robotic cochlear implant insertion can provide force profiles comparable to rigid fixation

Desired Result: To encourage the adoption of robotic-assisted insertion strategies that reduce mechanical trauma and improve cochlear implant surgical consistency

Level of Evidence - Level V (experimental bench study)

Indicate IRB or IACUC: Exempt – benchtop experimental model (no human or animal subjects).

Real-time Intracochlear Distance Sensing and Navigation using Optical Coherence Tomography

Pawina Jiramongkolchai, MD; Senyue Hao, BS; Ratul Paul, PhD; AJ Adkins, MS
Jacques Herzog, MD; Craig Buchman, MD; Chao Zhou, PhD

Hypothesis: Optical coherence tomography (OCT) can be used for real-time intracochlear navigation and distance sensing.

Background: OCT is a contrast- and radiation-free imaging modality that provides real-time 2- and 3-dimensional imaging of tissue microanatomy at higher resolutions than that of conventional MRI or CT. Because the fundamental working principle of OCT is to measure the time delay of backscattered near-infrared light using low-coherence interferometry, OCT functions as an intrinsic light-based distance sensor.

Methods: A single-mode fiber (SMF)-28 attached to a custom-built 1310 nm swept source (SS) OCT system (axial resolution=10 μm) was mounted onto a translation stage to allow finely controlled movement of the fiber. The system was validated in cochlear phantoms and tested in human cadaveric cochlea. In the cadaveric cochlea, bone overlying the scala vestibuli was removed to enable direct visualization of the fiber within the scala tympani. Measurement profiles to the lateral and medial walls of the scala tympani were obtained during insertion and pull-back of the fiber as accessed through the round window membrane.

Results: Our fiber-based SS-OCT system can detect a maximum distance of 6.9 mm with an acquisition speed of 8 μs. By sensing the distances of the fiber from the medial and lateral walls of the scala tympani in real-time, our SS-OCT system allowed us to make micro-adjustments of fiber trajectory to avoid damage to both the fiber tip and intracochlear lumen.

Conclusion: Fiber-based OCT can be used to provide real-time spatial navigation and distance sensing to critical structures within the cochlea.

Learning Objective: Understand application of optical coherence tomography for intracochlear use.

Desired Result: OCT can be used to provide navigation and spatial sensing within the cochlea.

Level of Evidence – V

Indicate IRB or IACUC: IRB #202410102

Randomized Double-Blinded Placebo-Controlled Clinical Trial of In-Office Regeneration of Chronic Tympanic Membrane Perforations: Preliminary Results

David R. Friedmann, MD, MSc; Ashley Feng, BS; Emmanuel Garcia-Morales, PhD
Victoria Lancaster, RN, Daniel Jethanamest, MD; J. Thomas Roland Jr., MD

Objective: To evaluate the efficacy of regenerating chronic tympanic membrane perforations in the office setting using a growth factor (FGF-2) compared to placebo.

Study Design: This Phase 2 double-blinded randomized clinical trial involved block randomization of enrolled subjects (1:1) with a chronic tympanic membrane perforation to undergo myringoplasty with fibroblast growth factor (FGF-2 NPC-18 *Nobelpharma*) vs. control.

Setting: Ambulatory academic otology neurotology practice.

Patients: Adults with chronic dry tympanic membrane perforations for at least six months without evidence of cholesteatoma. Patients who underwent prior tympanoplasty were excluded.

Interventions: Topical anesthetic was applied and the edges of the perforation were freshened. Myringoplasty with gelatin foam sponge impregnated with FGF-2 (intervention) or normal saline (placebo) was performed at three-week intervals until the perforation was closed for up to a maximum of three treatments. Subjects who were randomized to placebo and failed to close after three treatments were offered cross-over to receive FGF-2 for up to three additional treatments.

Main Outcome Measures: Primary outcome was rate of complete closure of tympanic membrane perforation confirmed with photographic documentation at each visit. Secondary outcomes included hearing improvement and post-treatment tympanometry.

Results: Fifty-one subjects were enrolled in this trial. Twenty-six subjects were randomized to the experimental arm. Of those, 16/26 (61.5%) experienced complete closure of the tympanic membrane. Among placebo, 10/25 (40.0%) achieved complete closure. Of the fifteen subjects randomized to placebo who failed to close, 10 crossed over with only 2/10 (20.0%) achieving salvage closure of the perforation.

Conclusions: In office closure of tympanic membrane regeneration is possible using this technique though overall success rates were lower than typically achieved with surgical tympanoplasty. When successful, normal tympanograms and minimal air bone gaps were observed unlike surgical tympanoplasty. Our preliminary results suggest higher success when FGF-2 growth factor is applied compared to an identical procedure using placebo.

Level of Evidence - Choose one value between Level II

Indicate IRB or IACUC: NYU Langone Health i21-00672

Efficacy of Tympanic Membrane Regeneration Therapy for Secondary Cholesteatoma with Tympanic Membrane Perforation

Shin-ichi Kanemaru, MD, PhD; Tomoya Yamaguchi, MD; Rie Kanai, MD
Eriko Otonari, MD; Maki Yamasoba, MD; Yuki Fujii, MD; Toshiki Maetani, MD, PhD

Objective: To investigate the effectiveness of tympanic membrane regeneration therapy (TMRT) for secondary cholesteatoma (SC) with tympanic membrane perforation (TMP)

Study Design: Intervention study

Setting: Research institute hospital

Patients: The study included 38 patients with SC (41 ears in 38 cases, M/F: 21/17, 12-86 y.o.) who underwent TMRT, and 33 patients with 33 ears (M/F: 15/18, 20-75 y.o.) who underwent conventional tympanoplasty (CTP) as a historical control.

Interventions: In TMRT, an endoscope is used to remove all of the remaining TM, leaving the tympanic ring intact, to secure the surgical field, and then the cholesteatoma is completely removed. For the TM repair procedure, the edge of the TMP was disrupted mechanically, and gelatin sponge immersed in basic fibroblast growth factor were placed inside and outside the tympanic cavity and covered with fibrin glue. The protocol was repeated up to four times until closure was complete.

Main Outcome Measures: Operative time, closure of the TMP, and hearing improvement were evaluated. Adverse events, including cholesteatoma recurrence, were monitored for a period of three years or more.

Results: The operative time, TM closure rate, and cholesteatoma recurrence rate were 65minutes, 100% (41/41), and 2.4% (1/41) in the TMRT group, respectively, and 125minutes, 93.9% (31/33), and 9.1% (3/33) in the CTP group, respectively. Average hearing improvement was 12.2dB in the TMRT group and 7.5dB in the CTP group.

Conclusions: As a treatment for SC arising from the edge of TMP, TMRT showed no difference in TM closure rate or cholesteatoma recurrence rate compared to CTP. However, TMRT was superior to CTP in terms of operative time and hearing improvement.

Learning Objective: TMRT is a new treatment method that became covered by health insurance in Japan in November 2019. This treatment method is based on a tissue engineering concept that is fundamentally different from traditional TM reconstruction. Therefore, it is important to fully understand this idea in order to regenerate the TM reliably. Appropriate treatment can regenerate a near-normal TM and provide good hearing with a very small AB gap. TMRT is gradually replacing most myringoplasty and some tympanoplasty in Japan.
Because the bFGF used in TMRT has the effect of growing cholesteatoma, it has been thought that TMRT is inappropriate for cholesteatoma; however, it has been shown that TMRT can be fully applied to cases of SC where the cholesteatoma is localized within the tympanic cavity. At the conclusion of this presentation, the participants should be able to know how to manage SC without conventional surgical therapy. This new regenerative treatment will change the former concept of the otologic surgery.

Desired Result: TMRT has completed Phase II clinical trials in the United States, and Phase III trials are planned to obtain FDA approval. This treatment is expected to spread around the world because it is short, minimally invasive, low cost, and requires easy training for the surgeon. I hope that this announcement will be of some help.

Level of Evidence - Level III

Indicate IRB or IACUC : TMRT is a new treatment that became covered by health insurance in Japan. The study was approved by the ethical committee of Kitano Hospital (P210600600) and Kanai Hospital (ECNo.2001).

Single-Cell RNA Sequencing Reveals Heterogeneity and Cell-Cell Interactions of Cholesteatoma Keratinocytes

Daniel R. Romano, MD; Song-Zhe Li, MD, PhD; Richard A. Chole, MD, PhD
Michael Hoa, MD; Sidharth V. Puram, MD, PhD; Keiko Hirose, MD

Hypothesis: Tympanic membrane and cholesteatoma keratinocytes will demonstrate significant transcriptional differences at the single cell level.

Background: Cholesteatoma is a disease defined by the abnormal presence of keratinizing stratified squamous epithelium in the middle ear and/or mastoid. As compared to epidermis, the matrix (keratinizing stratified squamous epithelial) layer of cholesteatomas demonstrates dysregulated differentiation and uncontrolled proliferation. However, the molecular processes that drive pathogenesis are poorly characterized.

Methods: Cholesteatoma specimens were prospectively collected from patients undergoing surgery and immediately dissociated into single cell suspensions. Cell suspensions were subjected to single-cell RNA-sequencing (scRNA-seq), and scRNA-seq analysis was performed in R (version 4.4.2). scRNA-seq datasets including a publicly available tympanic membrane scRNA-seq dataset were integrated using Harmony.

Results: After quality control steps, single cell transcriptional profiles for > 2,000 cholesteatoma keratinocytes from n = 13 patients were available for scRNA-seq analysis. Tympanic membrane and cholesteatoma keratinocytes were overall transcriptionally similar, clustering together into distinct populations of undifferentiated (KRT15+), wounded/healing (KRT6B+/KRT16+/ KRT6C+), cycling (MKI67+/CDK1+/PCNA+), and terminally differentiated keratinocytes (LOR+/FLG+). However, closer examination clearly demonstrated a cluster of $LAMC2^{hi}$/$ITGA6^{hi}$/$LAMA3^{hi}$ basal keratinocytes which exclusively derived from cholesteatoma samples. Gene ontology and cell-cell interaction analyses identified these $LAMA3^{hi}$/$ITGA6^{hi}$/$LAMC2^{hi}$ cells as upregulating genes associated with cellular adhesion and epithelial migration and as a major target of keratinocyte-keratinocyte epidermal growth factor signaling.

Conclusions: These results hint at a possible cholesteatoma specific transcriptional program. Further study is currently underway to validate this and determine how these transcriptional differences may drive cholesteatoma pathogenesis and/or clinical variability.

Learning Objective: Attendees will be able to describe the molecular heterogeneity and transcriptional differences of tympanic membrane and cholesteatoma keratinocytes.

Desired Result: We are hoping to improve on our current understanding of the cellular mechanisms underlying cholesteatoma formation, which could allow for improved treatment strategies.

Level of Evidence - V

Indicate IRB or IACUC: IRB #202302061, Washington University in St. Louis, originally approved on 02/15/23.

Cost of Facial Nerve Monitoring

Sammy Y. Gao, BS; Warren B. Chun, MD; Tyler M. Rist, MD
Robert F. Labadie MD, PhD

Objective: Evaluate the cost-effectiveness of intraoperative facial nerve monitoring (FNM) during otologic/neurotologic surgery.

Study Design: Decision-tree cost-effectiveness analysis with probabilistic sensitivity analysis (PSA) via 1,000-iteration Monte Carlo simulation.

Setting: Tertiary academic center

Patients: Hypothetical adult cohort undergoing otologic surgery

Interventions: Simulated FNM for all otologic surgery was compared to no FNM

Main Outcome Measures: Expected quality-adjusted life years (QALYs), expected cost per patient, incremental cost-effectiveness ratio (ICER; difference in cost / difference in QALY), and probability of cost-effectiveness at willingness-to-pay (WTP) thresholds. Model probabilities were derived from published literature and expert consensus, and costs were estimated from institutional price-transparency data and adjusted hospital cost-to-charge ratio. Cost-effectiveness was stratified by three common FNM vendors.

Results: FNM for all otologic surgeries (both primary and revision) was associated with an increase in QALY of 0.34 years compared to no monitoring. Average cost increased by $47.2 per patient for equipment purchased from Vendor 1 (ICER=$136.82/QALY), but decreased by $63.8 with Vendor 2 (ICER=–$184.9/QALY) and decreased by $115.8 with Vendor 3 (ICER=–$335.7/QALY). The breakeven threshold for utility of FNM versus rehabilitation of FN paresis was 44 cases/year for Vendor 2 and 27 cases/year for Vendor 3. PSA showed monitoring all otologic surgery was cost-effective in >95% of simulations at a $100,000/QALY WTP threshold with an increase in QALY of 0.34 years at average costs per patient of +$61.50 (Vendor 1), –$49.14 (Vendor 2), and –$105.48 (Vendor 3).

Conclusions: FNM for otologic surgery is cost-effective across vendors. Although use of higher-cost electrodes leads to increases in per-patient cost, the incremental cost per QALY gained remains minimal and well below accepted thresholds. These findings suggest routine FNM use is cost-effective, particularly in institutions with surgical volume to exceed breakeven thresholds.

Learning Objective: To understand how cost-effectiveness modeling can quantify the economic impact of different facial nerve monitoring electrode systems and their influence on per-patient cost in otologic surgery.

Desired Result: Attendees will be able to interpret how variations in electrode cost and performance affect overall cost-effectiveness, recognize breakeven thresholds by vendor, and apply these findings to optimize resource use in clinical practice.

Level of Evidence - III

Indicate IRB or IACUC: Exempt.

Machine Learning Identification of Hearing Loss from Natural Speech

Peter R. Dixon, MD, MSc; Paul Heider PhD; Carl Ehrett PhD; Theodore R. McRackan, MD, MSc
Judy R. Dubno, PhD; Leslie A. Lenert, MD, MS

Objective: Hearing loss disrupts auditory feedback, resulting in measurable changes in voice production. This study evaluates the extent to which acoustic-phonetic features from natural connected speech can identify individuals with hearing loss as a foundation for voice-based hearing screening.

Study Design: Cross-sectional

Setting: Bridge2AI-Voice, a multi-institutional NIH-funded initiative collecting standardized voice and health data.

Patients: 435 participants (median age 65 years, IQR 49-73; 59% female): 85 with hearing loss (self-reported 'serious difficulty hearing' or clinical diagnosis) and 350 without.

Interventions: Participants provided three brief connected speech samples. Acoustic-phonetic voice features were extracted using OpenSMILE and Parselmouth/Praat. Models were adjusted for age, sex, depression, Parkinson's disease, and cognitive impairment and evaluated using stratified 5-fold cross-validation.

Main Outcome Measures: Area under the receiver operating characteristic curve (AUROC)

Results: Gradient Boosted Decision Trees (XGBoost) achieved mean AUROC = 0.71 +/- 0.04, exceeding logistic regression with L2 regularization (0.65 +/- 0.08, $p = 0.14$). Calibration was strong (Brier = 0.17 ± 0.02). Feature-family permutation analysis showed that confounders, particularly age, explained most model performance (delta-AUROC = 0.15 +/- 0.09), while mel frequency cepstral coefficient-, prosodic-, and voice-quality features contributed modest, consistent signal (delta-AUROC = 0.02-0.01), supporting physiologic links between altered auditory feedback and vocal control.

Conclusions: This study provides the first multi-institutional evidence that machine-extracted voice features can detect hearing loss from short, unconstrained speech samples. The approach demonstrates technical rigor, interpretable model behavior, and cross-validated accuracy comparable to early-stage voice biomarkers in other domains. Because hearing status was based on self-report rather than audiometric confirmation, future work with confirmed hearing loss severity will be essential to establish clinical utility for hearing screening.

Learning Objective: Participants will understand the relationship between acoustic voice features and hearing loss and recognize key methodological requirements for translating voice biomarkers to clinical practice.

Desired Result: To demonstrate the feasibility of voice biomarkers for hearing loss detection and motivate prospective studies of individuals with audiometrically confirmed hearing loss that establish voice analysis as a passive, scalable tool for hearing screening in clinical practice.

Level of Evidence - III

Indicate IRB or IACUC: Exempt

Electron Microscopy of Otoconia in a Hypercalcemic Mouse Model

Andriy O. Grynyk, BS; Callie S. Burke, BS; Richard Pellegrino, MS; Jessia Costa, DMD, PhD
Andrew Arnold, MD; Kourosh Parham, MD, PhD

Hypothesis: Mice with chronic hypercalcemia have smaller otoconia and altered surface morphology when compared to controls.

Background: Serum calcium dysregulation may contribute to otoconial degeneration and has been linked to benign paroxysmal positional vertigo (BPPV).

Methods: Four female cyclin D1 transgenic mice modeling primary hyperparathyroidism (PHPT) and four female wild-type mice of similar age were studied. Utricular otoconia were extracted under sodium cacodylate solution, gold-coated, and imaged using a Zeiss Sigma scanning electron microscope (SEM). Individual otoconia were hand measured using ImageJ to quantify major axis, minor axis, and area. Statistical analysis included linear mixed-effects modelling and Mann-Whitney testing across three otoconia size categories (small, medium, large), as there is a natural variation in otoconia size within the utricle. The frequency of fractured otoconia was assessed for structural stability.

Results: Control mice exhibited larger otoconia than experimental mice across major axis (9.09 ± 0.16 μm vs. 5.15 ± 0.048 μm), minor axis (4.55 ± 0.066 μm vs. 2.79 ± 0.022 μm), and area (39.98 ± 1.55 μm^2 vs. 13.24 ± 0.28 μm^2). The linear mixed-effects model showed a significant interaction between group and size category for all three metrics. Subgroup analysis showed the largest difference in the large otoconia category, indicating significance when evaluated for major axis ($p = 0.039$), minor axis ($p = 0.038$), and area ($p = 0.032$). Otoconia fracture frequency was low. There was a 4.4-fold increase in cracks within the hypercalcemic mice.

Conclusions: Mice with chronic hypercalcemia have fewer large otoconia when compared to normal mice, with increased frequency of fractured otoconia.

Learning Objective: Understand the impact of calcium dysregulation on otoconia structure.

Desired Result: Help clinicians understand how calcium dysregulation alters otoconia structure, which will aid management of BPPV.

Level of Evidence – N/A (basic science)

Indicate IRB or IACUC: IRB exempt. UConn IACUC protocol AP-200856-0126.

Kinematic Methods for Identification of Moderate Vestibular Loss

Morgan A. Terry, MD; Hannah R. Smith, BS; Camellia K. Liu, BS; Daniel B. Putterman, AuD
Jae W. Lee, PhD; Timothy E. Hullar, MD; Angela C. Garinis, PhD

Objective: Detecting vestibular dysfunction is important for diagnosing and treating patients with imbalance, but quantitative vestibular testing requires a specialized laboratory and highly trained staff. Kinematic methods, which measure the motion of body parts while standing and walking, are far simpler and have been shown to distinguish normal subjects from those with dramatic vestibular losses such as following vestibular schwannoma resection. However, their efficacy in diagnosing clinically challenging patients with more subtle losses is not well understood.

Study Design: Cross-sectional.

Setting: Tertiary ambulatory referral center.

Patients: English-speaking adults with either normal function, partial unilateral vestibular loss (Meniere's), or total unilateral vestibular loss (following vestibular schwannoma resection).

Interventions: Diagnostic gait task while wearing six inertial sensors.

Main Outcome Measures: Kinematic parameters of the 2-Minute Walk Test

Results: 24 subjects participated **(**control: n=10; partial unilateral: n=7; total unilateral: n=7). Stride length (p=0.019) was able to distinguish both control and partial loss from total unilateral loss but not from each other. Gait speed varied among the three groups significantly (p=0.006) but did not distinguish control or total loss from partial loss.

Conclusions: Kinematic analysis shows early promise in distinguishing intermediate vestibular losses. This offers the possibility of low-cost, convenient vestibular testing that may be useful for screening and triaging patients in lieu of conventional in-lab vestibular testing. Further exploration into kinematic metrics during walking tasks with continued enrollment may elucidate sensitive parameters of interest.

Learning Objective: Understand how kinematics may be utilized to detect subtle vestibular losses and its potential advantages in both detection and monitoring of therapies.

Desired Result: If kinematics is a sensitive detector of vestibular loss, there are many potential advantages for its use in both detection and guided therapies including ease of access, administration (remote option), and tolerability.

Level of Evidence - III

Indicate IRB or IACUC: OHSU IRB# STUDY00027062 approved 4/1/2024 (began collecting data 3/2025)

Cognitive Performance Differs Among Adults with Unilateral Audiovestibular Disorders: A Pilot Study

Maura K. Cosetti, MD; Carly Feist BA; Liraz Aire, PhD
Jen Kelly, DPT, Anat Lubetzky PT, PhD

Objective: Adults with bilateral hearing loss are at risk of cognitive decline. However, less is known about cognition in unilateral audiovestibular disorders, specifically unilateral hearing loss (UHL), unilateral vestibular hypofunction (UVH), and unilateral Meniere's Disease (MD.) Common complaints among these patients include brain fog, difficulty concentrating, forgetfulness, among others. We aimed to identify how cognitive performance differs across these 3 groups, and which domains require clinical attention.

Study Design: cross-sectional

Setting: outpatient academic center

Patients: 28 controls (mean age 59 years, range 41-78) and 30 patients (10 UHL [4F PTA <25 dB in unaffected ear; > 40 affected ear] mean age 55, 25-76; 10 unilateral definitive MD, mean age 53, 32-78; 10 UVH, mean age 59, 24-82)

Interventions: Proportion of participants per group that performed below average and any significant differences between a clinical group and controls.

Main Outcome Measures: Age-adjusted standardized scores of 8-domain computerized cognitive test battery: compositive, verbal, visual and working memory; sustained attention, reaction time, cognitive flexibility and executive function.

Results: Across most domains, controls outperformed patients with unilateral disease. Comparisons between groups and controls were significant in the domains of composite memory (proportion performing below average: 18% controls, 50% UHL ($Z=1.98$, $P=0.047$), 30% MD, 20% UVH), verbal memory (14% controls, 50% UHL and MD ($Z=2.28$, $P=0.022$), 30% UVH); executive function (7% controls, 30% UHL, 40% MD ($Z=2.39$, $P=0.017$), 10% UVH) and sustained attention (0% controls, 30% UHL ($Z=2.97$, $P=0.003$), 10% MD, 40% UVH ($Z=3.48$, $P<0.001$).

Conclusions: Unilateral audio-vestibular disorders demonstrate differences in cognitive performance compared to controls along specific domains that may reflect challenges unique to hearing loss, vestibular loss or a combination.

Learning Objective: Participants will explain the differences in domain-based cognitive performance between controls and groups of patients with unilateral hearing loss, vestibular dysfunction and definitive Meniere's disease.

Desired Result: Participants will appreciate the nuances of neurocognitive testing, and the potential relationship between disorders affecting unilateral hearing and balance

Level of Evidence – III

Indicate IRB or IACUC: STUDY-21-01026, Mount Sinai

Surgical Treatments Decrease the Association Between CHL Pathologies and Depression in the All of Us Research Program

Hannah N. W. Weinstein, BA; S. Dillon Powell, ME; Ramzi K. Elased, BA
Lauren H. Tucker, MD, MS; Justin S. Golub, MD, MS

Objective: Previously, we found patients with specific conductive hearing loss (CHL) pathologies had higher odds of depression. This study investigates the effect of surgical treatments on this association.

Study Design: Cross-sectional epidemiologic study.

Setting: The NIH All of Us Research Program, which includes aggregated data from the electronic health records of voluntary participants.

Patients: Adult participants from the All of Us Research Program.

Main Outcome Measures: Exposures and outcomes were defined by ICD-10 codes. Exposures included otosclerosis (H80.X), cholesteatoma (H71.X), and tympanic membrane (TM) perforation (H72.X). Outcomes included major depressive disorder (MDD; F32-33) and dysthymia (F34.1). Treatments were identified with CPT codes and included tympanoplasty (69631-69633 69635-69637, 69641-69646, 69610), mastoidectomy (69502, 69505, 69511, 69601-69604), myringoplasty (69620), and stapedectomy/stapedotomy (69660-69662). Multivariable regression controlling for age, sex, education, race, ethnicity, education, smoking history and relevant surgical treatment was used to calculate absolute change in odds of depression for participants with/without a CHL pathology.

Results: 363,297 adults were included. Controlling for covariates, the odds of MDD and dysthymia among those with TM perforation decreased by **0.05** (OR=2.37;2.15-2.62; p<0.001 to OR=2.32;2.10-2.56; p<0.001) and **0.09** (OR=2.90;2.29-3.60; p<0.001 to OR=2.81;2.20-3.52; p<0.001), respectively, after the addition of tympanoplasty and/or myringoplasty. Among those with cholesteatoma, the odds of MDD and dysthymia decreased by **0.27** (OR=1.85;1.49-2.28; p<0.001 to OR=1.58;1.26-1.97; p<0.001) and **0.41** (OR=2.18;1.22-3.57; p=0.004 to OR=1.77;0.936-3.09; p=0.060), respectively, after the addition of tympanoplasty and/or mastoidectomy. Among those with otosclerosis the odds of MDD decreased by **0.06** (OR=1.48; 95% CI 1.16-1.88; p<0.001 to OR=1.42;1.09-1.83; p=0.008) following the addition of stapedectomy/stapedotomy. Otosclerosis was not associated with dysthymia.

Conclusions: Surgical treatments reduce the association of CHL pathologies with MDD and dysthymia in the All of Us Research Program. The largest decrease was seen for cholesteatoma.

Learning Objective: After this presentation, attendees will understand how surgical treatment history for conductive hearing loss pathologies impacts the association between hearing loss and depressive disorders.

Desired Result: Increase in physician knowledge regarding the relationship between hearing loss and depressive disorders, and the potential for interventions to improve patient outcomes.

Level of Evidence: IV

Indicate IRB or IACUC: All study procedures were confirmed as meeting criteria for non-human subjects research by the All of Us Research Program IRB.

Timing of Cochlear Implantation Influences Neuropsychiatric Outcomes in Sensorineural Hearing Loss

Atri Bhattacharyya, BA; Judith S. Kempfle, MD

Objective: To investigate whether the timing of cochlear implantation (CI) in adults with sensorineural hearing loss (SNHL) is associated with long-term neuropsychiatric outcomes.

Study Design: Retrospective cohort study using TriNetX, a multi-institutional electronic health record network.

Setting: Academic and community healthcare systems contributing to the TriNetX network.

Patients: Adults (≥18 years) with a diagnosis of SNHL who underwent CI were categorized into two groups: early CI (within 1 year of SNHL diagnosis) and late CI (1–5 years after SNHL diagnosis). Follow-up extended up to 10 years post-implantation.

Interventions: Cochlear Implantation

Main Outcome Measures: Incidence of first-time diagnoses of dementia, depression, and mild cognitive impairment (MCI) within 1–10 years after implantation. Odds ratios (ORs) were calculated after propensity score matching for age, sex, race, English language, and medical comorbidities.

Results: After matching, 3,282 patients were included in each cohort. Late CI was associated with significantly higher odds of depression and dementia compared with early CI. Patients in the late CI group had increased odds of first-time depression (ICD-10 F32.A; OR 1.464, 95% CI 1.131–1.896) and dementia (ICD-10 F01, F02, F03, G30, G31; OR 1.348, 95% CI 1.042–1.745). No significant difference was observed in the incidence of MCI between cohorts.

Conclusions: Delayed cochlear implantation in adults with SNHL was associated with an increased risk of subsequent depression and dementia during long-term follow-up. These findings suggest that earlier implantation may mitigate neuropsychiatric sequelae associated with prolonged auditory deprivation.

Learning Objective: To assess how timing of cochlear implantation affects the development of neuropsychiatric disorders in adults with SNHL.

Desired Result: To demonstrate that earlier cochlear implantation is associated with a lower risk of depression and dementia compared with delayed implantation.

Level of Evidence – Level III

Indicate IRB or IACUC: Exempt

Tinnitus Improvement Predicts Domain-Specific Quality of Life Gains after Cochlear Implantation

Sophia Chehade, BS; Tamara Mijovic, MD; Emily Kay-Rivest, MD

Objective: To determine the relationship between tinnitus improvement and domain-specific quality of life outcomes following cochlear implantation in adult recipients.

Study Design: Retrospective chart review

Setting: Single institution academic hospital

Patients: 181 adult CI recipients (aged 19–91 years; mean = 61.4 ± 17.5)

Interventions: Quality of life questionnaires

Main Outcome Measures: Tinnitus Handicap Inventory (THI) and Cochlear Implant Quality of Life instruments (CIQOL-10 Global and CIQOL-35 Profile) assessed preoperatively and at 6 and 12 months postoperatively.

Results: Linear mixed-effects models demonstrated a strong relationship between tinnitus burden and quality of life. Higher tinnitus burden was independently associated with lower CIQOL-10 and CIQOL-35 item scores, particularly in the Emotional (β = -0.18 to -0.31, FDR $p < 0.05$) and Listening Effort domains (β = -0.12 to -0.26, FDR $p < 0.05$). Patients with greater chronic tinnitus burden had persistently lower Global and Emotional scores ($\beta \approx$ -0.25, FDR $p < 0.05$). A 30-point reduction in THI corresponded to 0.5–0.9-point improvements in Emotional and 0.4–0.6-point improvements in Listening Effort scores (0–4 CIQOL scale), equivalent to 10–20 points on the normalized 0–100 scale and reflecting clinically meaningful improvements. Independent of tinnitus changes, scores across most domains also improved over time, with Communication, Entertainment, and Social domains showing marked gains by 6 months (β = +0.30 to +0.50, FDR $p < 0.05$) that were sustained at 12 months.

Conclusions: Cochlear implantation produces broad and lasting quality of life gains, but emotional and cognitive benefits are closely tied to tinnitus trajectory. Patients with persistent tinnitus experience diminished improvements, whereas those achieving substantial tinnitus relief show the greatest gains in emotional well-being, listening effort, and overall quality of life.

Learning Objective: Participants will be able to describe how changes in tinnitus severity after cochlear implantation influence domain-specific quality of life outcomes and interpret CIQOL-10 and CIQOL-35 results in relation to tinnitus burden and improvement.

Desired Result: To enhance clinician understanding of how tinnitus relief impacts patient-reported outcomes after cochlear implantation, thereby improving patient counseling, outcome tracking, and integration of tinnitus assessment into routine post-implant care.

Level of Evidence: Level IV

Indicate IRB or IACUC: IRB 2025-11122, McGill University, approved on 8/2/2025

Temporal and Spectral Contributions to Music Perception Among Hearing-Assistive Device Users

Emmeline Y. Lin, BS; Brooke Barry, BS, BA; Patpong Jiradejvong, MS
Karen C. Barrett, PhD; Nicole T. Jiam, MD

Objective: To investigate timbre and pitch perception abilities between cochlear implant and hearing aid users.

Study Design: Cross-sectional observational study.

Setting: Tertiary care center.

Patients: 52 adults including 11 normal-hearing (NH) listeners, 17 bilateral cochlear implant users (CICI), 16 bimodal users (CIHA), and 8 bilateral hearing aid users (HAHA) who qualified for CI.

Interventions/Methods: Three abilities were assessed: 1) timbre identification (identify which instrument played a note, with variable temporal envelope modifications); 2) pitch discrimination (discriminate between two pitches played simultaneously by the same instrument); and 3) timbre discrimination (discriminate between two different instruments playing the same or different pitches).

Main Outcome Measures: One-way ANOVA with post-hoc comparisons and effect size calculations (Cohen's d) to determine between-group differences; Pearson's calculations to examine within-group correlations between test performances.

Results: For timbre identification, NH outperformed all hearing-impaired groups when temporal envelope cues (attack/release) were unaltered or reduced ($p<0.001$). When these cues were removed, performance differences between NH, HAHA, and CIHA disappeared, although NH performance remained superior to CICI ($p=0.0006$). All groups performed at chance levels for discriminating simultaneous, harmonic tones sharing overtone series. For timbre discrimination, NH and HAHA significantly differentiated between same-pitch and different-pitch conditions ($p= 0.007$), while CI users (CIHA and CICI) did not. Effect sizes for between-group comparisons were large (Cohen's $d > 1.6$). Performance across the three tasks was not correlated within groups.

Conclusions: Temporal envelope cues are important for timbre identification across all listening groups. HAHA, like NH, may retain access to the timbre and pitch cues needed for music perception, likely due to access to fine spectral cues and limited distortion compared to CI-processing strategies and device limitations. These findings may help guide post-operative musical-listening expectations among individuals considering cochlear implantation.

Learning Objective: To enhance understanding of differences in timbre and pitch perception challenges between hearing aid, bimodal device, and cochlear implant users.

Desired Result: To better understand the musical advantages and disadvantages of CIs among hearing aid users eligible for and/or considering initial implantation, or bimodal users considering a second implant.

Level of Evidence - III

Indicate IRB or IACUC: UCSF - 24-41324

Downstream Effects of Regulatory and Reimbursement Expansion on Cochlear Implantation: A 2012-2024 Medicare Analysis

Akshay Warrier, BA; Ryan Bartholomew, MD; Liliya Benchetrit, MD; Daniel J. Lee, MD

Objective: To evaluate the impact of the 2019 FDA single-sided deafness (SSD) indication and the 2022 Medicare eligibility expansion on cochlear implantation (CI) procedure volume, geographic distribution, provider participation, and inflation-adjusted reimbursement.

Study Design: Retrospective interrupted time series (ITS) with segmented regression using national Medicare claims (2012–2024).

Setting: U.S. Medicare Part B claims across hospital and ambulatory sites of service.

Patients: All Medicare beneficiaries receiving CI services (CPT-level identification) from 2012–2024; provider and state identifiers used for distributional analyses.

Intervention(s): Policy exposures: (1) 2019 FDA approval for SSD; (2) 2022 Medicare coverage expansion with relaxed speech-recognition thresholds.

Main Outcome Measure(s): Total Medicare payments, payment per allowed service (inflation-adjusted), procedure volume, provider counts and mean provider volume, state-level service density; secondary visualization via violin plots and reimbursement-ratio trends; comparator trends for hypoglossal nerve stimulation (HGNS).

Results: Inflation-adjusted reimbursement per CI service plateaued or declined after 2019 (segmented estimate −172.2; P=0.08), and reimbursement ratios remained largely static. Procedure volume rose modestly, increasing total CI payments without a corresponding per-service increase. Geographic heatmaps showed broader post-2019 distribution with more states reaching moderate volumes, but mean provider volume remained flat, yielding a broader yet shallower delivery pattern on violin plots. In contrast, HGNS displayed contemporaneous increases in both reimbursement and volume, underscoring relative financial inertia for CI.

Conclusions: Regulatory and coverage expansions broadened access and modestly increased CI volume but did not raise per-service reimbursement, revealing a gap between policy intent and financial execution. Fee schedule rigidity, adoption dynamics, and site-of-service factors likely mediate this disconnect. Policy efforts to improve CI access should align eligibility changes with reimbursement structures and provider incentives.

Learning Objectives
• Quantify how 2019/2022 policy changes affected CI volume, geography, and reimbursement.
• Interpret segmented regression (ITS) findings for payment-per-service versus total spending.
• Contrast CI trends with HGNS to contextualize device-based reimbursement dynamics.

Desired Result: Provide an empirical framework linking eligibility expansions to real-world utilization and payment patterns, informing policy design that couples access with sustainable reimbursement and provider engagement**.**

Level Of Evidence: Retrospective observational claims analysis; not classifiable within traditional clinical evidence hierarchies (e.g., RCTs/cohorts).

Indicate IRB or IACUC: IRB: Exempt

Binaural Hearing and Language Development after Cochlear Implantation in Children with Congenital Single-Sided Deafness

Piotr H. Skarzynski, MD, PhD, MSc; Dorota Pastuszak, MSc; Anita Obrycka, PhD
Artur Lorens, Prof; Anna Ratuszniak, PhD; Henryk Skarzynski, Prof

Objective: To assess the binaural hearing benefits after cochlear implantation (CI) in children with congenital single-sided deafness (SSD) in relation to their language development.

Study Design: cross-sectional

Setting: Tertiary referral center.

Patients: Twenty-seven children with congenital single-sided deafness who had undergone cochlear implantation in the ear with profound hearing loss were included in the study. The mean age at implantation was 4.6 years *(SD=2.7)*. Patients were evaluated preoperatively and at 14 months of CI use.

Interventions: Diagnostic

Main Outcome Measures: Receptive and expressive language skills were evaluated using standardized tests. Three binaural effects — redundancy, head shadow, and squelch — were assessed using speech-in-noise tests in different spatial configurations of speech and noise.

Results: The postoperative distribution of low, average, and high scores shifted toward higher values for both receptive ($\chi^2=6.75;\ p=.009$) and expressive ($\chi^2=9.09;\ p=.003$) language skills. Among the binaural effects, redundancy of 1.3 dB SNR (t(21)=2.26, p=.035) and head shadow of 4.0 dB SNR *(t(21)=5.50, p<.001*) were observed. The squelch effect was not found (*t(20)=1.01, p=.327*). Moreover, all three binaural effects were observed in children with average or high expressive language development scores, whereas in children with low scores, only the head shadow effect was present.

Conclusions: Cochlear implantation in children with SSD restores binaural hearing essential for language development. Binaural processing abilities could serve as an indicator of expressive language development.

Learning Objective: To understand how CI in children with SSD supports binaural hearing and its role in facilitating language development.

Desired Result: To enhance competence in managing SSD through CI.

Level of Evidence: III

Indicate IRB or IACUC: The Bioethics Committee of the Institute of Physiology and Pathology of Hearing (IFPS:KB/Statement 7/2022)

Spoken Language Outcomes after Early Cochlear Implantation in a Diverse, Multi-Institutional Cohort of Congenitally Deaf Children

Evan J. Patel, MD; Samantha Anne, MD; Daniela Carvalho, MD; Laura Covello, MA, CCC-A
Jason Park, MD, PhD; Patricia Yoon, MD; Dylan K. Chan, MD, PhD

Objective: To evaluate spoken language outcomes in a diverse, multi-institutional cohort of children with severe-to-profound hearing loss who have undergone early cochlear implantation.

Study Design: Retrospective cohort

Setting: Multi-institutional study at nine cochlear implant centers and schools with data from 2017-2025

Patients: Children with bilateral congenital severe-to-profound SNHL who underwent cochlear implantation prior to 24 months of age.

Interventions: Cochlear implantation

Main Outcome Measures: Standardized, age-normed language assessments (Preschool Language Scales (PLS) and Receptive-Expressive Emergent Language (REEL)). Sociodemographic status was assessed using the Social Vulnerability Index (SVI), a validated, national geocoded measure based on residential home address.

Results: 140 patients identified at nine separate institutions were included. Mean SVI was 0.48 (SD 0.28; range: 0-0.97). The majority of patients (57.9%, 81 patients) were implanted before 12 months (early CI) while 42.1% (59 patients) were implanted from 12-24 months (late CI). At age 3, the mean total language score for the early CI group was higher than that of the late CI group (94.8 vs 74.6, $p < 0.001$). This difference persisted to age 5, when the early CI group also had significantly better language than the late CI group (97.3 vs 74.1, $p < 0.001$). SVI was not associated with age at implantation ($p = 0.30$). On multivariable regression, SVI (HR 17.5, $p = 0.01$), pre-operative ABR threshold (HR -0.44, $p = 0.01$) and age at CI (HR 0.09, $p < 0.001$) were associated with total language.

Conclusions: Language outcomes in a diverse cohort of deaf babies implanted before 12 months of age are comparable to normal hearing counterparts, suggesting that cochlear implantation provides sufficient access to sound to support full development of spoken language.

Learning Objective: To understand expectations for spoken language outcomes in children with severe-to-profound hearing loss who have undergone cochlear implantation

Desired Result: Learners will appreciate that cochlear implantation before 12 months of age provides sufficient access to sound for the development of spoken language.

Level of Evidence – Level IV

Indicate IRB or IACUC: Approved by IRB #24-42150 at the University of California – San Francisco.