PROGRAM and ABSTRACTS

of the

One Hundred Fifty Second Annual Meeting

AMERICAN OTOLOGICAL SOCIETY

May 3-5, 2019

GRAND BALLROOM
7-8

JW Marriott Austin
Austin, TX

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JULY 1, 2018 - JUNE 30, 2019

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CONTINUING MEDICAL EDUCATION CREDIT INFORMATION

Accreditation

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education through the joint providership of the American College of Surgeons and the American Otological Society. The American College of Surgeons is accredited by the ACCME to provide continuing medical education (CME) for physician

AMA PRA Category 1 Credits™

The American College of Surgeons designates this live activity for a maximum of **8.0** ***AMA PRA Category 1 Credits™***. Physicians should claim only the credit commensurate with the extent of their participation in the activity.
Of the *AMA PRA Category 1 Credits™* listed a maximum of **0** credits meet the requirements for Self-Assessment.

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AMERICAN COLLEGE OF SURGEONS
DIVISION OF EDUCATION

Table of Contents

(2019 AOS Program Book)

American Otological Society
Mission Statement

Purpose - The American Otological Society, created in 1868, is dedicated to fostering a dialogue on and dissemination of, information pertaining to advances in evidence based diagnosis and management of otologic and neurotologic disorders. The focus on otologic and neurotologic disorders and scientific advances are translated to the provision of quality care that is consistent with the ACGME general competency areas and the Institute of Medicine competencies.

Target Audience - The primary target audience for the educational efforts of the American Otological Society is the current and potential members of the society. These members are physicians, physicians-in-training, audiologists and researchers in the fields of otology and neurotology. Educational activities are also open to other healthcare professionals who are involved in the care of patients with otologic and neurotologic conditions.

Activities - The primary activity of the American Otological Society is the Annual Meeting that focuses on the advancement of the scientific and clinical evidence that supports advances in otologic and neurotologic care to patients. Additionally, non certified educational support and resources include the publication and dissemination of peer reviewed and evidence-based content through Otology & Neurotology Journal and support for research in otology/neurotology and lateral skull base surgery and related disciplines.

Content - The content for the Annual Meeting and other related educational efforts are focused on otologic and neurotologic evidence based science, clinical standards of care, effects on communication, and other topics to the specialty.

Expected Results - The expected results are focused on enhancing knowledge translation and promoting competence for the membership and other identified target audiences. The Annual Meeting, the CME certified annual activity of the society, and the other scholarly activities such as the publication of the Journal and support for research provide a rich and robust environment for self assessment and reflection, access to resources for lifelong learning and opportunities for discussion and re-evaluation.

Resolution on Diversity of Meeting Presenters and Participation for the American Otological Society and the American Neurotology Society

- Whereas, the councils of the American Neurotology Society and American Otological Society desire to promote inclusivity within the membership of both organizations.

- Whereas it is recognized that diverse leadership and diversity of presenters allows for cross pollination of knowledge, perspective and experiences enabling a stronger and more robust educational experience for our members.

- Whereas the Councils of the organizations recognize the importance of acknowledging diversity among our patients, our trainees and our colleagues.

- Whereas, the purpose of the education programs of both organizations is to disseminate information designed to improve physician knowledge, patient care and outcomes, and advance the respective specialties.

- Whereas, valuable scientific contributions to Otology and Neurotology by colleagues (regardless of gender, race, or other attributes) should be presented at the society's respective meetings.

- Be it resolved that the Scientific Program Committees of the American Neurotology Society and American Otological Society will select speakers and panel members endeavoring to balance educational goals while promoting the diversity of our respective Societies' memberships and educational offerings.

- Be it resolved the Executive Councils of the ANS and AOS will select participation at all levels of the organizations endeavoring to reflect diversity of our respective Societies' memberships.

2019 Spring Meeting CME Activity Planning

Practice gaps in Otology are identified through polling the registered AOS attendees at the close of our annual meeting by way of an online CME evaluation; this evaluation is required to receive CME credit. With the change to an online CME form in 2018, our response rate improved to nearly 90%. The responses are discussed in meetings of the AOS Council and Program Advisory committee. The evaluation is used as a tool to determine the success of the CME program in meeting program objectives, addressing professional practice gaps and educational needs. The responses are peer-reviewed by the Council prior to the next meeting to assist the Program Committee in developing future AOS Continuing Medical Education programs. The educational program is designed to address the topics identified as practice gaps through individual presentations and in-depth panel discussions. Based on the response, the following data regarding professional practice gaps among attendees were noted:

- The long-term consequences of auditory deprivation and hearing loss are not fully appreciated. Providing appropriate rehabilitation options such as amplification or assistive listening devices is important to maximize the child's development and capacities.
- Differences in the pathological states of ears with Eustachian tube dysfunction that can benefit from balloon dilation are not fully established nor routinely recognized. Lack of knowledge of these criteria impacts treatment choice and expected treatment outcomes.
- Electrode arrays designed to end up in different regions of the cochlea can have differences in current usage and non-auditory stimulation. These factors should be considered when selecting the ideal electrode array for a given patient.

The AOS chose these education formats because they have proven to be the optimal approaches that engage learners with direct impact on their knowledge and practice patterns. Panel discussions with experts in the field has been requested by attendees and highly rated as an effective format in previous meetings. Didactic presentations are focused on medical topics of high impact and interest to our attendees. Post-presentation question and answer periods facilitate knowledge and clarification for the participants. The American Otological Society is committed to improving public health care through the provision of high- quality continuing medical education to our members.

To close the identified practice gaps, participants of this activity will need to learn:

- Children with mild or unilateral hearing loss are frequently not provided rehabilitation options. Children with mild hearing loss and/or unilateral hearing loss must be provided with appropriate rehabilitation strategies and monitored.
- Balloon dilation of the Eustachian tube is used for a variety of different pathological states. Use of balloon dilation of the Eustachian tube should be based on clear criteria based on outcomes of clinical trial data.
- Surgeons should understand the rationale and potential benefits and pitfalls of different electrode arrays designed for placement in different regions of the scala. Clinicians should understand the consequences of placement of intracochlear electrodes on inner ear inflammation and vestibular tissues.

Learning Objective(s) - At the end of this activity, participants will be able to:

- Recognize the impact early hearing loss on development and performance.
- Implement appropriate selection criteria for use of balloon dilation of the Eustachian tube.
- Identify disadvantaged groups for cochlear implantation and create platforms to enhance access to this technology.

How will this educational activity improve competence, practice performance, and patient outcomes?

- This activity will increase the practitioner's awareness of the impact of early hearing loss on development and performance in children.
- This activity will increase the practitioner's knowledge of the various animal models of age-related hearing loss and how data from these models can be translated into understanding of the pathophysiology of human presbycusis.

Position Statement: Any presentations, conversations, exhibits, or other meeting communications, including descriptions of the use of drugs or devices, does not imply or constitute endorsement of any company, product, application, or use by the American Otological Society.

The following statement was read, submitted, and signed by every individual connected with this educational activity. Failure to comply disqualifies the individual from planning or speaking at any AOS Continuing Medical Education program.

Disclosure Information

In compliance with the ACCME Accreditation Criteria, the American College of Surgeons, as the accredited provider of this activity, must ensure that anyone in a position to control the content of the educational activity has disclosed all relevant financial relationships with any commercial interest. All reported conflicts are managed by a designated official to ensure a bias-free presentation. Please see the insert to this program for the complete disclosure list.

In accordance with the ACCME Accreditation Criteria, the American College of Surgeons, as the accredited provider of this activity, must ensure that anyone in a position to control the content of the educational activity has disclosed all relevant financial relationships with any commercial interest. Therefore, it is mandatory that both the program planning committee and speakers complete disclosure forms. Members of the program committee were required to disclose all financial relationships and speakers were required to disclose any financial relationship as it pertains to the content of the presentations. The ACCME defines a 'commercial interest' as "any entity producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients". It does not consider providers of clinical service directly to patients to be commercial interests. The ACCME considers "relevant" financial relationships as financial transactions (in any amount) that may create a conflict of interest and occur within the 12 months preceding the time that the individual is being asked to assume a role controlling content of the educational activity.

AOS is also required, through our joint providership partners, to manage any reported conflict and eliminate the potential for bias during the activity. All program committee members and speakers were contacted and the conflicts have been managed to our satisfaction. However, if you perceive a bias during a session, please report the circumstances on the online CME evaluation form.

Please note we have advised the speakers that it is their responsibility to disclose at the start of their presentation if they will be describing the use of a device, product, or drug that is not FDA approved or the off-label use of an approved device, product, or drug or unapproved usage.

The requirement for disclosure is not intended to imply any impropriety of such relationships, but simply to identify such relationships through full disclosure and to allow the audience to form its own judgments regarding the presentation.

PUBLICATION /SUBMISSION STATEMENT

The material in this abstract, has not been submitted for publication, published, nor presented previously at another national or international meeting and is not under any consideration for presentation at another national or international meeting.

The penalty for duplicate presentation/publication is prohibition of the author and co-authors from presenting at a COSM society meeting for a period of three years. Submitting Author's Signature (required All authors were advised that the submitted paper becomes the property of Otology & Neurotology and cannot be reprinted without permission of the Journal.

Duplicate abstract submission to more than one Society will result in the abstract being disqualified and it will not be considered for presentation on either the AOS or ANS programs.

THE AMERICAN OTOLOGICAL SOCIETY WOULD LIKE TO THANK THE FOLLOWING MEMBERS FOR THEIR CONTRIBUTION, TIME AND EXPERTISE TO ENSURE WE HAVE A TREMENDOUS 2019 AOS SCIENTIFIC PROGRAM

PROGRAM ADVISORY COMMITTEE

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David Friedland, MD
Ana H. Kim, MD
Miriam Redleaf, MD

Combined Poster Reception AOS, ANS, ASPO, TRIO
Friday, May 3, 2019
5:30 pm – 7:00 pm
JW Marriot Austin - *Griffin Hall—Level 2*

WIN Reception (Women in Neurotology)
Friday, May 3, 2019
6:00 – 7:00
JW Marriot Austin - *Level 2-203-204*

AOS President's Reception & Banquet
Saturday, May 4, 2019
Reception - 6:30-7:15 pm
Dinner/Dance - 7:15 to 10:30pm
JW Marriot Austin - *Grand Ballroom 1-3*
Formal attire/Black tie optional *(Advanced Reservations Required, Members and Invited Guests only)*

UPCOMING MEETINGS

ANS "Super Saturday" - September 14, 2019
AAO-HNSF Annual Meeting & OTO EXPO
September 15-18, 2019
Hilton Riverside - New Orleans, LA

153rd Annual AOS Spring Meeting (in conjunction with COSM)
April 24–26, 2020 - Hilton Atlanta - Atlanta, Georgia

The Abstract deadline for the AOS 153rd Annual meeting is Tuesday, October 15, 2019. Abstract Instructions and submission form will be available on the website July 15th.
Website - www.americanotologicalsociety.org

All primary and contributing authors are required to complete a disclosure/conflict of interest statement at time of abstract submission in order for the abstract to be considered by the Program Advisory Committee.

Journal Requirements/Instructions to Primary Authors

Manuscripts are required of ALL ORAL presentations. Manuscripts must be submitted online a minimum of four weeks prior to the annual meeting, via the journal's website. Instructions for registering, submitting a manuscript, and the author guidelines can be found on the Editorial Manager site: https://www.editorialmanager.com/on/

The journal of OTOLOGY & NEUROTOLOGY does not accept paper manuscripts. Manuscripts will be peer reviewed prior to the Annual meeting for conflict of interest review and resolution.

Failure to comply with the guidelines & requirements of the American Otological Society and the O&N Journal will result in the disqualification of your presentation.

For Society business, please forward all inquiries to:

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AMERICAN OTOLOGICAL SOCIETY
152nd Annual Meeting
SCIENTIFIC PROGRAM
May 3-5, 2019
JW Marriott Austin
Austin, TX

SATURDAY, MAY 4, 2019

1:00 BUSINESS MEETING *(New member introduction)*
(Members Only)

1:20 SCIENTIFIC PROGRAM
(*Open to registered Members and Non-members – Badge required for admittance*)

1:20 WELCOME & OPENING REMARKS BY THE PRESIDENT
Carol A. Bauer, MD

PRESIDENTIAL CITATIONS
Herman A. Jenkins, MD
Miriam I. Redleaf, MD
Debara L. Tucci, MD
Horst R. Konrad, MD

1:30 GUEST OF HONOR LECTURE
Age-related Hearing Loss: Translation from Animals Models to Human Hearing
Judy R. Dubno, PhD
Department of Otolaryngology-Head and Neck Surgery
Medical University of South Carolina

1:55 INTRODUCTION

1:56 Effect of Vitamin D Deficiency and Rickets on Hearing Loss in Children
Charmee H. Mehta, BSPH
Michaela F. Close, BS
James R. Dornhoffer, MD
Yuan F. Liu, MD
Shaun A. Nguyen, MD
Teddy R. McRackan, MD, MSCR
Ted A. Meyer, MD, PhD

2:03 Factors Influencing Duration of Hearing Loss Prior to Cochlear Implantation
James R. Dornhoffer, MD
Meredith Holcomb, AuD
Ted A. Meyer, MD, PhD
Judy R. Dubno, PhD
Teddy R. McRackan, MD, MSCR

2:10 Systematic Review and Network Meta-analysis of Cognitive and/ or Behavioral Therapies (CBT) for Tinnitus
Evie C. Landry, DSS, MD, MSc
Calla N. Simeone, BA, MSc
Xochitl Citlalli Romo Sandoval, BSc, MSc

Brian D. Westerberg, MD, MHSc
Jane Lea, BSc, MD
Glynnis Tidball, BA, DipAL, MSc (Aud, SLP)

2:17 Effect of Malnutrition on Hearing Loss in Children
Michaela F. Close, BS
Charmee H. Mehta, BSPH
James R. Dornhoffer, MD
Yuan F. Liu, MD
Shaun A. Nguyen MD
Teddy R. McRackan, MD, MSCR
Ted A. Meyer, MD, PhD

2:24 DISCUSSION

2:30 SAUMIL N. MERCHANT MEMORIAL LECTURE
Say What? Brief Periods of Hearing Loss during Early Development Can Have Consequences Later in Life
Daniel J. Tollin, PhD
Department of Physiology and Biophysics
University of Colorado School of Medicine

2:55 BREAK WITH EXHIBITORS

3:25 Polymorphisms in NLRP3 Inflammasome May Increase Host Susceptibility to Acquired Cholesteatoma
Neel R. Sangal, BA
Marcus Elias, BS
Biju Joseph, PHD
Luis Ulloa, PHD
Robert Jyung, MD

3:32 Change in Eustachian Tube Function with Balloon Dilation
Cuneyt M. Alper, MD
Miriam S. Teixeira, MD, PhD
Tanya J. Rath, MD
Denise Hall-Burton, MD
J. Douglas Swarts, PhD

3:39 Balloon Dilation for Eustachian Tube Dilatory Dysfunction in Children
Joonas Toivonen, MD
Kosuke Kawai, ScD
Dennis Poe, MD, PhD

3:46 Toll-like Receptor 4 Signaling and Downstream Neutrophilic Inflammation Mediate Endotoxemia-Enhanced Blood-Labyrinth Barrier Trafficking
Zachary D. Urdang, PhD
Jessica L. Bills, BS
David Y. Cahana, BS
Leslie M. Muldoon, PhD
Edward A. Neuwelt, MD

3:53 Quinolone Ear Drops Cause Perforations in Intact Rat Tympanic Membranes
Carolyn O. Dirain, PhD
David N. Karnani, BS
Patrick J. Antonelli, MD

4:00 DISCUSSION

4:05 PANEL
Pediatric Mild and Unilateral Hearing Loss: New Data
Karen J. Enright, MD, PhD, Moderator
Samantha Anne, MD, MS
David Friedmann, MD
Judith Lieu, MD, MSPH

5:00 DISCUSSION

5:10 CLOSING REMARKS/ADJOURNMENT

SUNDAY, MAY 5, 2019

7:00 BUSINESS MEETING *(Committee Reports)*
(Members Only)

7:30 SCIENTIFIC PROGRAM
(Open to registered Members and Non-members – Badge required for admittance)

7:30 WELCOME & OPENING REMARKS BY THE PRESIDENT
Carol A. Bauer, MD

7:35 Results from a Second-Generation Vestibular Implant in Human Subjects: Diagnosis May Impact Electrical Sensitivity of Vestibular Afferents
Jay T. Rubinstein, MD, PhD
James O. Phillips, PhD
Leo Ling, PhD
Kaibao Nie, PhD
Amy Nowack

7:42 Vestibular End Organ Preservation in the Implanted Cochlea
Brooke M. Su, MD, MPH
Ivan A. Lopez, PhD
Gail Ishiyama, MD
Akira Ishiyama, MD

7:49 Quantification of Cognitive Dysfunction in Dizzy Patients using the Neuropsychological Vertigo Inventory
Yuan F. Liu, MD
Taylor D. Locklear, BS
Jeffrey D. Sharon, MD
Shaun A. Nguyen, MD
Habib G. Rizk, MD

7:56 A Cohort Study Comparing Importance of Clinical Factors in Determining Diagnosis and Treatment for Superior Semicircular Canal Dehiscence Syndrome
Lisa Zhang, BS, BA
Francis X. Creighton Jr, MD
John P. Carey, MD

8:03 The cVEMP as a Prognostic Tool for Development of Bilateral Meniere's Disease
Kimberley S. Noij, MD
Barbara S. Herrmann, PhD
John J. Guinan Jr.. PhD
Steven D. Rauch, MD

8:10 Imaging is Not Indicated in the Investigation of Isolated Objective Vestibular Weakness
Deanna Gigliotti, MSc
Brian Blakley, MD
Paige Moore, MD
Jordan Hochman, MD

8:17 DISCUSSION

8:25 AOS CLINICIAN SCIENTIST AWARD PRESENTATION
Hearing Loss and Dementia: Where Are We Now?
Richard K. Gurgel, MD
University of Utah

8:40 Impact of Underlying Diagnosis on Speech and Quality of Life Outcomes after Cochlear Implantation for Single-Sided Deafness
Tiffany Peng, MD (Primary)
Joshua J. Sturm, MD, PhD (Presenter)
Abby Owen
Megan Kuhlmey, AuD
Ilana P. Cellum, AuD
Lawrence R. Lustig, MD
Ana H. Kim, MD

8:47 Prevalence of Xerostomia Among Cochlear Implant Recipients - A Cross-Sectional Survey
Heather M. Weinreich, MD, MPH
Benjamin Ostrander, MSE
Seth E. Pross, MD
Howard W. Francis, MD, MBA

8:54 Identifying Disadvantaged Groups for Cochlear Implantation: Demographics from a Large Cochlear Implant Program
Natalie Schauwecker, BBA, BS
Anthony M. Tolisano, MD
Bethany Baumgart, AuD
Johanna Whitson, AuD
J. Walter Kutz, MD
Brandon Isaacson, MD
Jacob B. Hunter, MD

9:01 Lateral Wall Electrodes Increase the Rate of Post-Activation Non-Auditory Percepts
Adam C. Kaufman, MD, PhD
James G. Naples, MD
Douglas C. Bigelow, MD
Steven J. Eliades, MD, PhD
Hannah S. Kaufman, AuD
Michael J. Ruckenstein, MD

9:08 Cochlear Implantation with a Slim, Modiolar Array
Jonathan L. McJunkin, MD
Nedim Durakovic, MD
Jacques Herzog, MD
Cameron C. Wick, MD
Craig A. Buchman, MD

9:15 Controlled Microperforation of Human Round Window Membrane in Situ
Harry Chiang, BA
Michelle Yu, BS
Wenbin Wang, MS
Aykut Aksit, MS
Miguel Arriaga, PhD
Jeffrey W. Kysar, PhD
Anil K. Lalwani, MD

9:22 DISCUSSION

9:28 COFFEE BREAK

9:50 Regular Wave Patterns on Ambient Pressure Tympanometry in Patients with Pulsatile Tinnitus-associated Pathologies
Anthony Thai, BA
Zahra N. Sayyid, BS
Davood K. Hosseini, MD
Yifei Ma, MS
Austin Swanson, AuD
Matthew Fitzgerald, PhD
Yona Vaisbuch, MD

9:57 Assessment of Hearing-Aid Benefit through Patient-Reported Outcomes
James R. Dornhoffer, MD
Ted A. Meyer, MD, PhD
Judy R. Dubno, PhD
Teddy R. McRackan, MD, MSCR

RESIDENT RESEARCH TRAVEL AWARD

10:04 Immune Response of Macrophage Population to Cochlear Implantation
Kathryn Y. Noonan, MD
Ivan Lopez, PhD
Gail Ishiyama, MD
Akira Ishiyama, MD

10:11 The Future of Cochlear Implant
Juichi Ito, MD, PhD

10:18 Evaluation of Intracochlear Trauma with Manual and Robotic-assisted Cochlear Implant Insertion
Christopher R. Kaufmann, MD
Allan M. Henslee, PhD
Marlan R. Hansen, MD

10:25 Effect of Laser Stapedotomy on Intracochlear Pressure Measurements
Emily S. Misch, MD
Renee M. Banakis Hartl, MD,
AuD Samuel P. Gubbels, MD
Nathaniel T. Greene, PhD

RESIDENT RESEARCH TRAVEL AWARD

10:32 Utility of Perilymph microRNA Sampling for Identification of Active Gene Expression Pathways in Otosclerosis
Helena Wichova, MD
Matthew Shew, MD
Hinrich Staecker, MD, PhD

10:39 DISCUSSION

10:50 PANEL

Looking Through the rEARview Mirror: Unexpected Challenges in Endoscopic Ear Surgery
Maura K. Cosetti, MD, Moderator
Alicia M. Quesnel, MD
Alejandro Rivas, MD
Brandon Isaacson, MD
Erika A. Woodson, MD

11:50 DISCUSSION/COMMENTS

12:00 INTRODUCTION OF INCOMING PRESIDENT
John P. Carey, MD

12:05 CLOSING REMARKS/ADJOURNMENT

SELECTED ABSTRACTS

ORAL PRESENTATIONS

IN ORDER OF PRESENTATION

152nd Annual Meeting
AMERICAN OTOLOGICAL SOCIETY

May 3-5, 2019
JW Marriott Austin
Austin, TX

Effect of Vitamin D Deficiency and Rickets on Hearing Loss in Children

Charmee H. Mehta, BSPH; Michaela F. Close, BS; James R. Dornhoffer, MD
Yuan F. Liu, MD; Shaun A. Nguyen, MD
Teddy R. McRackan MD; Ted A. Meyer, MD, PhD

Objective: To characterize how vitamin D deficiency and rickets influences hearing loss (HL) in children.

Study design: Retrospective review.

Setting: Tertiary referral hospital.

Patients: Children in the Audiological and Genetic Database with a diagnosis of vitamin D deficiency or rickets.

Intervention: none

Main outcome measures: Prevalence, type, severity (4-tone pure-tone average, PTA), and progression of HL.

Results: Of 1197 children with vitamin D deficiency, 751 (62.7%) had HL, with 19.4% having at least moderate HL. 25.4% had conductive, 9.3% sensorineural, and 30.8% had mixed hearing loss. 34.5% had undefined HL with audiograms obtained in a sound-field without bone-conduction thresholds. Children with rickets had a significantly higher rate of HL (79% vs 61%, $p<0.001$) and more HL at baseline (30.0 dB vs 22.5 dB, $p=0.002$) than those with vitamin D deficiency only. Over a median follow-up of 2.0 years (IQR 0.3-4.7), children with rickets continued to display hearing loss (23.8 dB vs 17.5 dB, $p=0.001$). Furthermore, children with femur fractures were more likely to have HL than those without femur fractures (86% vs 62%, $p=0.006$). As these children age, the prevalence of sensorineural hearing loss increases significantly: children 6 years or younger (4%), children 6-12 (9%, $p=0.002$), and children older than 12 (14%, $p<0.001$).

Conclusions: HL is highly prevalent in children with vitamin D deficiency. Children with rickets have a significantly higher prevalence and increased severity compared to children with vitamin D deficiency only. Increased age with deficiency is associated with increased prevalence of sensorineural HL, suggesting age-dependent vulnerability to vitamin D deficiency–related HL.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge regarding influence of vitamin D deficiency and rickets on hearing loss in children.

Learning Objective: To characterize how vitamin D deficiency and rickets influences hearing loss (HL) in children.

Desired Result: Consideration of vitamin D deficiency and rickets as an indicator for audiological screening.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Exempt

Factors Influencing Duration of Hearing Loss Prior to Cochlear Implantation

James R. Dornhoffer, MD; Meredith Holcomb, AuD; Shaun A. Nguyen MD
Ted A. Meyer, MD, PhD; Judy R. Dubno, PhD; Theodore R. McRackan, MD, MSCR

Objective: Determine the impact of demographic and audiologic factors on duration of hearing loss prior to cochlear implantation.

Study design: Retrospective review of a prospectively maintained cochlear implant database

Setting: University-based tertiary medical center

Patients: 492 patients undergoing cochlear implantation from 2012 to 2018

Interventions/main outcomes measured: Multivariate analysis was performed to establish independent associations between demographic/audiologic factors and duration of hearing loss before cochlear implantation, which is a known predictor of poorer cochlear implant outcomes.

Results: When controlling for other variables, non-white patients had increased duration of hearing loss prior to cochlear implantation when compared to white patients (HR=0.157, p=0.038). Although these patients had higher aided pure-tone averages (46.3 vs. 37.1 dB HL) and lower aided speech recognition scores (CNC quiet 9.4% vs 19.3% and AzBio quiet 11.4% vs. 22.9%), non-whites were less likely to have worn hearing aids prior to cochlear implantation (40.0% vs. 67.5%; all $p<0.001$). Increased age showed a weak positive association with duration of hearing loss. No independent relationships were noted between duration of hearing loss prior to implantation and sex (p=0.19), insurance type (p=0.26), pre-operative hearing aid use (p=0.17), or other audiologic factors.

Conclusion: These results demonstrate that non-white patients have significant delays in treatment for moderate-to-profound sensorineural hearing loss, which may impact their use and benefit from cochlear implantation. Additional research is needed to determine the factors that contribute to significant treatment delays, which may include reduced access to hearing healthcare.

Define Professional Practice Gap & Educational Need: There is a lack of awareness of the impact of racial and demographic factors on length of time before cochlear implantation.

Learning Objective: Practitioners will be made aware of the impact of the at risk status of non-white patients for delayed presentation for cochlear implant evaluation and increased length of time before cochlear implantation.

Desired Result: Practitioners will be able to focus on at-risk populations in their community, in order to expedite cochlear implant evaluation and encourage routine hearing health care in these populations. Due to the association of length of deafness before implantation and cochlear implant outcomes, this focus will ideally offer non-white patients the best opportunity for success with cochlear implantation.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Systematic Review and Network Meta-analysis of Cognitive and/or Behavioral Therapies (CBT) for Tinnitus

Evie C. Landry, DSS, MD, MSc; Calla N. Simeone, BA, MSc
Xochitl Citlalli Romo Sandoval, BSc, MSc; Brian D. Westerberg, MD, MHSc
Jane Lea, BSc, MD; Glynnis Tidball, BA, DipAL, MSc (Aud, SLP)

Objective: To evaluate the efficacy of cognitive and/or behavioral therapies in improving health-related quality of life (HRQOL), depression and anxiety associated with tinnitus.

Data Sources: EMBASE, MEDLINE, Pubmed, PsycINFO and the Cochrane Registry were used to identify english studies from database inception until February 2018.

Study Selection: Randomized controlled trials(RCTs) comparing cognitive and/or behavioral therapies to one another or to waitlist controls for the treatment of tinnitus were included.

Data extraction: Quality and risk were assessed using GRADE and Cochrane's Risk of Bias tool respectively.

Data synthesis: Pairwise meta-analysis (12 RCTs:1,144 patients) compared psychological interventions to waitlist controls. Outcomes were measured using standardized mean differences(SMDs) and 95% confidence intervals(CI). I2 and subgroup analyses were used to assess heterogeneity. Network meta-analysis(NMA) (19 RCTS:1,543 patients) compared psychological therapies head-to-head. Treatment effects were presented by network diagrams, interval plots and ranking diagrams indicating SMDs with 95%CI. Direct and indirect results were further assessed by inconsistency plots.

Conclusions: Results are consistent with previously published guidelines indicating that CBT is an effective therapy for tinnitus. While guided self-administered forms of CBT had larger effect sizes (SMD:3.44; 95% CI:-.022,7.09; I2:99%) on tinnitus HRQOL, only face-to-face CBT was shown to make statistically significant improvements (SMD:0.75; 95%CI:0.53,0.97; I2:0%). Guided self-administered CBT had the highest likelihood of being ranked first in improving tinnitus HRQOL(75.1%), depression(82.7%) and anxiety(87.2%), though statistically insignificant. This NMA is the first of its kind in this therapeutic area and provides new insights on the effects of different forms of cognitive and/or behavioral therapies for tinnitus.

Define Professional Practice Gap & Educational Need: 1. Tinnitus presents a major burden on health care systems with up to 21% of the general adult population being affected (Kim 2015). Although a wide range of therapies exists for the treatment of subjective tinnitus, none have proven to be curative. 2. Psychological therapies have been widely adopted due to evidence showing that disabling secondary effects depend more on psychological rather than acoustic properties (Cima 2014). 3. Given that health systems have increasing pressures to provide cost-effective services, policy-makers depend on the results of rigorously designed systematic reviews to inform important decisions about service provision.

Learning Objective: The learning objective will be to evaluate the efficacy of cognitive-behavioral therapy (CBT) compared to waitlist or other forms of cognitive or behavioral therapies, for the treatment of tinnitus in adults.

Desired Result: 1. Desired results will be to provide updated evidence that reconfirms the findings of previously published meta-analyses and Cochrane Reviews that CBT is an effective form of therapy for tinnitus. 2. This network meta-analysis, being the first of its kind in this therapeutic area, will provide new insights on the effects of different forms of cognitive and/or behavioral therapies for tinnitus and will explore how the method of delivery influenced results.

Level of Evidence: LEVEL I - Large RCTs with clear cut results

IRB- Exempt

Effect of Malnutrition on Hearing Loss in Children

Michaela F. Close, BS; Charmee H. Mehta, BSPH; James R. Dornhoffer, MD
Yuan F. Liu, MD; Shaun A. Nguyen MD
Teddy R. McRackan, MD; Ted A. Meyer, MD, PhD

Objective: To characterize the relation between malnutrition and hearing loss (HL) in children.

Study design: Retrospective review.

Setting: Tertiary referral hospital.

Patients: Children in the Audiological and Genetic Database with a diagnosis of protein-calorie malnutrition, marasmus, and/or kwashiorkor.

Interventions: none

Main outcome measures: Prevalence, type, severity (4-tone pure-tone average, PTA), and progression of HL.

Results: Of 846 children with malnutrition, 597 (70.6%) had HL, with 24.0% having at least moderate HL. Prevalence and severity of hearing loss did not differ by age, but children older than 3 years were more likely to have sensorineural HL (OR=2.36, CI 1.33-4.20). Prevalence of HL did not differ among children with different severities of malnutrition, but severely malnourished children showed significantly worse initial (33.8 dB vs 20 dB, p=0.004) and final PTA (28.8 dB vs 18.8 dB, p=0.002) over a median follow up time of 1.2 years (IQR 0.6-2.9). Severely malnourished children also had significantly higher odds of sensorineural HL (OR=2.51, CI 1.24-5.23) and mixed HL (OR=1.62, CI 1.04-2.52). Among malnourished children, those with short stature had more severe initial HL (25.0 dB vs 21.25, p=0.007). Further analysis of the influence of otolaryngologic and nutritional comorbidities on severity and progression of HL will be discussed.

Conclusions: Prevalence of HL is high in malnourished children. Severe malnutrition was associated with greater severity of HL, less improvement over time, and worse hearing in general than lesser degrees of malnutrition.

Define Professional Practice Gap & Educational Need: Lack of awareness about the relation between malnutrition and hearing loss

Learning Objective: To characterize the relation between malnutrition and hearing loss in children

Desired Result: Malnutrition should be considered as an indicator for audiological screening and earlier intervention

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Exempt

Polymorphisms in NLRP3 Inflammasome May Increase Host Susceptibility to Acquired Cholesteatoma

Neel R. Sangal, BA; Marcus Elias, BS; Biju Joseph, PhD
Luis Ulloa, PhD; Robert Jyung, MD

Introduction: Recently, inflammation mediated by the nucleotide-binding domain, leucine-rich repeat containing protein 3 (NLRP3) complex has been implicated in the pathogenesis of acquired cholesteatoma. We aim to investigate the incidence and association of polymorphisms in inflammasome associated genes NLRP3 and CARD8 with acquired cholesteatoma formation.

Methods: This is a cross-sectional study assessing rates of mutation in genes of interest in patients with and without cholesteatoma. Based on power analyses on genotype frequency, a total of 132 saliva samples were collected from acquired cholesteatoma patients (n=67) and control patients (n=65) for DNA extraction. Taq-Man SNP genotyping quantitative polymerase chain analysis was utilized to assess the frequency of NLRP3 (QQ- normal, QK- heterozygous, KK- homozygous polymorphism) and CARD8 (CC, CX, XX) polymorphisms. Comparative statistics between the acquired cholesteatoma and control cohort used chi-squared testing with $p<0.05$ considered significant.

Results: The CARD8 homozygous polymorphism XX held significantly higher rates in the acquired cholesteatoma group (28% vs. 11%, p=0.036). The CARD8 CC (31% cholest vs. 42% control, p=0.421) and CX (40% cholest vs. 46% control, p=0.284) polymorphisms did not demonstrate significant variability between groups. The NLRP3 polymorphisms QQ (88% cholest vs. 94% control, p=0.74) and QK (6% cholest vs. 10% control, p=0.84) showed no significant differences in rates. Only 1 patient with cholesteatoma presented with homozygous polymorphism of the NLRP3 gene.

Conclusions: The CARD8 homozygous polymorphsim showed significantly increased rates in the acquired cholesteatoma cohort. These findings raise significant questions for future study in understanding the pathogenesis of acquired cholesteatoma.

Define Professional Practice Gap & Educational Need: Lack of basic knowledge about the pathogenesis of bone erosion in cholesteatoma on a biomolecular level.

Learning Objective: We hope to identify a novel causal mechanism for aquired cholesteatoma and introduce ideas for future study.

Desired Result: Researchers will be able to use the knowledge gained from the presentation to develop methods to study the effects of inflammation on bone erosion in cholesteatoma.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

Change in Eustachian Tube Function with Balloon Dilation

Cuneyt M. Alper, MD; Miriam S. Teixeira, MD, PhD; Tanya J. Rath, MD
Denise Hall-Burton, MD; J. Douglas Swarts, PhD

Objective: Assess the Eustachian tube (ET) function (ETF) outcomes of balloon dilation of Eustachian tube (BDET)

Study design: Prospective cohort for repeated testing outcomes

Setting: Clinical Research Center

Patients: Ten adults with unilateral or bilateral ventilation tubes (VTs) inserted for otitis media with effusion and verified ET dysfunction (ETD) with advanced test methodology

Intervention: Unilateral balloon dilation of ET

Main outcome measures: Changes in the passive and active muscular properties with BDET, assessed by ETF tests including Forced Response Test (FRT), Inflation Deflation Test (IDT), Pressure Chamber tests and pre- post-operative functional CT scans.

Results: With the FRT, the Opening pressure (OP) at 11 ml/min was 473±167 daPa before the BDET, changing to 341±200 daPa at the 6-month post-BDET visit. Closing pressure (CP) at 11 ml/min was 161±146 daPa before the BDET and changed 93±82 daPa at the 6-month post-BDET visit. Ability to correct positive and negative MEP gradient improved from 28±34% and %20±28% to 76±65% and %29±34% respectively. The images from the pre- and post-BDET functional CT scans did not show apparent changes in the anatomy in most subjects. However, during the limited duration of follow-up most subjects continued to have ETD and need VTs. Passive properties of the ET have changed, the ET was easier to open and it stayed open longer with likely decreased peri-tubal tissue pressures, and there was more effective muscular function.

Conclusions: Adults with VTs may benefit from BDET, however severe ETD may not completely resolve, and patients may continue to need VTs.

Define Professional Practice Gap & Educational Need: Lack of knowledge of indications and testing criteria for, and test results and outcomes of the Eustachian tube balloon dilation

Learning Objective: Learn the indications and testing criteria for, and test results and outcomes of the Eustachian tube balloon dilation

Desired Result: Attendees will seek more information regarding the indications and testing criteria for, and test results and outcomes of the Eustachian tube balloon dilation, and apply this to their practice

Level of evidence does not apply because: This is a prospective longitudional follow-up and outcomes study of repeat testing on the same cohort with unique set of advanced test methods, before and after an intervention

IRB - Approved

Balloon Dilation for Eustachian Tube Dilatory Dysfunction in Children

Joonas Toivonen, MD; Kosuke Kawai, ScD; Dennis Poe, MD, PhD

Objective: To determine the safety and efficacy of balloon dilation of the Eustachian tube (ET) in pediatric patients

Study design: Retrospective case-controlled series

Setting: Tertiary medical center

Patients: Pediatric patients (<18 years) with persistent (≥2 years) recurrent or chronic otitis media with previous tympanostomy tube insertion vs case controls

Intervention(s): Balloon dilation of the cartilaginous ET (BDET) was performed under general anesthesia using concomitant myringotomy with/without tube placement if indicated. Adjunctive adenoidectomy, turbinectomy and/or tympanoplasty were used in selected cases. For suspected disease in the bony ET, an illuminated guidewire was used for probing and clearing the lumen.

Main outcome measure(s): Outcome measures were tympanogram, audiogram, otomicroscopy, ET mucosal inflammation score, Valsalva maneuver.

Results: 48 ETs (27 patients), ages 7 – 17 years (mean 12.5, SD 3.2) underwent BDET. Follow-up ranged from 0.23 to 3.15 years (mean 1.3 years, SD = 0.9). Significant improvements were observed for all measures (p<0.01). Tympanic membranes were healthy in 8% of cases preoperatively, 39% at 6 months (n=41), 52% at 12 months (n=29) and 75% at 36 months (n=12) postoperatively. Tympanograms improved to type A in 47% of cases at 6 months, 56% at 12 months, and 82% at 36 months. Mean scores of mucosal inflammation declined from preoperative 3.2 (± 0.5) to postoperative 2.5 (± 0.7) at 6 months and 1.7 (± 0.6) at 36 months. Complications included 2 cases of patulous ET that resolved over months.

Conclusions: BDET is a safe and possibly effective procedure in selected pediatric patients with recurrent or chronic otitis media

Define Professional Practice Gap & Educational Need: Balloon dilation of the Eustachian tube (ET) is used in the treatment of dilatory dysfunction of the ET. There are very few publications on the results of balloon dilation of the ET (BDET) in the pediatric population.

Learning Objective: Physicians should be aware that BDET is a safe and possibly effective procedure in selected pediatric patients with recurrent or chronic otitis media.

Desired Result: Attendees will be able to consider BDET as a treatment for pediatric patients with recurrent or chronic otitis media.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

Toll-like Receptor 4 Signaling and Downstream Neutrophilic Inflammation Mediate Endotoxemia-Enhanced Blood-Labyrinth Barrier Trafficking

Zachary D. Urdang, PhD; Jessica L. Bills, BS; David Y. Cahana, BS
Leslie M. Muldoon, PhD; Edward A. Neuwelt, MD

Hypothesis: Both toll-like receptor 4 (TLR4) and downstream neutrophil activity are required for endotoxemia-enhanced blood-labyrinth barrier (BLB) trafficking.

Background: Aminoglycoside and cisplatin are valuable clinical therapies; however, these drugs often cause life-long hearing loss. Endotoxemia enhances the ototoxicity of aminoglycosides and cisplatin in a TLR4 dependent mechanism for which downstream pro-inflammatory signaling orchestrates effector immune cells including neutrophils. Neutrophil-mediated vascular injury (NMVI) can enhance molecular trafficking across endothelial barriers and may contribute to endotoxemia-enhanced drug-induced ototoxicity.

Methods: Lipopolysaccharide (LPS) hypo-responsive TLR4-KO mice and congenitally neutropenic granulocyte colony stimulating factor (GCSF) GCSF-KO mice were studied to investigate the relative contributions of TLR4 signaling and downstream neutrophil activity to endotoxemia-enhanced BLB trafficking. C57Bl/6 wild-type mice were used as a positive control. Mice were treated with LPS and 24 hours later cochleae were analyzed for gene transcription of innate inflammatory cytokine/chemokine signaling molecules, neutrophil recruitment, and vascular trafficking of the paracellular tracer biocytin-TMR.

Results: Cochlear transcription of innate pro-inflammatory cytokines/chemokines was increased in endotoxemic C57Bl/6 and GCSF-KO, but not in TLR4-KO mice. More neutrophils were recruited to endotoxemic C57Bl/6 cochleae compared to both TLR4- and GCSF-KO cochleae. Endotoxemia enhanced BLB trafficking of biocytin-TMR in endotoxemic C57Bl/6 cochleae and this was attenuated in both TLR4- and GCSF-KO mice.

Conclusion: Together these results suggest that TLR4-mediated innate immunity cytokine/chemokine signaling alone is not sufficient for endotoxemia-enhanced trafficking of biocytin-TMR and that downstream neutrophil activity is required to enhance BLB trafficking. Clinically, targeting neutrophilic inflammation could protect hearing during aminoglycoside, cisplatin, or other ototoxic drug therapies.

Define Professional Practice Gap & Educational Need: 1. Knowledge about role of the neutrophil in blood-labyrinth barrier permeability .

Learning Objective: 1. Understand how innate neutrophilic inflammation perturbs blood-labyrinth barrier permeability. 2. Understand the role of toll-like receptor 4 in innate immune signaling. 3. Understand how neutrophil mediated vascular injury may influence blood-labyrinth barrier trafficking and permeability.

Desired Result: Understand the hypothetical clinical applications for how endotoxemia, sepsis, and neutrophils interact and can affect blood-labyrinth physiology.

Level of evidence does not apply because: Basic Science Study

IRB - Approved

Quinolone Ear Drops Cause Perforations in Intact Rat Tympanic Membranes

Carolyn O. Dirain, PhD; David N. Karnani, BS
Patrick J. Antonelli, MD

Hypothesis: Quinolone ear drops promote the development of perforations (TMPs) in intact tympanic membrane (TMs).

Background: Quinolone ear drops have been associated with TMPs after tympanostomy tubes in children. In the rat, these agents demonstrated cytoxicity in TM fibroblasts and impairment of TM healing following myringotomy in a drug-specific manner and potentiation by steroids.

Methods: Rats were randomized to 6 groups (10/group), with one ear receiving otic instillation of 30 µL of dexamethasone, ofloxacin, ciprofloxacin, ofloxacin+dexamethasone, ciprofloxacin+dexamethasone, or neomycin—all at standard clinical concentrations—and the contralateral ear receiving saline, twice daily for 10 days. The TMs were assessed over 28 days.

Results: No TMPs were seen in ears treated with saline, dexamethasone and neomycin. At day 10, TMPs were seen in 1 of 10 ofloxacin- and 3 of 10 ciprofloxacin+dexamethasone-treated ears (p=0.038). At day 14, the ofloxacin TMP healed. In contrast, the 3 ciprofloxacin+dexamethasone TMPs remained and one new TMP developed in this group, a ciprofloxacin, and an ofloxacin+dexamethasone-treated ears also have TMPs (p=0.02). By day 21, the ofloxacin+dexamethasone TMP and 2 of 4 of the ciprofloxacin+dexamethasone TMPs healed but two new TMPs were seen in ciprofloxacin+dexamethasone ears and one new TMP developed in the ofloxacin+dexamethasone-treated ears (p=0.02). At day 28, 1 of 10 ciprofloxacin, 1 of 10 ofloxacin+dexamethasone, and 4 of 10 ciprofloxacin+dexamethasone-treated ears have TMPs (p=0.02).

Conclusions: Application of quinolone ear drops can cause TMPs in intact TMs. This effect appears to be drug-specific and potentiated by steroids, as noted in prior studies.

Define Professional Practice Gap & Educational Need: The use of quinolone ear drops, specifically ciprofloxacin and ofloxacin, has risen dramatically over the past 15 years. This is largely because of their perceived absence of undesirable side effects, and concerns over ototoxicity of alternative agents, such as aminoglycoside ear drops (eg, neomycin). Ciprofloxacin and ofloxacin are the only antibiotics approved by the U.S. Food and Drug Administration for instillation into the middle ear. Earlier findings from tissue culture, animal, and epidemiological studies have shown that quinolones impair TM healing and increase the risk of permanent TMPs. These effects appear to be aggravated by steroids. It is unclear whether quinolone ear drops also increases the risk of TMP in intact TMs.

Learning Objective: At the conclusion of this presentation, the attendees will learn that quinolone ear drops can cause TMPs in intact TMs, ciprofloxacin appears to impart a greater risk than ofloxacin, and this effect is potentiated by the addition of dexamethasone.

Desired Result: Attendees may be able to apply this knowledge by considering the potential adverse impact of quinolone ear drops on TMs when prescribing antimicrobial ear drops.

Level of Evidence - Does not apply

IRB - IACUC approved

Results from a Second-Generation Vestibular Implant in Human Subjects: Diagnosis May Impact Electrical Sensitivity of Vestibular Afferents

Jay T. Rubinstein, MD, PhD, Leo Ling, PhD, Kaibao Nie, PhD
Amy Nowack; James O. Phillips, PhD

Objective: To report auditory and vestibular outcomes after placement of a combined vestibular and cochlear implant in Meniere's disease (MD) and in sudden hearing and vestibular loss.

Study Design: Retrospective case studies

Setting: Tertiary referral center

Patients: Two human subjects received a second-generation vestibular implant that also includes a Hybrid-L intracochlear array. Subject one had sudden hearing and vestibular loss on the left ten years prior to implantation. She had subsequent symptoms and laboratory findings of bilateral vestibular loss. Subject two had bilateral Meniere's disease for over forty years with resolution of acute attacks but subsequent symptoms and laboratory findings of bilateral vestibular loss. Both subjects had severe-profound deafness in the left ear.

Intervention: Left ear implantation of a combined vestibular and cochlear implant. Electrode positions confirmed by temporal bone CT.

Main Outcome Measures: Electrically-evoked vestibular and cochlear compound action potentials (ECAPs), cochlear implant speech perception, electrically-evoked slow-phase eye velocities, and electrically-evoked vestibular percepts.

Results: Subject one had no intraoperative or postoperative vestibular ECAP measurable, but normal cochlear ECAPs and cochlear implant function in the expected range. She had minimal perceptual or eye-movement response to vestibular stimulation. Subject two had intraoperative ECAPs from two of three canals and normal cochlear ECAPs. Postoperatively, this subject had the largest slow-phase eye velocities to electrical vestibular stimulation that we have seen in humans, exceeding 100 degrees per second in the lateral semicircular canal. Her cochlear implant function is also in the normal range.

Conclusion: In these two subjects, the underlying cause of vestibular loss appears to have a profound impact on electrical sensitivity of vestibular afferents. No such effect was seen with cochlear nerve excitability. If this dichotomy is seen in more subjects, it may limit the potential application of vestibular implants to those diagnoses associated with preserved electrical sensitivity of vestibular afferents. We speculate that the dichotomy is due to anatomical differences between Scarpa's and the spiral ganglion. In one subject, the second-generation device is capable of producing much higher velocity electrically-evoked eye movements than in the four subjects who received the first-generation device.

Define Professional Practice Gap & Educational Need: Lack of knowledge about the clinical feasibility of vestibular implants

Learning Objective: Learn about progress in the development of vestibular implants

Desired Result: Reasonable expectations for the pace of device development

Level of evidence does not apply because: FDA feasibility study

IRB: Approved

Vestibular End Organ Preservation in the Implanted Cochlea

Brooke M. Su, MD, MPH; Ivan A. Lopez, PhD
Gail Ishiyama, MD Akira Ishiyama, MD

Hypothesis: Endolymphatic hydrops after cochlear implantation causes vestibular end-organ dysfunction.

Background: Vestibular dysfunction is a known risk after cochlear implantation (CI). CI has been shown to cause endolymphatic hydrops in the cochlea, though its effects on the cyto-architecture of vestibular end-organs are only beginning to be investigated.

Methods: Histopathological analysis of the vestibular end-organs (macula utricle, saccule, and canal cristae) of human temporal bones (HTB), all of which had undergone CI. Group 1 consisted of fifteen patients (CI) found to have endolymphatic hydrops (10 female, 5 male, ages 54 to 98 years). Group 2 consisted of eleven patients without hydrops (6 female, 5 male, ages 59 to 87 years).

Results: The vestibular sensory epithelia of the end-organs in group 1 were well-preserved; in 5 HTBs there was distension of the membranous labyrinth indicating hydrops, 2 HTBs showed ossification of the posterior canal, 3 showed rupture of the membranous labyrinth, 3 showed Scarpa's ganglion atrophy, and 2 had saccule deformation. Group 2 also had well-preserved vestibular end-organs sensory epithelia, though without distension of the membranous labyrinth. 3 HTBs had normal vestibular epithelia, 2 HTBs showed fibrosis in the perilymph, 1 had new bone formation around the otic capsule with normal epithelia, 3 had vestibular nerve atrophy and normal epithelia, and 2 demonstrated saccular degeneration.

Conclusion: In spite of relative morphological and cytologic preservation of the vestibular sensory epithelium, the presence of endolymphatic hydrops is also seen in the vestibular end-organs after CI. Additionally, changes such as vestibular nerve atrophy may also contribute to vestibular dysfunction.

Define Professional Practice Gap & Educational Need: Lack of knowledge on the histopathologic findings associated with vestibular dysfunction after cochlear implantation.

Learning Objective: To describe histopathologic findings of the vestibular end-organs after cochlear implantation that may be related to vestibular dysfunction.

Desired Result: To gain a better understanding of the mechanisms causing vestibular dysfunction after cochlear implantation, and subsequently investigate methods for prevention.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Approved

Neuropsychological Vertigo Inventory for Quantification of Cognitive Dysfunction in Dizzy Patients: Preliminary Results

Yuan F. Liu, MD; Taylor D. Locklear, MS; Jeffrey D. Sharon, MD
Shaun A. Nguyen, MD; Habib G. Rizk, MD

Objective: Currently available patient reported outcomes questionnaires for dizzy patients give limited insight into the cognitive dysfunction they often report. Using the newly developed English version of the Neuropsychological Vertigo Inventory (NVI), we aim to quantify the cognitive impairment of dizzy patients.

Study Design: Prospective cohort study.

Setting: Tertiary neurotology clinic.

Patients: Adults with vestibular diagnoses who completed the NVI between June 2018 and October 2018. Patients with neurologic disorders affecting cognition were excluded.

Interventions: none

Main outcome measure: NVI score

Results: Pilot data consisted of 68 enrolled subjects with various causes of dizziness, including 17 vestibular migraine (VM), 13 Ménière's disease (MD), and 14 benign paroxysmal positional vertigo (BPPV) patients with mean ages of 41, 55, and 64, respectively. VM patients were significantly younger than both MD ($p=0.029$) and BPPV ($p=0.001$) patients. Posthoc analysis following ANOVA showed that mean NVI scores of BPPV patients (50+/-17.4) were significantly lower than those of VM patients (68+/-16.7, $p=0.011$) and MD patients (71+/- 18.8, $p=0.019$). NVI scores were moderately correlated with DHI scores ($r=0.53$, $p<0.001$). A multiple linear regression model for NVI using age, vestibular diagnoses, depression, anxiety, and stroke has an R^2 of 82% ($p<0.001$), with definite VM and definite MD the two variables affecting the score the most.

Conclusions: Cognitive impairment as characterized by the NVI shows that VM patients have higher levels of cognitive dysfunction despite being significantly younger than BPPV patients. Despite being a peripheral disorder, MD elicited levels of cognitive dysfunction similar to VM (a central problem).

Define Professional Practice Gap & Educational Need: Lack of knowledge about cognitive dysfunction caused by vestibular disorders, leading to inadequate awareness of such dysfunction, and inability to address the dysfunction in practice when treating patients.

Learning Objective: To gain knowledge about degree of cognitive dysfunction in different vestibular disorders, including vestibular migraine, Meniere's disease, and benign paroxysmal positional vertigo, and how such dysfunction varies among the disorders.

Desired Result: Physicians may learn to use the Neuropsychological Vertigo Inventory in their own practice to screen for cognitive dysfunction in dizzy patients. They may also gain a tool for evaluating cognitive dysfunction in dizzy patient so that proper treatment or referrals may be made to better treat patients.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

A Cohort Study Comparing Importance of Clinical Factors in Determining Diagnosis and Treatment for Superior Semicircular Canal Dehiscence Syndrome

Lisa Zhang, BS, BA; Francis X. Creighton Jr, MD; John P. Carey, MD

Objective: To determine which clinical factors have the strongest impact on determining diagnosis and decision for surgical repair for superior semicircular canal dehiscence syndrome (SCDS).

Study design: Historical cohort study

Setting: Tertiary care referral center

Patients: A total of 81 patients were evaluated between October 2017 and October 2018 for SCDS. 38 patients were diagnosed with SCDS, and 28 of the individuals ultimately underwent SCDS repair.

Methods: Various clinical factors including presence of subjective reports of autophony, sensitivity to loud sounds, vertigo induced by loud sounds, dizziness, hearing their own heartbeats or other visceral organs, as well as low frequency conductive hearing loss, hyperacusis, and significant increase in affected ear oVEMP (>17) were analyzed with logistic regression both in patients who were diagnosed with SCDS and those who had surgical repair.

Results: From logistic regression analysis two factors emerged as significant predictors of a final diagnosis of SCDS: low frequency conductive hearing loss and oVEMP amplitude ($p = 0.002$, $p = 0.001$, respectively). The same factors were also significant predictors of whether individuals were offered and chose to have surgical repair of the dehiscence ($p = 0.004$, $p = 0.001$, respectively). A logistical regression indicated that these two factors accounted for 56% of the variance for diagnosing SCDS and 59% of the variance for those who had surgical repair.

Conclusions: Low frequency conductive hearing loss and increased oVEMP amplitude are the strongest predictive factors for making a diagnosis of SCDS and for its surgical repair.

Define Professional Practice Gap & Educational Need: Lack of research determining which clinical factors have the strongest impact on determining diagnosis and decision for surgical repair for superior semicircular canal dehiscence syndrome (SCDS).

Learning Objective: Low frequency conductive hearing loss and increased oVEMP amplitude are the strongest predictive factors for making a diagnosis of SCDS and for its surgical repair.

Desired Result: A better understanding of which clinical factors are most important for referral, diagnosis, and management of SCDS.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

The cVEMP as a Prognostic Tool for Development of Bilateral Meniere's Disease

Kimberley S. Noij, MD; Barbara S. Herrmann, PhD
John J. Guinan Jr., PhD; Steven D. Rauch, MD

Objective: To investigate if cVEMP is predictive for the development of bilateral Meniere's disease (MD).

Study design: Retrospective cohort study

Setting: Tertiary care center

Patients: Medical charts of 71 patients previously diagnosed with unilateral Meniere's disease and who had cVEMP testing between 2002 and 2011 were screened. Patients with an air-bone gap (ABG) of ≥15 dB at one or more frequencies at the time of cVEMP testing were excluded (n=5).

Intervention: The remaining patients (n=66) were contacted by email, phone or mail to answer a questionnaire about their Meniere's disease to identify who developed bilateral disease; i.e. involvement of their second ear. Thirty-five patients answered the questionnaire. Medical charts of the remaining 31 patients were reviewed. Patients with a follow-up time of at least 5 years were included for analyses. In total, 49 patients were included.

Main outcome measure: cVEMP thresholds and tuning measured previously were analyzed with respect to the development of bilateral disease in the interim since that previous testing.

Results: Twelve of the 49 (24.5%) included patients developed bilateral disease. Originally unaffected ears that subsequently developed Meniere's disease had significantly higher cVEMP thresholds than the ears that remained unaffected ($p<0.001$). A difference in tuning was also observed. cVEMP threshold was lower at 1000 Hz than 500 Hz in 83.3% of the newly affected ears, while this tuning pattern occurred in only 16.2% of ears that remained unaffected.

Conclusion: cVEMP threshold and tuning are predictive of which unilateral MD patients will develop bilateral disease.

Define Professional Practice Gap & Educational Need: Lack of knowledge

Learning Objective: Educate

Desired Result: Clinical applicability

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Imaging is Not Indicated in the Investigation of Isolated Objective Vestibular Weakness

Deanna Gigliotti, MSc; Brian Blakley, MD
Paige Moore, MD; Jordan Hochman, MD

Objective: Unilateral vestibular weakness (uVW) has considerable potential etiologies. One source is a vestibular schwannoma. This article evaluates, in the absence of other symptoms and signs, if uVW is an analogue to asymmetric sensorineural hearing loss and serves as an indication for lateral skull base imaging.

Study Design: Retrospective chart review

Setting: Academic tertiary center

Patients: All patients undergoing caloric assessment between January 1 2012 and June 30 2017 were investigated. Patients with uVW (unilateral weakness score >25% on electronystagmography) were included in the study. A Provincial encompassing image library was surveyed for potential adequate imaging (CT IAC infused, MRI brain, MRI IAC) of the target population within the preceding 5 years.

Intervention: diagnostic.

Main Outcome Measure: presence/absence of vestibular schwannoma on imaging.

Results: Of the 3000 ENG reviewed during the period, 737 patients were identified with uVW. Of these, 458 had sufficient imaging, and 10 vestibular schwannomas were identified (cost of $50,581.94 per tumor). Only one individual had a vestibulopathy in isolation, while the remaining 9 tumor patients also suffered from documented sensorineural hearing loss that would have mandated MRI scanning.

Conclusion: The results of our study suggest that in isolation, vestibular weakness is an insufficient indicator for lateral skull base imaging.

Define Professional Practice Gap & Educational Need: Uncertainty regarding the indication and cost benefit of imaging patients with unilateral vestibular weakness

Learning Objective: At the end of this presentation, attendees will appreciate that in isolation unilateral vestibular weakness does not require imaging

Desired Result: (How will attendees APPLY the knowledge they learned from the presentation): The implementation and employ of patient-centric, cost effective investigations in the dizzy patient.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Exempt

Impact of Underlying Diagnosis on Speech and Quality of Life Outcomes after Cochlear Implantation for Single-Sided Deafness

Tiffany Peng, MD; Joshua J. Sturm, MD, PhD; Abby Owen
Megan Kuhlmey, AuD; Ilana P. Cellum, AuD
Lawrence R. Lustig, MD; Ana H. Kim, MD

Objective: Our objective was to compare outcomes in speech and quality of life in those undergoing cochlear implantation for single-sided deafness (SSD), with the aim to characterize the clinical impact of underlying diagnosis in the affected ear.

Study Design: Prospective case series

Setting: Academic Cochlear Implant Center

Patients: We review the outcome of 38 adult patients implanted with the diagnosis of SSD.

Interventions: All patients were evaluated at 3-, 6, and 12-months post-operatively using AZBio® sentence and speech, consonant-nucleus-consonant (CNC), and Bamford-Kowal-Bench Sentences in Noise(BKB-SIN) tests depending on appropriate testing level. Our previously validated Comprehensive Cochlear Implant Quality of Life (CCIQ) questionnaire was also administered.

Main Outcome Measures: Speech perception, quality of life

Results: Subjects were stratified by the underlying diagnosis: Meniere's (MD; n=9), sudden sensorineural hearing loss (SSNHL; n=12), and Other (eg TBI, acoustic neuroma, progressive, noise-induced; n=17). The mean preoperative PTA of the implanted ear was 76dB±24; that of the non-implanted ear was 33dB±6. SSNHL demonstrated the highest speech perception score at 3 months (98%), and "Other" demonstrated the lowest scores at 85%. All 3 groups demonstrated a nadir in speech scores at 6 months before improving at 12 months. The "other" diagnoses group maintained the lowest speech testing across all time points. All 3 groups reported improved quality of life on CCIQ testing.

Conclusions: Subjects with SSNHL and MD demonstrate excellent speech and quality of life outcomes after cochlear implantation for SSD. Subjects with other diagnoses underlying their SSD demonstrated lower scores on speech testing but nonetheless reported improved quality of life on CCIQ.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of current outcomes in cochlear implantation for single sided deafness 2. Lack of contemporary knowledge on how underlying diagnosis/etiology of deafness impacts outcomes in cochlear implantation for single-sided deafness 3. Lack of contemporary knowledge in the natural history of speech outcomes and rehabilitation after cochlear implantation for single-sided deafness

Learning Objective: Participants will understand speech outcomes and quality of life outcomes in cochlear implantation for single-sided deafness, as well as strategies for how outcomes may be evaluated in this population. Participants will demonstrate understanding of how outcomes progress and differ among implantees based on the etiology for their single-sided deafness.

Desired Result: Participants will have improved capacity for patient counseling and expectations management for speech and quality of life after cochlear implantation for single-sided deafness. They will also have a data set by which to compare their own patient outcomes in the 12 months following cochlear implantation for these indications.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB -Approved

Prevalence of Xerostomia Among Cochlear Implant Recipients
A Cross-Sectional Survey

Heather M. Weinreich, MD, MPH; Benjamin Ostrander, MSE
Seth E. Pross, MD; Howard Francis, MD, MBA

Objective: To determine the prevalence of xerostomia among adult cochlear implant (CI) recipients and if an association exists with unilateral versus bilateral implantation.

Study Design: Cross-sectional survey administered via electronic format.

Setting: Outpatient CI center based in a tertiary care facility.

Patients: Adults greater than or equal to 18 years of age who received an implant or transitioned care to the Johns Hopkins Listening Center in Baltimore, MD.

Intervention: Presence of CI, either unilateral or bilateral

Outcome: Presence or absence of xerostomia, as assessed by an ordinal variable (low risk, at risk, high risk) created from the validated Xerostomia Inventory Score.

Results: A total of 278 subjects completed greater than 50% of the survey, giving a response rate of 21.8%. 59% were female. Average age at completion of the survey was 59 years (SD ± 16). 27% had bilateral implants. No mean age difference was seen between those with xerostomia versus without. 70% of subjects were on at least one medication with possible xerostomia side effect. There was no significant difference between rate of medication use between unilateral and bilateral CI recipients. When controlling for medication use, mean age between those with xerostomia was similar to those without. Bilateral recipients not on a medication and who developed xerostomia were younger. Prevalence of xerostomia was 20.5% for all recipients, 17.3% for bilateral and 21.6 % for unilateral. After excluding subjects taking a medication, the rate dropped to 12.3%.

Conclusion: The prevalence of xerostomia among CI patients is over 10%, regardless of unilateral vs. bilateral implantation status.

Define Professional Practice Gap & Educational Need: 1. Lack of knowledge regarding rate of xerostomia in cochlear implant population 2. Lack of knowledge regarding rate of xerostomia between bilateral and unilateral cochlear implant recipients 3. Lack of knowledge regarding risk factors for xerostomia in a cochlear implant population

Learning Objective: 1. Calculate the prevalence of xerostomia in a cochlear implant population 2. Determine if prevalence varies between bilateral and unilateral cochlear implant recipients 3. Investigate associations between xerostomia and possible risk factors in a cochlear implant population

Desired Result: Submandibular glands provide basal saliva production which has implication for development of xerostomia and dental health. An awareness of the rate of xerostomia in their cochlear implants recipients and an understanding this may have implications for surgical approaches (e.g. sacrifice of chorda tympani). We also would like attendees to consider the implication this has in bilateral recipients where both chorda tympani nerves may be sacrifice. Moreover, we want to provide knowledge of possible risk factors especially in older patients.

Level of Evidence: Descriptive Cross-sectional study. Some consider Level IV evidence - defer to AOS

IRB - Approved

Identifying Disadvantaged Groups for Cochlear Implantation: Demographics from a Large Cochlear Implant Program

Natalie Schauwecker, BBA, BS; Anthony M. Tolisano, MD
Bethany Baumgart, AuD; Johanna Whitson, AuD
J. Walter Kutz, MD; Brandon Isaacson, MD; Jacob B. Hunter, MD

Objective: To characterize the demographics of patients undergoing cochlear implant (CI) evaluations.

Study Design: Retrospective chart review between 2009 and 2018.

Setting: University CI program.

Patients: Adults referred for CI evaluation.

Main Outcome Measures: Demographics, insurance status, and proximity to the CI program.

Results: 784 CI evaluations were performed. The mean age was 64.2 years (range, 18-92 years), 54.7% were male, 87.6% were white, and 89.3% were primary English speakers. Overall, 74.7% qualified for CI, of which 63.8% pursued surgery. The majority (63.9%) had public insurance (e.g. Medicare or Medicaid), followed by private insurance (29.8%) and military insurance (3.3%). Females qualified for CI at a higher rate than males (79.4% vs. 70.9%, p=0.0064) but pursued surgery at the same rate (62.4% vs. 65.1%, p=0.5471). Minorities qualified for CI at a much higher rate compared to whites (90.1% vs. 75.4%, p=0.0027) but were significantly less likely to pursue surgery (57.5% vs. 70.9%, p=0.0282). English and non-English speaking patients qualified for surgery at similar rates (75.1% vs. 81.2%, p= 0.3051) but English speakers pursued surgery at a higher rate (65.3% vs. 48.2%, p= 0.0131). Although driving distance did not predict patients who qualified for CI, patients who pursued CI lived at a significantly greater distance compared to those who did not pursue CI (34.01 miles vs. 26.78 miles, p=0.0181).

Conclusions: Disadvantaged groups, such as minorities, non-English speakers, and women, qualify for CI at a higher rate, suggesting the possibility of delayed CI candidacy referral, and generally pursue surgery at a lower rate.

Define Professional Practice Gap and Educational Need: There has not been a large assessment of the social demographics of patients who undergo cochlear implant evaluations, who qualify for them, and ultimately who pursue cochlear implant surgery. This is especially important for disadvantaged groups who may have increased obstacles to obtaining care.

Learning Objective: To characterize the demographics of patients undergoing cochlear implant evaluations.

Desired Result: To identify demographics such as gender, race, ethnicity, language, and marital status that might impede patients from pursuing cochlear implantation. This can lead to changes in patient referral and even in formal testing to ensure any patient that could benefit from surgery has the opportunity to pursue cochlear implantation.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB- Approved

Lateral Wall Electrodes Increase the Rate of Post-Activation Non-Auditory Percepts

Adam C. Kaufman, MD, PhD; James G. Naples, MD; Douglas C. Bigelow, MD
Steven J. Eliades, MD, PhD; Hannah S. Kaufman, AuD; Michael J. Ruckenstein, MD

Objective: To evaluate factors influencing the development of non-auditory percepts and facial nerve stimulation after cochlear implant (CI) activation.

Study: Retrospective Cohort Study

Setting: Tertiary referral center

Patients: Over the course of five years, 518 consecutive patients who underwent CI were evaluated. Of those, 497 patients had information regarding CI activation.

Interventions: Lateral wall electrodes (LWE) or perimodiolar/mid-scalar electrodes (PME) were used during implantation per patient preference without regard to anatomical factors.

Primary Outcome Measure: Non-auditory percepts and facial nerve stimulation after activation of CI.

Results: Among the 497 patients who had their devices activated at our institution, 357 (72%) patients were implanted with an LWE while 140 (28%) patients were implanted with a PME. Of the patients with LWE, 49 (13.7%) patients experienced some form of non-auditory percept. In comparison, only 11 (9.2%) patients with a PME had some form of non-auditory percept ($P<0.05$). Among the patients who had an LWE, 33 (9.2%) patients had facial nerve stimulation compared to only 6 (4.3%) patients with PME. This difference was statistically significantly ($P<0.05$). Additionally, the 11 (2.2%) patients who had incomplete insertion of the electrode had a significant increase ($P<0.05$) in facial nerve stimulation and the 51 (10.2%) patients who needed a cochleostomy for insertion had a higher rate ($P<0.05$) of both non-auditory percept and facial nerve stimulation. The average patient needed 2.85 electrodes modified or disabled to control symptoms.

Conclusions: The use of LWE, cochleostomies, and incomplete insertions significantly increase the rate of non-auditory percepts after activation of CIs.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge about the differing risks for facial nerve stimulation and non-auditory percepts between lateral wall and perimodiolar electrodes. There is a lack of awareness of all the factors that contribute to non-auditory percepts after cochlear implantation.

Learning Objective: To understand that the use of lateral wall electrodes, cochleostomies, and incomplete insertions significantly increase the rate of non-auditory percepts and facial nerve stimulation after activation of cochlear implants.

Desired Result: Physicians will be better able to counsel patients about the risks of different cochlear implant electrodes in relationship to risk of facial nerve stimulation and non-auditory percept. Additionally, this study further validates the practice of exchanging lateral wall electrode to perimodiolar electrodes in the event of uncontrollable facial stimulation.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Cochlear Implantation with a Slim, Modiolar Array

Jonathan L. McJunkin, MD; Nedim Durakovic, MD; Jacques Herzog, MD
Cameron C. Wick, MD; Craig A. Buchman, MD

Objective: Describe the surgical findings associated with successful array insertion in a multi-center trial

Study Design: Prospective, multi-center, within-subject experimental design

Setting: Tertiary referral centers (N=13)

Patients: Adults ≥ 18 years old

Intervention: Cochlear Implantation with a slim, modiolar array

Main Outcome measures: Surgeon operative questionnaire, complications and post-operative computer tomography (CT) reconstructions of electrode scalar location

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

Conclusion: The slim, modiolar electrode array has a very consistent perimodiolar position and a low translocation rate. Surgeons used an extended round window approach most frequently to accomplish the sheath-dependent insertion technique. Intraoperative x-ray is needed to detect tip rollovers in the operating room.

Define Professional Practice Gap & Educational Need: 1. Lack of widespread experience with the new slim, modiolar cochlear implant(CI) array. 2. Few reports on scalar location and translocation rates with the new slim, modiolar CI array.

Learning Objective: 1. Describe surgical experiences and insights gained from a multi-institutional study on the new slim, modiolar CI array. 2. Describe slim, modiolar CI array locations based on postoperative CT scan reconstructions.

Desired Result: Attendees will learn the slim, modiolar CI array is best placed with an extended round window cochleostomy and consistently remains within the scala tympani in a perimodiolar position.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

Controlled Microperforation of Human Round Window Membrane *in situ*

Harry Chiang, BA; Michelle Yu, BS; Wenbin Wang, MS
Aykut Aksit, MS; Miguel Arriaga, PhD; Jeffrey W. Kysar, PhD
Anil K. Lalwani, MD

Hypothesis: 3D-printed microneedles can create precise holes on the scale of microns in the *human* round window membrane (hRWM).

Background: An intact RWM is a barrier to delivery of therapeutic material into the inner ear. Microperforation of guinea pig RWM has been shown to overcome this barrier by enhancing diffusion 35-fold. In humans, the challenge is to design a microneedle that can perforate the thicker hRWM.

Methods: Based on the mechanical properties of the hRWM, 100 μm diameter microneedles with 5 μm tip diameter were designed and fabricated using 2-photon polymerization. With a micro-indenter equipped with microneedles, hRWM from fresh frozen temporal bones were perforated *in situ*, simultaneously measuring force and displacement (N=9). Confocal microscopy was used to characterize the RWM perforation. Microneedles were examined for deformity after use.

Results: The microneedles successfully perforated the hRWM without tearing the membrane. The perforations were lens-shaped measuring 131.3±3.0 x 15.6±1.9 μm with the length of major axis slightly larger than the microneedle shaft diameter. The mean force required for perforation was 29.0±6.7 mN, more than an order of magnitude greater than that previously measured in guinea pig (1.2±0.6 mN). There was no significant deformation of the microneedles.

Conclusions: 3D-printed microneedles are strong, resist breakage with use, and create small perforations that separate, but do not tear the connective tissue fibers of the human round window membrane. Separation of collagen fibers without tearing is encouraging for clinical use of microneedles, as it should facilitate healing of the hRWM after perforation.

Define Professional Practice Gap & Educational Need: Lack of a tool to overcome inconsistencies with drug delivery across the round window membrane to the inner ear

Learning Objective: 1. To learn how microneedles can create precise holes in human round window membrane 2. To understand the anatomy and mechanics of microneedle perforations in human round window membrane

Desired Result: Microneedles show promise as a technology for improving delivery to the inner ear without compromising round window membrane integrity

Level of evidence does not apply because: Basic sciences study

IRB - Exempt

Regular Wave Patterns on Ambient Pressure Tympanometry in Patients with Pulsatile Tinnitus-associated Pathologies

Anthony Thai, BA; Zahra N. Sayyid, BS; Davood K. Hosseini, MD
Yifei Ma, MS; Austin Swanson, AuD
Matthew Fitzgerald, PhD; Yona Vaisbuch, MD

Objective: To introduce the potential use of continuous ambient pressure tympanometry (APT) in the screening of pathologies associated with pulsatile tinnitus

Study design: Retrospective cohort study. APT was performed randomly, and medical records, including imaging, were reviewed. APT findings were objectively characterized using an algorithm based on regularity, frequency and amplitude of the waves. Patients without otologic symptoms or without imaging findings were categorized as controls, and patients with otologic symptoms or imaging findings were categorized as cases.

Setting: Tertiary otology referral center

Patients: Adult patients

Intervention(s): screening with baseline ambient pressure tympanometry

Main outcome measure(s): amplitude and frequency of APT waves; diagnoses based on symptoms and imaging

Results: APT was performed on 589 patients (1035 ears). We identified 465 control patients (827 ears). In this control group, 70% of ears did not display regular APT wave patterns. We identified 124 patients (207 ears) with otologic symptoms or imaging findings. From this group of cases, we identified 9 distinct diagnoses, including superior semicircular canal dehiscence (23 patients, 34 ears), glomus tumors (5 patients, 6 ears), carotid dehiscence (3 patients, 4 ears), myoclonus (3 patients), inner ear hydrops (3 patients), jugular bulb dehiscence (2 patients), sigmoid sinus dehiscence (2 patients), encephalocele (2 patients), and aberrant carotid artery (1 patient).

Conclusion: Characteristic wave patterns on APT over time may be indicative of otherwise unrecognized pathology associated with pulsatile tinnitus. APT is a simple, feasible and widely accessible tool that can help with screening or direct suspicion.

Define Professional Practice Gap & Educational Need: Lack of awareness of usage of an existing screening tool (ambient pressure tympanometry) for identification of pulsatile tinnitus-associated pathologies

Learning Objective: Familiarize participants with ambient pressure tympanometry, wave patterns on this test, and correlations with various pathologies

Desired Result: The attendee will be able to interpret wave patterns on ambient pressure tympanometry and discuss correlations with various otologic pathologies

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Assessment of Hearing-Aid Benefit through Patient-Reported Outcomes

James R. Dornhoffer, MD; Ted A. Meyer, MD, PhD
Judy R. Dubno, PhD; Theodore R. McRackan, MD, MSCR

Objective: Determine the association between audiologic and patient-reported outcome measures in hearing-aid users.

Study design: Independent review of audiologic and patient-reported outcomes from a middle-ear implant FDA clinical trial

Setting: Multicenter clinical trial

Patients: 95 hearing-aid users undergoing evaluation for middle-ear implantation

Interventions/main outcomes measured: Pure-tone thresholds (PTA), word recognition scores in quiet (NU-6), scores from low and high predictability Speech Perception in Noise test (low/high SPIN), and patient-reported assessment of communication abilities (Abbreviated Profile of Hearing Aid Benefit, APHAB), all measured unaided and aided. Correlations were examined among audiologic measures and global APHAB and APHAB sub-domain scores. Benefit was defined as the difference in scores between unaided and aided listening.

Results: Significant improvements in all audiologic and patient-reported outcome measures ($p<0.001$ for all) were observed when comparing unaided and aided listening. No significant correlations were found between aided audiologic measures (PTA, NU-6, and SPIN) and aided APHAB or APHAB sub-domain scores (all $p>0.05$). Benefit measured by NU-6 and SPIN high showed weak positive correlations with benefit measured by global APHAB ($r=0.37$, $p<0.001$; and $r=0.28$, p=0.l005, respectively) and with benefit measured by ease of communication APHAB sub-domain ($r=0.37$, $p<0.001$; and $r=0.33$, $p=0.001$, respectively).

Conclusion: Hearing-aid benefit assessed with audiologic outcomes is generally a poor predictor of patient-reported benefit of hearing aids to communication abilities. As such, patient-reported outcomes may provide a unique assessment of patients' perceived benefit from hearing-aid use, which can be used to direct future hearing aid programming, auditory training, or recommendations of alternative hearing services or technologies.

Define Professional Practice Gap & Educational Need: There is a lack of awareness regarding the true association between audiologic and patient-reported outcome measures in hearing-aid users.

Learning Objective: Practitioners will be informed that patient reported hearing-aid benefit and audiologic outcome measures poorly correlate. As such, patient reported outcome measures offer a unique tool for assessment of hearing aid benefit.

Desired Result: Practitioners and researchers will use patient reported outcome measures as a unique assessment tool. Additionally, patient reported measures may be used to direct future hearing-aid research, programming, auditory training, and treatment recommendations.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Exempt

RESIDENT RESEARCH TRAVEL AWARD

Immune Response of Macrophage Population to Cochlear Implantation

Kathryn Y. Noonan, MD; Ivan Lopez, PhD
Gail Ishiyama, MD; Akira Ishiyama, MD

Hypothesis: Macrophages play a role in both preserving cochlear integrity and in the immune response to cochlear implantation (CI).

Background: CI often induces a biologic reaction that may lead to implant failure or reduced hearing. Macrophages are found as resident immune cells in human cochlea and have been recently shown to phagocytize implant material. It has been demonstrated in animal models that macrophage populations increase with surgical stress, however there is limited knowledge of their function and response to CI. This study seeks to investigate the inflammatory response to cochlear implantation by comparing macrophages in implanted and non-implanted temporal bones.

Methods: Nineteen temporal bones from nine implanted ears, seven contralateral controls and three normal control ears were evaluated for the presence and distribution of CD68 and Iba1 positive macrophages.

Results: Two types of macrophages were detected in the cochleas: 1) CD68 or Iba1 positive macrophages only, and 2) CD68 and Iba1 colocalization in macrophages. Macrophage distribution was ubiquitous: They were present in the stria vascularis, Rosenthal canal and mid-modiolus intermingled in the spiral ganglia neurons area. Positive Iba1 and CD68 macrophages were found in the CI and non-CI contralateral and normal cochleas. Ib1a was seen in ramified/amoeboid cells, CD68 was seen in foamy, round macrophages. In CI cochlea, both types of macrophages were detected surrounding the CI path and fibrotic areas (Scala tympani or vestibule).

Conclusion: These results indicate both CD68 and Iba1 macrophages are present in response to CI and reside in the cochlea likely preserving cochlear integrity.

Define Professional Practice Gap & Educational Need: Cochlear implantation causes significant fibrosis and often results in loss of residual hearing. Steroids are often given to protect against the inflammatory response to inner ear insults yet this immune response is poorly understood. Studies have demonstrated that immune cells including macrophages can be found in normal cochlea. The response of these cells to surgical trauma and their contribution to the inflammatory process is yet to be described.

Learning Objective: Describe the distribution and macrophage population in normal human cochlea Compare macrophages in normal cochlea with cochlea that have undergone cochlear implantation Improved understanding of the immune response to surgical stress

Desired Result: Informed decision making with cochlear implant candidates Better management of the inflammatory response to surgical stress

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

The Future of Cochlear Implant

Juichi Ito, MD, PhD

The future development of cochlear implant will be shown in the fields of mechanical and biotechnological development. As for biotechnological improvement we have investigated whether SGNs regeneration would improve the cochlear implant performance.

Model animals of guinea pigs and monkeys with degeneration of cochlear hair cells and SGNs were made. Cell transplantation to the SGN area was performed. As for donor cells mesenchymal stem cells (MSCs), embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) were used. Then cochlear implant was performed.

After that electrically stimulated auditory brain stem response (eABR) was investigated. The threshold of eABR measured from cell transplanted animals were lower compared to control animals without cell transplantation.

As for mechanotechnological Improvement a new CI device has been developed. Newly invented device is called artificial auditory epithelium (AAE) or HIBIKI device. The mechanism of AAE is to vibrate the basilar membrane of the cochlea and cause distortions of the vibrating portion of the device. Then electricity produced by the vibrating portion is lead to the SGNs (cochlear nerve) by electrodes and stimulate them. The characteristic of this device is totally-implantable in the inner ear, as well as there is no need of extra battery.

In conclusion both biotechnological way with cell transplantation and mechanotechnological way by AAE are promising way for the future development of CI.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge for the development of cochlear implant

Learning Objective: Learn gap between current and future cochlear implant

Desired Result: Attendee will learn the future development of cochlear implant

Level of evidence does not apply because: this presentation is something research level for the near future clinical use

IRB - Approved

Evaluation of Intracochlear Trauma with Manual and Robotic-assisted Cochlear Implant Insertion

Christopher R. Kaufmann, MD; Allan M. Henslee, PhD
Marlan R. Hansen, MD

Hypothesis: The objective was to evaluate the effect of cochlear implant (CI) insertion technique on electrode position and intracochlear trauma in cadaveric cochleae. We hypothesize that a robotic assistive insertion device will reduce intracochlear trauma compared to manual insertions.

Background: Variability in CI outcomes exists across patients, implant centers, surgeons, and electrode types. While surgical techniques that reduce electrode insertion trauma are well established, insertion trauma remains one contributing factor to variability in CI outcomes. Prior work has shown that robotic-assisted insertion tools reduce both maximum insertion forces and insertion variability compared to manual insertions.

Methods: Round window CI electrode insertions were performed either by hand (n=12) or utilizing a robotic assistive device (iotaSOFT, n=12) in fresh frozen, human cadaveric cochleae using electrodes from 4 different CI manufacturers. Following insertions, samples were imaged via high resolution X-ray microscopy (Zeiss Xradia) to evaluate electrode position and intracochlear trauma according to the Eshraghi scale.[1]

Results: Electrode insertions performed manually had an insertion angle of 358.5 ± 113.2° compared to 325.4 ± 84.5° for device-assisted insertions. Electrode insertions performed manually exhibited a higher Eshraghi score of 3.1 ± 1.2 compared to 1.6 ± 0.5 for device-assisted insertions. Manual insertions had higher rates of scalar translocations and fracture of the osseous spiral lamina.

Conclusions: The robotic-assistive system reduced trauma and scalar translocations associated with electrode insertions in cadaveric cochleae compared to manual insertions. Surgical tools which help to precisely and more consistently insert electrodes may improve CI outcomes, including hearing preservation.

Define Professional Practice Gap & Educational Need: Inconsistencies in insertion techniques of cochlear implant electrodes.

Learning Objective: Attendees should understand differences in intracochlear damage observed between robotically-assisted and manual (by hand) cochlear implant electrode insertions.

Desired Result: Attendees can make more informed decisions regarding cochlear implant electrode insertions.

Level of evidence does not apply because: This is not a clinical study.

IRB - Exempt

Effect of Laser Stapedotomy on Intracochlear Pressure Measurements

Emily S. Misch, MD; Renee M. Banakis Hartl, MD, AuD
Samuel P. Gubbels, MD; Nathaniel T. Greene, PhD

Hypothesis: Surgical manipulations during laser stapedotomy can produce intracochlear pressure changes comparable to pressures created by high-intensity acoustic stimuli.

Background: New-onset sensorineural hearing loss is a known risk of stapes surgery and may be related to pressure changes within the cochlea during laser use or other surgical manipulations. Here, we test the hypothesis that high sound pressure levels are generated during laser stapedotomy.

Methods: Human cadaveric heads underwent mastoidectomy. Fiber-optic sensors were placed in scala tympani and vestibuli to measure intracochlear pressures during key steps in stapedotomy surgery, including cutting stapedius tendon, lasering of stapedial crurae, crural downfracture, and lasering of the footplate. The difference in pressure magnitude between key steps was calculated using a one-way ANOVA.

Results: Key steps in laser stapedotomy produced high-intensity pressure spikes in the cochlea. Pressure transients were comparable to intracochlear pressures measured in response to high intensity impulsive acoustic stimuli.

Conclusion: Our results demonstrate that surgical manipulations during laser stapedotomy can create significant pressure changes within the cochlea. Intracochlear pressure magnitudes were comparable to high-intensity acoustic stimulation. Results from this investigation suggest that intracochlear pressure transients from stapedotomy may be of sufficient magnitude to cause damage to the sensory epithelium and affirm the importance of limiting surgical traumatic exposures.

Define Professional Practice Gap & Educational Need: Limited understanding of the intracochlear environment during laser stapedotomy surgery.

Learning Objective: 1. Better appreciate the potential for causing cochlear trauma during laser stapedotomy. 2. Develop an understanding of the relative levels of damaging exposures by examining the equivalent ear canal sound pressure level exposures that correlate with cochlear pressure levels during laser stapedotomy.

Desired Result: 1. Participants will improve understanding of the potential intraoperative causes of new-onset SNHL after laser stapedotomy. 2. Participants will consider iatrogenic cochlear trauma from intracochlear pressure transients created during laser stapedotomy when analyzing their own patient outcomes.

Level of Evidence does not apply because: This is a basic science translational project aimed at examining the potential mechanism of cochlear trauma that cannot be randomized or blinded in a traditional sense.

IRB - Exempt

RESIDENT RESEARCH TRAVEL AWARD

Utility of Perilymph microRNA Sampling for Identification of Active Gene Expression Pathways in Otosclerosis

Helena Wichova, MD; Matthew Shew, MD; Hinrich Staecker, MD, PhD

Hypothesis: Profiling of microRNA (miRNA) within perilymph samples collected at the time of stapedectomy can be utilized to identify active gene expression pathways in otosclerosis as compared to controls.

Background: MiRNAs are small non-coding RNAs that effect gene expression by post-transcription regulation and silencing. Perilymph sampling allows for a novel way to collect material actively involved in the disease process.

Methods: Perilymph was collected at time of stapedectomy, underwent a microarray analysis, and significantly expressed miRNAs were correlated to known bone morphology pathways using a cochlear transcriptome library. To determine miRNA related specifically to otosclerosis hearing-reservation cochlear implant controls were used for statistical analysis.

Results: A total of 321 significantly expressed miRNAs were identified within the four otosclerosis perilymph samples. MiRNAs associated with 23 genes involved in bone morphology pathways were significantly expressed. A significant difference in the otosclerotic samples as compared to control was noted in miRNA expression regulating HMGA2, ITGB3, SMO, CCND1, TP53, TP63, and RBL2 gene pathways. No significant difference was noted in miRNAs expression associated with ACE, RELN, COL1A1, and COL1A2, genes which were previously correlated with otosclerosis.

Conclusions: Perilymph miRNA profiling obtained at the time of stapedectomy consistently identifies differentially expressed genes compared to controls. Perilymph miRNA sampling with cochlear transcriptome library cross-referencing can be successfully utilized to identify active gene expression pathways in otosclerosis.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge regarding pathogenesis of otosclerosis

Learning Objective: To utilize microRNA profiling of perilymph samples collected at the time of stapedectomy to identify active gene expression pathways in otosclerosis

Desired Result: Perilymph miRNA sampling with cochlear transcriptome library cross-referencing can identify active gene expression pathways in otosclerosis and identify potential pharmacologic intervention points

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

SELECTED ABSTRACTS

POSTER PRESENTATIONS

152nd Annual Meeting
AMERICAN OTOLOGICAL SOCIETY

May 3-5, 2019
JW Marriott Austin
Austin, TX

POSTERS WILL BE VIEWED ON FRIDAY & SATURDAY
ORAL PRESENTATIONS ARE SATURDAY & SUNDAY

Reducing Postoperative Call Volume through Verbal Preoperative Education

Alexander Chern, MD; Marc L. Bennett, MD

Objective: To improve patient satisfaction and understanding of what to expect after chronic ear surgery and reduce call volume to an otology clinic at an academic tertiary referral center

Study Design: Quality improvement initiative

Setting: A single academic tertiary referral center

Patients: One hundred and ten patients who underwent chronic ear surgery in March to May 2018

Intervention: Preoperative counseling over the phone 1 week prior to surgery

Main Outcome Measures: Patient call volume to the clinic within a 2-week postoperative window, patient understanding and satisfaction of perioperative course

Results: There was a significant increase in patient satisfaction (6.4% increase, 9.8 intervention vs. 8.9 no intervention, p=0.0032) and in patient understanding of what to expect after surgery (8% increase, 9.5 intervention vs. 8.9 no intervention, p=0.0275). There was a significant decrease in mean number of calls per patient to the clinic (57.5% decrease, 0.31 intervention vs. 0.72 no intervention, p=0.0105) and in percentage of patients who made any number of calls to the clinic (20% intervention vs. 46%, no intervention, p=0.00438). Intervention group had less variation in number of calls per patient (i.e., smaller variance, VAR=0.47) compared to the no intervention group (VAR=0.87).

Conclusions: Verbal preoperative counseling over the phone was effective in significantly reducing unnecessary call volume to the clinic and in improving patient satisfaction and overall understanding of what to expect after surgery.

Define Professional Practice Gap & Educational Need: Otolaryngologists receive an overwhelming number of phone calls. Any methods to reduce calls and achieve better outcomes are beneficial to all.

Learning Objective: Attendees will appreciate quality improvement strategies to attain patient satisfaction and understanding, as well as reduce clinic call volume.

Desired Result: Attendees will implement the discussed quality improvement strategies in their own practice to improve patient satisfaction and understanding, optimize clinical workflow, and ultimately facilitate quality patient care.

Level of Evidence: Does not apply - This study is a quality improvement initiative.

IRB: Exempt

Hearing Loss's Incidence and Impact on Employment in the United States

Kian Tehranchi BS; Anita Jeyakumar, MD, MS

Background: Research is limited on recent estimates of the incidence of hearing loss (HL) in the US and its impact upon wages and labor force participation. Such estimates are important for demonstrating the cost-effectiveness of interventions.

Objective: To determine the incidence of HL as well as differences in wages and labor force participation rates between individuals with and without HL.

Methods: Data reflecting 1% of the U.S population from the public use microdata sample (PUMS) of the 2011-2016 American Community Survey (ACS) was analyzed. Incidence rates were determined by calculating changes in the proportion of individuals with HL in sequential age groups year-to-year from 2011-2016. Average self-reported wages and labor force participation rates were compared between individuals with and without HL between 2012-2016.

Results: HL incidence rates were 13.4, 0.4, 3.8, 18.1, and 117.1 per 10,000 people among 0-2, 3-17, 18-44, 45-64, and 65+ year-olds, respectively. HL 18-44, 45-64 and 65+ year-olds participated in the labor force at 86%, 81%, and 61% of the rate of hearing individuals. HL 18-44, 45-64 and 65+ year-olds earned 78%, 73% and 72% of the wages earned by non-HL individuals.

Conclusions: Calculated HL incidence and labor force participation rates were higher than previously published in literature analyzing 1991 census data. The changes may be due to the methodology used in this study but may also reflect improvements in diagnosis, access to technology and the implementation of the Americans with Disabilities Act (ADA) of 1990.

Define Professional Practice Gap & Educational Need: Research is limited on recent estimates of the incidence of hearing loss in the US and its impact upon wages and labor force participation.

Learning Objective: Learners will have increased knowledge on recent estimates on the incidence of hearing loss and the impact of this hearing loss upon patient's income and participation in the labor force.

Desired Result: Attendees will be able to apply this knowledge on recent estimates of the incidence and economic impact of hearing loss in future research aimed at demonstrating the cost effectiveness of potential future interventions

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Exempt

Precurved Electrode Insertion Techniques Affect Final Electrode Position in Temporal Bones

William G. Morrel, MD; Nauman F. Manzoor, MD; Ashley M. Nassiri, MD, MBA
Benoit M. Dawant, PhD; Jack H. Noble, PhD; Robert F. Labadie, MD, PhD

Hypothesis: Alterations to the recommended insertion technique for precurved cochlear implant (CI) electrode arrays (EA) inserted using an external sheath (Cochlear 532) will affect final intracochlear electrode position.

Background: Little objective data exists regarding optimal insertion technique for precurved EAs.

Methods: Insertions were performed using various depths, sheath positions, and insertion trajectories to explore the range of impact on final EA position. Subsequently, a series of insertions was performed in three fresh, never frozen temporal bone specimens using (i) "standard" insertion to the base insertion depth, (ii) slight "over-insertion" and subsequent "pull-back" to the base insertion depth, and (iii) insertion to a specimen-customized, "optimal depth" predicted from preoperative imaging. CT scans were acquired with the external sheath inserted without an EA and for EAs inserted using techniques i, ii, and iii.

Results: Inducing tip fold-over was difficult and required positioning the tip of the sheath at the round window. One scalar translocation occurred and was successfully corrected by removal and reinsertion. The sheath constrained insertion to a trajectory coplanar with cochlea's basal turn. Compared to (i) "standard" insertion, both (ii) "over-insertion with pull-back" and (iii) "optimal depth" reduced average distance between electrode contacts and the modiolar wall by 13.6% and 16.4%, respectively, with minimal change in angular insertion depth (+1.8% and –2.5%).

Conclusions: Better perimodiolar positioning is possible with slight over-insertion and pull-back of the electrode to an optimal depth calculated from preoperative imaging.

Define Professional Practice Gap & Educational Need: Lack of consistent insertion technique among practitioners; Lack of objective data regarding ideal insertion technique

Learning Objective: Identify techniques to improve precurved cochlear implant electrode positioning

Desired Result: Utilize ideal insertion technique for precurved cochlear implant electrode placement

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Exempt

Outcomes of Primary Pediatric Stapedotomy

Joshua C. Page, MD (primary); Victoria Gau, MD (presenter); Matthew Bridges, BA
Joshua Jervis-Bardy, MD, PhD; DeAnne King, MD, PhD
John L. Dornhoffer, MD

Objective: To review a single surgeon experience with pediatric stapedotomy for juvenile otosclerosis (JO), congenital stapes fixation (CSF) and tympanosclerosis.

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Patients: 63 pediatric patients (4-20 years of age) undergoing 72 stapedotomies from 2001 to 2017.

Main Outcome Measures: Hearing result based on preoperative, first postoperative and best postoperative PTA-ABG. Age, sex, diagnosis, procedure performed, prosthesis, footplate graft and ossicular anomalies were considered.

Results: There were 63 kids (72 ears) who underwent stapedotomy with an average post-operative audiogram out to 2.78 years. Final post-operative air-bone gap for tympanosclerosis was significantly worse than for other indications (29.8 dB [± 10.8 dB]) (p=.020). Significant improvement was seen for congenital stapes fixation (CSF) (20.0 dB [± 11.5 dB]) and juvenile otosclerosis (JO) (22.8 dB [± 14.9 dB]).

Conclusion: Our data suggest, that in our clinic, stapedotomy is safe to perform in children. While we achieved desirable results for JO and CSF, patients with tympanosclerosis did not achieve a statistically better hearing outcome. Tympanosclerosis deserves special consideration and may be better served with a staged procedure or amplification in lieu of surgical intervention.

Define Professional Practice Gap & Educational Need: Inconsistencies in the management of pediatric stapes surgery from a technical standpoint; Disagreement regarding the management of tympanosclerosis causing stapes fixation

Learning Objective: To report our experience with pediatric stapedotomy done for congenital stapes fixation (CSF), juvenile otosclerosis (JO) and tympanoslerosis; To discuss our stapedotomy technique and management considerations; To discuss management strategies and algorithm for tympanosclerosis

Desired Result: Surgeons will better understand the nuances related to operating on pediatric CSF, JO and tympanosclerosis; Surgeons will reconsider the appropriate algorithm for managing tympanosclerosis

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Surgical Intervention for Acute Mastoiditis: 10 Years' Experience of a Tertiary Children Hospital

Sagit Stern Shavit, MD; David Ulanovski, MD; Lirit Levi, MD
Meirav Sokolov, MD; Eyal Raveh, MD

Objective: To evaluate the clinical course of children with acute mastoiditis (AM) who required surgical intervention.

Study Design: Historical cohort, case-control study.

Setting: The database of a tertiary children hospital was reviewed for children who underwent surgery for AM.

Main Outcome Measure: Course of disease and patients' characteristics were compared with non-operated mastoiditis.

Results: Between 2008-2017, 570 children were admitted with AM, 82 children (14%) underwent surgery and were compared with control of 167 non-operated children. Surgery included cortical mastoidectomy, 38% had also removal of bony plate over the epidural space for drainage. Operated children presented with prolonged fever, pre-admission diagnosis of AOM, discharge and sub-periosteal abscess. Their average temperature, WBC, neutrophil count and CRP were significantly higher (39.15vs37.9, 19.96Kvs16.5K, 67%vs55.8%, 17vs8.8, p=0.0001). The most common pathogens in the operated mastoiditis were Fusobacterium (50%), Gr.A streptococcus and H.influenza. CT scan was required in 98% compared with 2% in non-operated. Sub-periosteal abscess, sinus vein thrombosis and epidural abscess were diagnosed in 95%, 35% and 38%. Operated children were treated for average of 20 days compared with 5.6 days (p=0.0001). A significant increase in the total number of surgeries for mastoiditis and surgeries due to Fusobacterium was seen between the first and the second half of the cohort (p=0.0083, p=0.0001).

Conclusion: In children with AM presenting with sub-periosteal abscess, high fever, leukocytosis and high CRP levels, an early CT and surgical intervention is frequently required. Increase in complicated AM requiring surgery is attributed to an increase in Fusobacterium infection.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge exist regarding the need for surgical interference for acute mastoiditis.

Learning Objective: The aim of our study is to describe our practice of a large cohort of children with acute mastoiditis and to compare clinical course and patients characteristics between the children who required operation and the medically managed. Our second objective is to identify annual trends and patterns in the operated mastoiditis population.

Desired Result: Our results will improve physicians ability to identify severe cases that will require surgery as opposed to children that may benefit from conservative treatment only.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

NO EDITS TO MISSPELLINGS

National 30-day Readmission and Hospitalization Patterns in Acute Mastoiditis

Zachary G. Schwam, MD; Rocco Ferrandino, MD; Vivian Z. Kaul, MD
Maura K. Cosetti, MD; George B. Wanna, MD

Objectives: To determine the risk factors for unanticipated readmission and prolonged index admission after hospitalization for acute mastoiditis.

Study design: Retrospective cohort study.

Setting: National database.

Patients: Patients with a primary diagnosis of acute mastoiditis (International Classification of Disease-9th edition codes 383.00, 383.01, 383.02) were identified in the Nationwide Readmissions Database (2013-2014).

Interventions: None.

Main outcome measures: readmission rate, length of stay.

Results: There were 4,295 cases identified; 31.9% were patients <18 years. The 30-day readmission rate was 17.0%, and 7.9% of patients had a prolonged length of stay (LOS) of >8 days. On index admission, 26.5% underwent myringotomy and 21.7% underwent mastoidectomy or petrous apicotomy. Primary readmission diagnosis was mastoiditis in 16.0% of cases. Independent risk factors for readmission included Charlson score of 1 (odds ratio [OR] 1.91, p<.001) and living out of state (OR 3.74, p<.001), while undergoing mastoidectomy was associated with lower readmission rates (OR 0.13, p<.001). Factors independently associated with prolonged LOS in multivariate models included mastoidectomy (OR 2.46, p<.001) and disposition to a facility (OR 3.08), while private insurance (OR 0.44, p=.004) was associated with shorter LOS.

Conclusions: While readmission and prolonged LOS are rather common in the sampled cases of acute mastoiditis, few were documented as having undergone surgical intervention for this disease. Patient comorbidities and demographic variables are independently associated with both unintended readmission and prolonged length of stay.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of national treatment trends for mastoiditis.
2. Lack of awareness in independent risk factors for readmission following hospitalization for mastoiditis.
3. Lack of awareness in independent risk factors for prolonged hospitalization for mastoiditis.

Learning Objective: 1. To describe national treatment patterns for mastoiditis as found in a large national dataset.
2. To identify independent risk factors for unintended readmission and prolonged length of stay in patients with acute mastoiditis.

Desired Result: Attendees will use the independent risk factors identified in our dataset to inform the hospitalizations of their own patients; they will correlate the identified risk factors with their own patients' hospital courses and possibly attempt to target interventionable ones.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Exempt

T-tubes Through Cartilage Tympanoplasty: Is it Worth the Perforation Risk?

Joshua Cody Page, MD (primary); Anna Celeste Gibson, BS (presenter)
Joshua Jervis-Bardy, MD, PhD; John L. Dornhoffer, MD

Objective: To review a single surgeon experience with utilizing a T-tube placed through cartilage tympanoplasty for long-term ventilation of the chronic ear with regard to feasibility and risk for perforation

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Patients: 100 patients (4-71 years of age) who underwent either total island cartilage or posterior palisade cartilage tympanoplasties with T-tube placement from 1998 to 2016.

Main Outcome Measures: Long-term outcome of each T-tube was recorded with respect to retention rate and tympanic membrane status following either tube removal or extrusion. Audiometric data, age, sex, diagnosis and procedure performed were also recorded.

Results: There were 100 patients included: 50 who underwent total island cartilage tympanoplasty with tube placed through cartilage and 50 with only a posterior island graft with tube through native tympanic membrane, as a comparison. Sixty-eight T-tubes were placed in the total island group with 4 (5.9%) residual perforations following removal. Sixty-nine T-tubes were placed in the posterior graft group with 6 residual perforations (8.7%).

Conclusion: Our data suggest, that in our clinic, T-tube placement through cartilage tympanoplasty is worthwhile to provide long-term ventilation to the middle ear and portends no higher risk for residual perforation than tubes placed through native tympanic membrane.

Define Professional Practice Gap & Educational Need: Lack of knowledge on the long-term result following t-tube removal in setting of cartilage tympanoplasty

Learning Objective: We sought to determine if t-tube use through cartilage tympanoplasty increased the risk of perforation versus t-tube through native TM in similar ears.

Desired Result: We hope to show our experience that t-tube use through cartilage tympanoplasty can be valuable for long-term ventilation in the chronic ear without increased risk for residual perforation following removal.

Level of Evidence - LEVEL V - Case series, studies with no controls

IRB: Approved

Round Window and Facial Recess Packing Alter Cochlear Implant Electrode Distance to the Modiolus in the Basal Turn using a Cadaveric Model

Matthew M. Dedmon, MD, PhD; Robert J. Yawn, MD
Brendan P. O'Connell, MD; Yiyuan Zhao, PhD
Robert T. Dwyer, AuD; Alejandro Rivas, MD

Hypothesis: Packing of the round window and facial recess during cochlear implantation may alter intracochlear electrode position with respect to the modiolus.

Background: Electrode position inside the cochlea has significant consequences for implant performance. While many surgical aspects affecting electrode position have been studied, little is known about the effects of extracochlear packing on intracochlear electrode position.

Methods: One attending cochlear implant surgeon performed electrode round window insertions using 5 human cadaveric temporal bones. Two perimodiolar electrodes (Cochlear® Slim Modiolar 532™ (CI532) and Advanced Bionics® HiFocus™ Mid-Scala (MS)) and one lateral wall electrode (Cochlear® Slim Straight 522™ (CI522)) were used. Cadaveric muscle was used to pack the round window and facial recess for each insertion under the following conditions: 1) inferior to the electrode, 2) superior, and 3) both inferior and superior. Pre- and post-insertion computed tomography scans were analyzed with image processing software to compute distances between electrode contacts and the modiolus.

Results: Packing superior to CI532 resulted in decreased distances from the modiolus in the basal turn compared to inferior packing (0.39±0.09mm vs. 0.63±0.16mm, respectively, $p<0.001$). A similar effect was seen for CI522 when comparing superior (0.69±0.53mm) vs. inferior (0.95±0.38mm) packing ($p=0.04$). No statistical differences were observed for MS, or for any electrode in the mid/apical turns.

Conclusions: Round window and facial recess packing alter electrode distance to the modiolus in the basal turn using a cadaveric model. The effect was most pronounced with CI532, and appears to be device-dependent.

Define Professional Practice Gap & Educational Need: Lack of knowledge of the effects of round window and facial recess packing on the intracochlear position of cochlear implant electrodes.

Learning Objective: Demonstrate that round window and facial recess packing can change the proximity of a cochlear implant electrode to the modiolus in a cadaveric temporal bone model.

Desired Result: Understand that extracochlear packing may alter cochlear implant electrode location in the basal turn region of the cochlea.

Level of evidence does not apply because: anatomic study

IRB: Exempt

Distinct Temporal Bone Dissection Scales Demonstrate Equivalence in Distinguishing Trainee Performance

Shubhi Singh MD; Justyn Pisa AuD
Bertrum Unger MD; Jordan Hochman MD

Hypothesis: Different temporal bone dissection scales will independently distinguish resident surgeon performance by graduate year with each illustrating strong inter and intra rater reliability.

Background: Increasing emphasis on patient safety creates the need for quality assessment of fundamental surgical skills. Existing summative temporal bone rating scales are laborious and contain fundamental inconsistencies and redundancies. Evaluator fatigue is a concern.

Two new scales are compared to evaluate their construct validity prior to implementation in training.

Methods: Resident surgeons attending a National Otolaryngology Conference completed a mastoidectomy with posterior tympanotomy on identical 3D printed temporal bone models. Four blinded Neurotologists evaluated the drilled specimens using the CanadaWest (CW) and Iowa Temporal Bone Assessment Tool (ITBAT), with scoring repeated after a six week interval.

Results: Nineteen residents from nine postgraduate programs participated. Assessment was clustered into junior (Post Graduate Year or PGY 1, 2), intermediate (PGY 3) and senior resident (PGY 4, 5) cohorts. ANOVA analysis found significant differences between cohort performance ($p<0.05$) for both scales in consideration of PGY and subjective account of temporal bone surgical experience. Cohen's Kappa found strong inter-rater reliability with scores of 0.790 (ITBAT) and 0.858 (CW) respectively. The ITBAT illustrated a marginal intra rater score of 0.289, compared to [0.711] for the CW scale. The CW had a significantly lower average time to completion of 42.7 (+/- 16.8) seconds compared to 105.6 (+/- 38.9) seconds ($p=0.005$).

Conclusion: Both the ITBAT and CW Scales demonstrate construct validity and consistency in performance and consideration should be given to judicious use in training.

Define Professional Practice Gap & Educational Need: The literature supporting the employment of scales in surgical trainee evaluation is deficient. A more comprehensive evaluation of these instruments is required before use in competency-based education or the accreditation process.

Learning Objective: At this end of this presentation, attendees will appreciate the need for and the process in the genesis of a summative temporal bone grading schema. At the end of this presentation, attendees will become familiar with several of the different temporal bone dissection scales that have supporting literature and gain an appreciation of possible strengths and concerns.

Desired Result: The attendee will be presented with viable grading scales for temporal bone drilling which can be applied to resident physician training. The evidence presented will help the attendee decipher the best scale for their trainees based on consistency of assessment and duration to completion of scale.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Exempt

Density of Macrophage Immunostained with Anti Iba1+ antibody in the Vestibular Endorgans after Cochlear Implantation in the Human

Tadao Okayasu, MD, PhD; Jennifer T. O'Malley, BA; Joseph B. Nadol, Jr., MD

Hypothesis: Cochlear implantation may result in an increase in the density of macrophage in vestibular endorgans in the human.

Background: Vestibular symptoms are a common complication of cochlear implantation. In a previous study we demonstrated histological evidence of a foreign body response caused by silicon and platinum in the human following cochlear implantation. The objective of the current study was to seek evidence of a possible immune response in vestibular neuroepithelium after cochlear implantation.

Methods: The density of macrophages immunostained with anti-Iba1^{+} antibody in the vestibular endorgans (lateral and posterior semicircular canal, utricle and saccule) in ten human subjects who had undergone unilateral cochlear implantation was studied by light microscopy. The densities of macrophages in the neuroepithelium, subepithelial stroma, and dendrites process in the substromal area in four vestibular endorgans in implanted and unimplanted ears were compared. The distributions of phenotypes of macrophages (amoeboid, ramified and transitional) were also compared.

Results: The densities of macrophage in implanted ears in four endorgans were significantly greater than that in unimplanted ears except in subepithelial stroma of the utricle and posterior semicircular canal. In contrast in the neuroepithelium, the stromal distribution of amoeboid macrophages in unimplanted ears was significantly greater than in implanted ears.

Conclusion: Increase in the density of macrophages at four vestibular endorgans after implantation was demonstrated in human. The transition among phenotype of macrophages suggested possible migration of amoeboid macrophages from the subepithelial stroma into the neuroepithelium.

Define Professional Practice Gap & Educational Need: Hypothesis: Cochlear implantation may result in an increase in the density of macrophage in vestibular endorgans in the human.

Learning Objective: The objective of the current study was to seek evidence of a possible immune response in vestibular neuroepithelium after cochlear implantation.

Desired Result: Increase in the density of macrophages at four vestibular endorgans after implantation was demonstrated in human.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Hearing Preservation with the Use of Flex20 and Flex24 Electrodes in Patients with Partial Deafness

Piotr H. Skarzynski, PhD, MD, MS; Henryk Skarzynski, PhD, MD
Beata Dziendziel MS: Joanna J. Rajchel BS
Elzbieta Gos PhD; Artur Lorens, PhD

Objective: To evaluate the impact of electrode length on hearing preservation (HP) in Partial Deafness Treatment Electrical Complement (PDT-EC) subjects.

Study design: Retrospective case review.

Setting: Tertiary referral center.

Patients: The main eligibility criteria were: patient's age ≥ 18 years, preoperative hearing thresholds qualifying PDT-EC subjects and insufficient benefits with conventional hearing aids.

Interventions: All participants were subjected to minimally invasive cochlear implantation using the round window approach with the simultaneous administration of intravenous steroids. The patients were divided into two groups: one has received Flex20 electrode (16 patients) and the second group received the Flex24 electrode (15 patients).

Main Outcome Measure(s): Pure tone audiometry (125-8000 Hz) was performed preoperatively and at 1, 6, 12 and 24 months postoperatively. Hearing preservation (HP) was established using the HEARRING group formula (2013). Speech understanding was assessed preoperatively and at 12 and 24 months postoperatively.

Results: Mixed-design ANOVA with contrasts showed that long-term results in pure tone audiometry were similar for Flex20 and Flex24, although mean hearing thresholds were better for Flex20 in 500 Hz at 1 and 6 months follow-up than for Flex24. At least minimal HP was found in all Flex24 subjects and in 87.5% of Flex20 subjects. Postoperative speech understanding was significantly better after the operation and similar for both groups.

Conclusions: An excellent HP can be observed in PDT-EC patients while using the short flexible MED-EL electrodes. The length of the electrodes (Flex20 vs Flex24) does not affect the degree of HP in the long-term observation.

Define Professional Practice Gap & Educational Need: Although it is currently reported that the length of the electrode affects the hearing preservation, the methodological discrepancies of the studies published so far cause difficulties in drawing the final conclusions. There is lack of studies on hearing preservation with particular electrode types in specific groups of patients with partial deafness, using a well-established hearing preservation classification system.

Learning Objective: To evaluate the impact of electrode length on hearing preservation in homogenous group of patients with partial deafness, testing what electrode length can provide better hearing preservation.

Desired Result: Obtaining further arguments on what length of electrode can bring the best benefits to a demanding group of patients with normal hearing up to 1500 Hz.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Can Unaided Audiologic Testing Be Used as a Surrogate to Determine Cochlear Implant Candidacy?

Stephany J. Ngombu, BA; Aaron C. Moberly, MD

Objectives: The process to evaluate a patient for cochlear implant (CI) candidacy is time- and resource-consuming. Furthermore, without standardized criteria for whom to refer for CI candidacy evaluation, individuals who should receive testing are often overlooked. Our primary objective was to determine whether unaided pure tone audiograms and word recognition scores from adult patients with moderate-to-profound hearing loss would predict CI candidacy in the best-aided conditions during CI evaluation. Secondarily, we sought to determine if older patient age would impact the relationship between preoperative unaided testing and CI candidacy in aided conditions.

Study Design: Retrospective series review

Setting: Tertiary care outpatient clinic

Patients: Medical charts of 800 adult patients referred for CI evaluation from July 1989 through June 2017 were reviewed. Patients were excluded for history of neurofibromatosis type 2 or known cognitive impairment.

Interventions: Diagnostic testing to determine CI candidacy

Main outcome measure(s): Unaided audiologic pure tone averages and word recognition scores were examined as predictors of CI candidacy in best-aided conditions.

Results: Preliminary logistic regression analyses demonstrate that unaided word recognition score in either ear significantly predicts whether a patient is or is not a CI candidate. Additional analyses will be performed to examine the effects of age on this relationship.

Conclusions: Unaided word recognition can predict CI candidacy in adults. Findings suggest that the CI evaluation process might be streamlined to focus on unaided audiologic findings to determine candidacy.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge regarding unaided audiological findings that predict cochlear implant candidacy.

Learning Objective: To recognize unaided audiological findings that predict a patient's cochlear implant candidacy under best-aided listening conditions.

Desired Result: Attendees will be better able to recognize patients in their practice who may benefit from cochlear implantation.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Potential Confounding Factors May Bias the Association between Configurations of the Vertebrobasilar Artery System and the Incidence of Idiopathic Sudden Sensorineural Hearing Loss and Canal Paresis

Ayako Maruyama, MD; Yoshiyuki Kawashima, MD, PhD; Taro Fujikawa, MD, PhD
Taku Ito, MD, PhD; Takamori Takeda, MD; Takeshi Tsutsumi, MD, PhD

Objective: To investigate the impact of configurations of the vertebrobasilar artery system on the incidence of idiopathic sudden sensorineural hearing loss (ISSNHL) and canal paresis (CP).

Study Design: Retrospective case review.

Setting: Tertiary referral center.

Patients: One hundred and fifty consecutive patients diagnosed with ISSNHL and 111 patients with unilateral CP of uncertain cause between January 2011 and December 2015. The unaffected side of 123 patients with Bell's palsy or acoustic tumor served as control.

Interventions: All patients underwent magnetic resonance cisternography. CP was diagnosed with caloric testing.

Main Outcome Measures: 1) Branching patterns of the anterior/posterior inferior cerebellar artery (AICA/PICA) in the cerebellopontine angle area. 2) The direction and degree of the basilar artery (BA) curvature. 3) Vertebral artery (VA) dominance.

Results: The incidence of vascular loops of the AICA/PICA entering the internal acoustic canal and tortuous BA was significantly higher in patients with ISSNHL and CP on both the affected and healthy sides than in controls ($p<0.05$). The incidence of asymmetric VA was significantly higher in CP patients than in controls ($p=0.0033$), while no significant difference in the incidence was observed between ISSNHL patients and controls ($p=0.2363$). Remarkably, we found no correlation in the laterality between the affected ear and any configurations of arteries ($p>0.05$).

Conclusions: Our results indicate that vascular configurations of the vertebrobasilar system do not directly cause ISSNHL and CP. Instead, they suggest the presence of confounding factors that influence the vascular configurations and the development of ISSNHL and CP.

Define Professional Practice Gap & Educational Need: The etiology of SSNHL remains unclear. Among the proposed etiologies, one of the most compelling theories is vascular impairment. Several researchers have recently proposed the hypothesis that the presence of irregular vertebrobasilar artery and its branches increase the risk of SSNHL; however, whether or not the irregular vessels themselves can trigger SSNHL is unclear.

Learning Objective: The learning objective of this study is to confirm the recently proposed hypothesis regarding the etiology of SSNHL and clarify the impact of vascular configurations of the vertebrobasilar system on the development of ISSNHL and unexplained CP.

Desired Result: (How will attendees APPLY the knowledge they learned from the presentation): Attendees will better understand the clinical importance of performing magnetic resonance cisternography in patients with SSNHL and unexplained CP. The incidence of vascular loops of the AICA/PICA entering the internal acoustic canal and tortuous BA may suggest the presence of confounding factors, such as arterial sclerosis.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB: Approved

Comparison of HF Mid-scala and Helix CI Electrode Performance

Arne Ernst, MD, PhD; Rolf Battmer, PhD

Different types of cochlear implant electrodes have been developed to improve speech understanding and to provide a better performance of the cochlea-neural interface. It is therefore the aim of the present study to compare the performance of the HF mid-scala electrode (MS) and the Helix (HX) electrode (both from Advanced Bionics, Valencia, CA) which have different intracochlear positions.

In our prospective, non-randomized series, 51 patients (28 female, 23 female, average age 62 yr at implantation) with similar duration of deafness were included. The MS group (n =29) and the HX group (n = 22) were age- and gender matched and compared with respect to the most comfortable listening levels (M), impedances, monosyllables in quiet (Freiburger test) and a sentence test (OLSA) in adaptive noise at 3, 6 and 12 months. Group medians were compared using the Mann-Whitney U test ($p \leq 0.05$) and a general linear model (GLM) and univariate analysis were conducted to assess multifactorial interaction on main outcome which were monosyllables and speech-in-noise data for the 6 and 12-months' follow-up.

Median scores for the monosyllables in quiet for the MS group were significantly better than the HX group at each test interval ($p \leq 0.05$). Speech perception in quiet also significantly improved from 3 to 12 months for both groups ($p \leq 0.01$). There was no significant difference between the groups for speech in noise. Impedances were significantly lower for the MS group at 12 months ($p \leq 0.05$) except at the basal end and M levels were generally higher.

The MS group has better median performance for monosyllables in quiet than the HX group at each test interval although performance in noise was similar. For speech-in-noise, the MS group appeared to reach optimum performance quicker than the HX group. Impedance were lower in the MS group, other than at the most basal end and confirm the hypothesis that the MS as an array aimed at neither touching the modiolus nor the lateral wall when being placed in scala tympani has a more lateral position than the HX which contributed to this different performance.

Define Professional Practice Gap & Educational Need: Cochlear implant Technology has been improved over time largely by modifying electrode size/shape withe aim of atraumaticity in Insertion and, thus, preserving residual Hearing. This series is aimed at comparing two different electrodes of one manufacturer with respect to performance over a 12-months' period.

Learning Objective: The learning objective of this study to produce awareness among the surgeons that Performance data differ significantly between These two electrodes, even if personal attitudes lead to some preferences because of the handling.

Desired Result: The results of this study support that the mid scala electrode gives better audiological results in a 12-months' period than the Helix one.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Evaluation of a Wireless CROS Device with the NAIDA Q90 Speech Processor

Arne Ernst, MD, PhD; Rolf Battmer, PhD

It is the aim of the present study to investigate hearing aid technology feature and their impact in uni/bilateral CI and bimodal device users.

In our prospective, non-randomized series, 30 patients (16 female, 14 female, average age 49 yr) were investigated at baseline and 1 / 3 months after re-fitting. Ten patients each (3 groups) were recruited: unilateral CI users (A), bilateral CI users (B) and bimodal CI users with one CI and a contralateral hearing aid (C). At baseline, their performance with a conventional T mic was measured with a sentence test (OLSA) in noise and localization was tested (ONE - SO/N60/120/180) or (TWO -S0/N30/60/180). After refitting with UltraZoom (A), they were re-tested. Group B was given Ultra & StereoZoom mics and group C was fitted with a contralateral Phonak Naida Link hearing aid (HA) and loudness balancing. Controls were normal hearing subjects.

There was a significant advantage for Ultra/StereoZoom for all groups.The largest advantage (StereoZoom) was in group (B) and a significant advantage for StereoZoom over UltraZoom in group C ($p \leq 0.001$). Group B performed as well as controls in both lateralization setups and group C as well as in setup ONE. There was a significant benefit of 1.8 dB (sentence test) for ClearVoice over UltraZoom in group (A).

Ultra/StereoZoom microphone technology at the speech processor level provided a clinically and statistically significant benefit over the T mic and helps to improve CI performance significantly, particularly in those specific patient populations.

Define Professional Practice Gap & Educational Need: Cochlears implants were deeply influenced by modern hearing technology features (zoom/directional microphones, acoustic Input Streaming) from the hearing aid Industry. This is of great importance for patients with bimodal, unilateral, but to some extent also for bilateral CI users, particularly in noise and for spatial hearing. The impact of those Features should be systematically investigated to better counsel our patients and to better understand the Ratio of this approach.

Learning Objective: The learning objective of this study is to better understand that modern hearing aid features as combined or incorporated into CI technology can offer our patients an additional Benefit which leads to a hearing performance that comes close to normal Hearing controls.

Desired Result: The results of this study support the hypothesis that state-of-the-art hearing Technologies improve the Performance of CIs.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Exempt

Use of Google Trends to Evaluate for Geographical or Seasonal Variation in Search Terms for Benign Paroxysmal Positional Vertigo

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Brian D. Nicholas, MD

Objective(s): Google Trends is an increasingly used tool in the healthcare field, but its use in the field of otolaryngology has been limited to date. To assess its viability as a research tool, we examined search frequencies for terms related to benign paroxysmal positional vertigo (BPPV). By comparing frequencies between cities at different latitudes and throughout seasons, we assessed if suspected associations are reflected in online data.

Study Design: Retrospective database analysis.

Methods: Google Trends search frequency data from 5 U.S. cities for terms related to BPPV were obtained and compared. In addition, monthly averages were compared to detect seasonal variation. Data was analyzed in SPSS through ANOVA analysis.

Results: Latitude affected the search frequency for terms related to BPPV – averages between cities were almost always statistically different. However, there was not always a consistent trend with change in latitude. Comparison of monthly averages showed that individual search terms appear to demonstrate seasonal fluctuations.

Conclusion(s): BPPV related search term frequencies demonstrate differences among varying latitudes, but not always in a consistent trend. This may be reflective of previously published data suggesting that sunlight exposure and vitamin D levels may play a role in the pathogenesis of BPPV. There were seasonal variations among search terms for BPPV. This may suggest that Google Trends or other big data tools may be beneficial when comparing search frequencies in a categorical manner as a proxy for relative disease incidence.

Define Professional Practice Gap & Educational Need: Knowledge of Google Trends applicability and viability within the field of otolaryngology is limited.

Learning Objective: We will explore the benefits and limitations of Google Trends as a research tool within the field of otolaryngology.

Desired Result: Increasing physician awareness of Google Trends as a research tool specifically for the field of otolaryngology.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Exempt

Utility of the EAONO/JOS Staging System to Predict Cholesteatoma Recidivism after Canal-Wall-Up Tympanomastoidectomy

Simon I. Angeli, MD; David Shahal, MD; Bjorn Herman, MD

Objective: Evaluate the utility of the classification and staging system for acquired cholesteatoma proposed jointly by the European Academy of Otology and Neuro-otology and the Japan Otological Society (EAONO/JOS) to predict recurrent or residual disease.

Study design: Retrospective cohort.

Setting: Tertiary referral center.

Patients: Adults and children with acquired cholesteatoma.

Interventions: Primary and planned-second look tympanomastoidectomy.

Main outcome measure: Occurrence of recurrent and/or residual cholesteatoma during planned second-look tympanomastoidectomy. The independent variables were age, gender, size of canal defect, mucosa status, and cholesteatoma classification (pars flaccida and/or tensa), stage (I-IV), and site involvement (STAM: S1 supratubal recess, S2 sinus tympani, T tympanic cavity, A attic, M mastoid).

Results: There were 12 (9.6%) cases of cholesteatoma recidivism: recurrent cholesteatoma in five cases, residual cholesteatoma in six cases, and one additional patient with both recurrent and residual disease. Residual cholesteatoma was noted more frequently in children than in adults (Fisher's exact test, 2-tail, p=0.041, RR=7.89 [95% CI 0.98, 63.6]). Supratubal recess (S1) disease was associated with recurrent cholesteatoma (p=0.0384, RR of 5.944 [95% CI: 1.299, 27.191]) as well as with recidivism (p=0.014, RR 4.24 [95%CI: 1.511, 11.933]). Among other staging and clinical factors, only the presence of a large canal defects showed an association with residual disease.

Conclusion: Young age and large ear canal defects were associated with residual disease and S1 disease was associated with recurrence. While the EAONO/JOS classification and staging system for cholesteatoma facilitates description of the type and extent of disease, its prognostic value is still not proven.

Define Professional Practice Gap & Educational Need: There is lack of a universally accepted staging system for acquired cholesteatoma that provides prognostic and outcome information

Learning Objective: After completing this activity, participants with learn the new staging system for acquired cholesteatoma proposed jointly by the European Academy of Otology and Neuro-otology and the Japan Otological Society (EAONO/JOS), and its value to predict recurrent or residual disease after canal-wall-up tympanomastoidectomy

Desired Result: Attendees will learn to apply a newly proposed staging system to describe the extent of cholesteatoma involvement and obtain an understanding of its use in prognosis

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

A Protocol for Intra-operative Imaging of Cochlear Implantation

Stephanie J. Wong, MD; Alexis M. Strohl, MD; Benjamin T. Crane, MD, PhD

Objectives: Correct electrode placement is a challenge of cochlear implant surgery, which occurs because electrode position cannot be directly visualized. This work aims to 1) Develop a protocol for a practical, quick, consistent, single view plain radiograph able to be used to confirm electrode position, 2) test its utility for identifying misplaced electrodes in cadaveric heads, 3) confirm its utility on patients.

Study design: Study in specimens and clinical case series.

Setting: Tertiary academic hospital

Patients: Cadaveric heads, and patients undergoing cochlear implantation

Intervention(s): An intra-operative imaging protocol was developed specifying patient head position, machine and film position, and exposure. It was tested using intentionally misplaced electrodes in cadaveric specimens. This technique is used to confirm proper cochlear implantation in patients, during initial and revision surgery.

Main outcome measure(s): Ability to accurately identify electrode insertion based on radiographic images

Results: After adjusting radiographic exposure to account for the embalming process of the cadaveric heads, this new protocol was confirmed to be able to identify incorrect placement. This was also successfully used to confirm proper placement of cochlear implants in both adult and pediatric patients. The protocol allowed verification of the electrode position prior to awaking the patient. Cases of tip fold over, slide back after full insertion, and incorrect insertion were identified and corrected on the operating table.

Conclusions: Following a standardized radiographic protocol for cochlear implantation is a quick and easy method for checking electrode position.

Define Professional Practice Gap & Educational Need: The inconsistent and/or suboptimal use of imaging to confirm electrode placement for patients undergoing cochlear implantation.

Learning Objective: 1) Appreciate the value for consistent and practical intra-operative imaging to confirm correct cochlear implantation, 2) better understand a protocol specifying patient head position, machine and film position, and exposure, and 3) accurately identify electrode insertion based on radiographic images

Desired Result: 1) Reduce incidence of misplaced electrodes during cochlear implantation, and 2) To reduce the number of x-rays that are taken to get adequate visualization, thus decreasing radiation exposure and cost

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - IRB exemption was established for the use of imaging of the cadaveric heads and IRB approval was acquired from the University of Rochester's Research Subjects Review Board.

Cochlear Implantation in Labyrinthitis Ossificans: Long-term Outcomes

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Jourdan T. Holder, AuD; David S. Haynes, MD, MMHC
Matthew R. O'Malley, MD; Alejandro Rivas, MD

Objective: To describe long-term audiologic and surgical outcomes of cochlear implantation (CI) in the setting of labyrinthitis ossificans.

Study Design: Retrospective case review.

Setting: Tertiary referral center.

Patients: 13 ears in 11 patients with labyrinthitis ossificans who underwent CI from 2002-2017

Interventions: Rehabilitative (CI).

Outcome measures: Surgical outcomes, audiologic testing.

Results: Thirteen ears were included (61.5% female, 34.4 years) at the time of CI. Etiologies of labyrinthitis ossificans included meningitis (n=5), unknown (n=5), otosclerosis (n=1), chronic ear disease (n=1), and autoimmune-related (n=1). The median follow-up was 5.2 years (range, 1.3-12.2 years). Electrode insertion was achieved through cochleostomy (n=5), drilling of the basal turn (n=5), or round window approach (n=3). Electrode types included perimodiolar (n=8), lateral wall (n=4), and double array (n=1). Three cases resulted in incomplete insertion with 3-6 extracochlear electrodes. At last follow-up, 5 cases demonstrated improvement in speech understanding, 5 had no perceivable benefit, and 2 had improvement in sound awareness. Audiologic success was not correlated with duration of deafness (p=0.23), surgical approach (p=0.35), extent or etiology of ossification (p=0.6, p=0.2, respectively). One patient experienced a soft failure associated with a severe decline in performance 4 years postoperatively and was recommended to undergo CI replacement. Two patients underwent explantation for lack of benefit in the setting of facial stimulation (n=1) and pain (n=1).

Conclusions: CI in the setting of labyrinthitis ossificans may provide a significant audiologic benefit, however, the extent of benefit is highly variable and overall unpredictable. No specific markers of good performance were encountered.

Define Professional Practice Gap & Educational Need: Lack of knowledge regarding long-term outcomes in patients with labyrinthitis ossificans who undergo cochlear implantation.

Learning Objective: Present long-term surgical and audiologic outcomes for patients with labyrinthitis ossificans who undergo cochlear implantation.

Desired Result: Attendees will learn that in the long-term, over 50% of this patient population does have objective and subjective benefit from cochlear implantation, however, no preoperative findings are good predictors of long-term success. This information may be used in practice for clinical decision-making and patient counseling.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Approved

Scalar Location and Modiolar Proximity in Precurved Electrode Arrays Inserted using an External Sheath with Over-Insertion and Pull-Back Technique

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Jack Noble, PhD; Robert F. Labadie, MD, PhD
Marc L. Bennett, MD, MMHC; Alejandro Rivas, MD

Objectives: To determine intracochlear electrode position for precurved electrode array inserted using an external sheath and to determine the impact of slight over-insertion followed by pull-back upon final electrode position.

Study Design: Retrospective case review.

Setting: Tertiary referral center.

Patients: 38 ears (26 adult, 12 pediatric) undergoing cochlear implantation (CI) with precurved electrode array inserted using an external sheath.

Interventions: CI followed by computed tomography (CT).

Outcome measures: scalar location; average distance from electrode to modiolus, $\bar{M}$; angular insertion depth

Results: Seventy-four ears were implanted with precurved electrode arrays inserted using an external sheath (from 2016-2018). Thirty-eight implants with post-implantation CT were included. One implant (2.6%) exhibited translocation at 124° with an angular insertion depth of 261°. The remaining 37 (97.4%) had all electrodes located entirely within scala tympani. One instance of tip fold-over using standard insertion technique was noted intraoperatively and resolved with repositioning. Overall $\bar{M}$ ± standard deviation was 0.39±0.17mm with apical, middle, and basal electrode subgroups having $\bar{M}$ of 0.2±0.12mm, 0.52±0.34mm, and 0.48±0.25mm, respectively. Slight over-insertion and pull-back, controlling for each performing surgeon, resulted in statistically significant lower $\bar{M}$ (0.31mm) compared to those inserted using conventional technique (0.59mm, p=0.001) but was not associated with a significantly different angular insertion depth (p=0.11).

Conclusions: A new precurved electrode inserted using an external sheath had very low rates of translocation or tip fold-over. Slight over-insertion and subsequent pull-back improved electrode proximity to the modiolus.

Define Professional Practice Gap & Educational Need: Lack of knowledge regarding electrode positioning, modiolar distance, and angular insertion depth in a precurved electrode array inserted using an external sheath, as this information has practical applications in audiologic outcomes. Need for improved insertion technique that may maximize benefits of a precurved electrode.

Learning Objective: To determine electrode positioning, modiolar distance, and angular insertion depth in a precurved electrode array inserted using an external sheath and to determine the impact of electrode over-insertion and pull-back technique on electrode location.

Desired Result: Attendees will learn that the precurved electrode array inserted using an external sheath has minimal rates of translocation and tip fold-over (rates are comparable to a lateral wall electrode), which are important for hearing preservation and audiologic outcomes. The over-insertion and pull-back technique offers improved modiolar proximity. Both these conclusions impact clinical decision-making in electrode selection for patients as well as surgical technique in the OR.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Approved

Cochlear Implantation in Patients with Ménière's Disease: Does Disease Activity Affect the Outcome?

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Nauman Manzoor, MD; Gail S. Murray, PhD; Cliff Megerian, MD
Maroun T. Semaan, MD

Objective: Ménière's disease (MD) is characterized by episodes of vertigo, tinnitus, and sensorineural hearing loss (SNHL). In the setting of bilateral deafness due to MD alone or contralateral pathology, cochlear implantation (CI) improves hearing. Active MD is characterized by fluctuating auditory symptoms and vertigo; whereas remittance of vertiginous symptoms and severe, permanent SNHL characterizes the non-active disease state. This study evaluates outcomes for MD patients compared to the general CI population and assesses if disease activity affects implant outcomes.

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Patients: 23 patients with MD that received CI (7 active, 16 non-active, and 1 unknown), and 23 age-matched controls.

Intervention(s): Cochlear implantation.

Main outcome measure(s): Pure Tone Audiometry (PTA), Word Recognition Scores (WRS), Sentence Recognition Scores (SRS), and Speech Reception Thresholds (SRT).

Results: Best-aided preoperative and postoperative audiometric data were compared per ear between MD patients and controls and stratified by disease status using descriptive statistics with mixed-effects modeling. Patients with MD derived significantly more benefit from CI than controls when comparing differences between preoperative and postoperative levels for WRS (12.2%, p=0.0236), SRS (12.8%, p=0.0375), and SRT (-14.4 dB, p=0.0188), but not PTA. Patients with active MD had significantly greater gains in SRS (23.5%, p=0.0107) than non-active MD patients.

Conclusions: CI provides greater gains in functional hearing for patients with MD compared to age-matched controls. Patients with active MD seem to perform better with respect to SRS following CI than patients with non-active status.

Define Professional Practice Gap & Educational Need: Inconsistencies of outcomes of cochlear implantation in patient's with Ménière's disease and whether disease activity affects the outcome.

Learning Objective: To learn Ménière's disease and characteristic symptoms, indications for cochlear implantation, explore the outcomes for MD patients compared to the general CI population and assesses if disease activity affects implant outcomes.

Desired Result: Better understand the indications of cochlear implantation in Ménière's disease and learn about outcomes depending on the activity of the disease.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Approved

Stryker Surgical Simulator: Temporal Bone Simulator Validation Study

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Andrea McGlynn, MS; Allen O. Mitchell, MD; Craig R. Folsom, MD

Background: The Stryker Surgical Simulation (S3) is a hybrid, temporal bone simulator that uses both tactile and haptic feedback combined with a computer interface. We sought to validate S3 as an otolaryngology resident training tool for performing tympanomastoidectomies.

Methods: Fifteen residents and staff performed 5 basic cortical mastoidectomies. Subjective evaluation of the face validity and content validity was performed via pre and post questionnaires. Objective evaluation of content validity was assessed by blinded assessment of each temporal bone dissection specimen by a senior neurotologist.

Results: The residents had a longer drilling time on the first trial (43 vs. 28 minutes) but approached the staff group drilling time by the conclusion of the last trial. The mean staff Likert scale response for face validity was 4.5 compared to the trainee group mean response of 3.9 ($p = 0.22$). The mean staff response for content validity was 4.9 compared to the trainee group mean response of 4.3 ($p = 0.30$). The mean staff response for global assessment was 4.8 compared to the trainee group mean response of 5.0 ($p = 0.69$).

Conclusion: Both groups rated the simulator favorably on face validity, content validity and in all global assessment categories. Resident drillers showed progressively decreasing drilling times on serial trials, approaching staff performance times. Objective discrimination between experienced and novice participants was not achieved, likely due to low power. However, the data can be used to show the positive training merits of a hybrid simulator system using a temporal bone insert model.

Define Professional Practice Gap & Educational Need: 1. Shortage of validated, temporal bone simulation for resident training 2. Reduced surgical experience for resident surgeons in light of decreasing national cadaver availability

Learning Objective: The learner should acquire an improved understanding about need for validated surgical simulation, as well as an unique approach to qualitatively and quantitatively evaluate a novel surgical simulator.

Desired Result: The learner should be able to apply the principles of simulator validation to ensure residents are using only appropriate and accurate simulators in training.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

Comparison of Materials Used for 3D-Printing Temporal Bone Models to Simulate Surgical Dissection

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Armine Kocharyan, MD; Elias Kikano, MD
Nicholas Moon, BA Sarah E. Mowry, MD

Hypothesis: Identification of optimal materials for 3D printed temporal bones that closely mimic the experience of drilling native temporal bone has great potential application in skull base surgical training.

Background:3D printed temporal bones have been created and validated as adequate models for surgical planning and trainee education. There are many different printers and materials available to create these models. To date there has not been a head to head comparison of these different materials with regard to the "best" materials to utilize for the models.

Methods:3D printed temporal bones were constructed using 5 different materials and 4 printers. Evaluation of drilling of the different models by 4 skull base surgeons and 4 senior otolaryngology/ neurosurgery residents assessed the haptic experience of drilling and recreation of the temporal bone anatomy.

Results: Results demonstrate the photopolymer and polycarbonate models served as accurate simulators for cadaveric bone drilling, and both the photopolymer and Acrylic-White model most accurately recreate a model for cortical mastoidectomy. Although ABS closely replicates change in pitch during *in vivo* temporal bone surgery, it generates the most odor and least accurately replicates the anatomy of the mastoid, antrum, tegmen, and otic capsule. Acrylic-Blue performed poorly in simulation, likely due to its dark color and translucent appearance.

Conclusions: This work demonstrates that 3D printing temporal bones with different materials results in variable recreation of the temporal bone anatomy and drilling experience. Overall, the Photopolymer used in this work serves to recapitulate temporal bone drilling most accurately.

Define Professional Practice Gap & Educational Need: There currently exists a gap between current surgical trainee drilling methodologies and practical application of these practices. Temporal bone dissection using cadaver specimens has historically been a standard educational tool for teaching otologic surgery. However, access to cadaveric resources has increasingly become more difficult. To overcome this limitation, this work identifies different materials for application in 3D-printing temporal bones for use in surgical dissection training and surgical planning.

Learning Objective: Current literature describes the use of 3D-printed temporal bones for application in skull base surgical training. However, to date, there has not been a head to head comparison of these different materials with regard to the "best" materials to utilize for the models. Therefore, the overall goal of this research project is to investigate which 3D-printed model looks and drills most like a cadaveric bone. This study will result in exciting new data that will hopefully change skull base drilling training by providing a realistic dissection experience for established surgeons as well as otolaryngology and neurosurgery residents, without the need for costly cadaveric bones.

Desired Result: There are many different desktop printers and materials available to create temporal bone models. This work examines the ideal material to 3D-print temporal bones for surgical drilling. Different temporal bone constructs were printed using patient-specific 3D models based on computed tomography data which was digitalized and segmented using Mimics software. Therefore, attendees can 3D print patient-specific models using a desktop printer at their home institutions to create constructs for surgical dissection practice as well as enhanced preoperative planning. Practice drilling using a replica of a patient's own temporal bone has the potential to improve intraoperative decisions and patient outcomes.

Level of evidence does not apply because: The work presented did not include patients clearly divided into trials. Each 3D printed construct was compared to all other constructs.

IRB - Approved

Comparison of Transcanal Endoscopic and Microscopic Improved Simple Underlay Myringoplasty

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Shintaro Fujimura, MD; Hiroki Kagoshima, MD
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Objective: Simple underlay myringoplasty using a microscope, which was first developed by Yuasa in 1989, is widely performed for repairing a tympanic membrane (TM) perforation, however closure rate by Yuasa's procedure is not so high. We hypothesized that TM perforation may not be completely repaired by simple underlay myringoplasty because of delayed wound healing of the TM epithelium in a dry environment and displacement of the graft from the TM perforation edge. Therefore, we modified conventional simple underlay myringoplasty. On the other hand, recently an endoscope is becoming more frequently used in middle ear surgery. Endoscopic ear surgery (EES) is suitable for simple underlay myringoplasty. The objectives of this study are to show the effectiveness of our improved simple underlay myringoplasty techniques, and to compare the results of endscopic myringoplasty with that of microscopic myringoplasty.

Study design: Retrospective medical records review

Patients: Eighty four patients having TM perforation who underwent our improved underlay myringoplasty at Tenri Hospital

Methods: Patients were divided into 45 patients in microscopic ear surgery (MES) group and 39 patients in EES group. Closure rate of TM, hearing improvement and operation time were all assessed and compared between two groups.

Results: Closure rate in MES and EES group were 91.1% and 84.6%, respectively. Hearing improvement of MES and EES group were achieved 94.6% and 100%, respectively. Mean operation time of MES and EES group were 39.5±12.7 minutes and 44.0±16.3 minutes, respectively. These values were not significantly different.

Conclusion: Favorable outcomes were obtained using our improved simple underlay myringoplasty.

Define Professional Practice Gap & Educational Need: In this presentation, we modified conventional Yuasa's simple underlay myringoplasty because the rate of successful closure by conventional procedure is not so high. This concern is a professional practice gap. Therefore, this presentation is valuable for educational need of clinicians performing simple underlay myringoplasty.

Learning Objective: Low closure rate of a tympanic membrane perforation using conventional Yuasa's procedure is a problem to be solved. The learning objective in this presentation is useful for filling the identified practice gap.

Desired Result: In this study, favorable outcomes were obtained using our improved simple underlay myringoplasty. Therefore, Attendees will apply the knowledge gained from this presentation for better medical treatment of a tympanic membrane perforation.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Exempt

Educational Value of Endoscopic Versus Microscopic Ear Surgery

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Objective: Despite recent enthusiasm for endoscopic ear surgery, studies comparing endoscopic and microscopic outcomes have largely shown equivalence. We hypothesize that endoscopic ear surgery will have superior educational value to microscopic ear surgery among medical students.

Study Design: Prospective survey

Setting: Tertiary care academic medical center

Intervention: A survey was anonymously completed by third- and fourth-year medical students immediately after they observed either endoscopic or microscopic ear surgery

Main Outcome Measures: 21 items on a Likert scale (1=worst, 5=best) spanning 4 domains: (1) view of specific anatomic structures, (2) ability to see area of interest, (3) video quality assessed by the validated Maryland Visual Comfort Scale, (4) perceived educational value

Methods: Unpaired T-tests were used to compare score differences between the endoscopic and microscopic groups, with a Benjamin-Hochberg adjustment for multiple comparisons. Individual items and domain means were compared.

Results: 32 surveys were completed (12 endoscopic, 20 microscopic). Across domains, the endoscope was superior to the microscope for perceived educational value (4.68 vs 3.95, raw p=0.0009, adjusted p=0.004). Across individual items, the endoscope was superior to the microscope for view of the ear canal (5.00 vs. 4.38, raw p=0.003, adjusted p=0.03), ability to clearly hear the attending's voice (4.75 vs. 3.85, raw p=0.004, adjusted p=0.03), and understanding surgical steps (4.75 vs 3.95, raw p=0.0008, adjusted p=0.02). The microscope was not superior for any items.

Conclusions: Endoscopic ear surgery was superior to microscopic ear surgery for several key educational items among medical students. This has implications for improving surgical training.

Define Professional Practice Gap & Educational Need: There is variation on the visualization tool that otolaryngologists use when performing ear surgery. This gap exists because measurable advantages of endoscopic versus microscopic techniques, including educational value, are unclear. Educational Needs: Attending physicians need to understand whether endoscopic or microscopic ear surgery have advantages for teaching students/trainees.

Learning Objective: To learn whether endoscopic or microscopic ear surgery has superior educational value across a span of domains.

Desired Result: The potentially superior educational value of endoscopic ear surgery should be considered when otolaryngologists are performing ear surgery with students/trainees present.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB: Approved

Prospective Evaluation of Opioid Consumption after Otologic Surgery

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Noor S. Ali, MD; Taha A. Jan, MD; Nikolas H. Blevins, MD

Objective: To prospectively evaluate opioid consumption following outpatient otologic surgery.

Study design: Prospective observational

Setting: Single tertiary referral center

Patients: Patients scheduled for otologic surgery who did not have a history of chronic opioid use were recruited between February and September 2018.

Interventions and Main Outcome Measures: All participants underwent otologic surgery and received postoperative opioid prescriptions per the surgeons' regular prescribing patterns. Opioid consumption was queried using telephone or in-person surveys administered between postoperative day 5 and 15. Patient demographics, surgical details, and opioid prescription patterns were abstracted from medical records. Opioid dispensation records were reviewed through the California Department of Justice.

Results: 43 patients with an average age of 50±18 years were prescribed 65.4±39.9 mg of morphine equivalents (ME) and consumed 32.8±38.6 mg ME over the course of 2.6±2.2 days postoperatively. Patients who received a postauricular incision (27/43 patients) were prescribed significantly more than those who underwent transcanal procedures (18/43 patients) (78.5 vs 47.9 mg ME; t-test, p=0.01), consumed significantly more (45.5 vs 15.8 mg ME; t-test p=0.01), and for a significantly longer duration (3.4 vs 1.6 days; t-test, p=0.01). Of the postauricular incisions, there was no significant difference in consumption between those who underwent mastoidectomy (14/27 patients) with those who did not (13/27 patients) (40.0 vs 52.0 mg ME; t-test, p=0.05).

Conclusions: Patients in our cohort consumed approximately half of the prescribed opioids. Those with postauricular incisions used significantly more than those with transcanal incisions. Postoperative opioid prescription recommendations should be tailored according to the extent of surgery.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness of postoperative opioid needs and consumption patterns in patients following otologic surgery 2. Inconsistencies in prescribing patterns for opioids after otologic surgeries

Learning Objective: 1. To characterize opioid prescription, dispensation, and consumption patterns as it relates to otologic surgery

Desired Result: 1. Attendees should tailor their opioid prescription patterns according to extent of surgery 2. Attendees should appreciate how patients typically consume approximately half of the prescribed opioids after otologic surgery, which is consistent with consumption patterns in other types of surgery

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Approval

Sensitivity of High-Resolution Computed Tomography in Otosclerosis Patients Undergoing Primary Stapedectomy

Anne K. Maxwell, MD; Mohamed Hosam, MD
Adam Master, MD; William H. Slattery, III, MD

Objective: To determine the incidence of abnormal otospongiotic or otosclerotic findings on high-resolution computed tomography (HRCT) as read by local radiologists in patients with surgically-confirmed otosclerosis.

Study design: Retrospective chart review.

Setting: Tertiary-referral private otology-neurotology practice.

Patients: Adults (>18 years old) who underwent primary stapedectomy between 2012-2017 who also had a preoperative HRCT.

Intervention: Preoperative HRCT then stapedectomy.

Main outcome measures: Positive identification and location of otosclerosis as reported by the local radiologist. We then correlated this with surgical location as documented at time of surgery. Audiometry, demographic data, intraoperative findings, and surgical technique were secondarily reviewed.

Results: 708 stapedectomies were performed during the study time frame. Preoperative HRCT scans were available for 70 primary stapedectomy surgeries performed in 56 patients. Otosclerosis was reported in 20/70 (28.6%). Following a negative report by the local radiologist, a re-review by the surgeon and/or collaborating neuroradiologist confirmed otosclerosis in 10/50 additional cases (20%). There was an overall sensitivity of 43%. Intraoperatively, cases with negative reads tended to have more limited localization at the ligament (8.3%) or anterior crus (37.5%), compared with positive reads, which demonstrated more extensive involvement, with bipolar foci (30.0%), diffuse (20.0%), or obliterated (5.0%) manifestations more common. Acoustic reflexes were characteristically absent.

Conclusions: While HRCT may aid diagnosis and rule out concomitant pathology in certain cases of clinical uncertainty or unexplained symptoms, its sensitivity for otosclerosis remains low. HRCT should not be relied upon to diagnose routine fenestral otosclerosis.

Define Professional Practice Gap & Educational Need: Prior studies have investigated sensitivity of high-resolution computed tomography (HRCT) when read by neuroradiologists in a study setting. In clinical practice, however, patients are often referred for initial consultation with a CT report and no study images. In this setting, there is a lack of knowledge of the more clinically-applicable question of sensitivity of the local radiologist's interpretation of otosclerosis as documented in the CT report.

Learning Objective: To understand the low sensitivity of HRCT as read by local radiologists in patients with surgically-confirmed otosclerosis.

Desired Result: Attendees will maintain a high level of suspicion for otosclerosis even if a preoperative HRCT is negative for the disease. Additionally, attendees will not order HRCT for diagnostic workup of otosclerosis in routine cases with no unusual symptoms, thereby reducing financial waste in the medical system.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB: Approved

Management of Acute Mastoiditis with Immediate Needle Aspiration for Subperiosteal Abscess

Noam Bartov, MD; Yonatan Lahav, MD; Gil Lahav, MD
Elchanan Zloczower, MD; Udi Katzenell, MD
Ohad Hilly, MD; Hagit Shoffel-Havakuk, MD

Objectives: To assess the safety and outcome of a conservative management scheme of acute mastoiditis with immediate myringotomy and postauricular needle aspiration of a subperiosteal abscess.

Study Design: Retrospective cohort.

Setting: Tertiary referral-hospital.

Patients: 283 Children (age<12) with acute mastoiditis admitted between 1999 and 2017. Data collection includes patient characteristics, signs and symptoms, physical examination, laboratory tests, treatment regime, imaging findings and long-term outcomes.

Intervention: Treatment under a conservative management scheme of acute mastoiditis, with immediate myringotomy and postauricular needle aspiration of a subperiosteal abscess. Computed tomography and mastoidectomy were reserved for selected cases.

Main outcomes: Duration of hospitalization, readmission rate, immediate intracranial complications and late neurologic or otologic complications.

Results: Ninety-eight children (34.6%) had a suspected subperiosteal-abscess on admission and underwent a trial of immediate postauricular needle aspiration, and 56.1% (55 cases) were positive. Of these 55, 83.6% (46) did not subsequently undergo mastoidectomy. Twenty-four additional children had a subperiosteal-abscess, proven by computed tomography or surgery, bringing the total subperiosteal abscess cases to 79 (27.9%). Of children with proven subperiosteal abscess, 70.9% (56) did not subsequently undergo mastoidectomy. Intracranial complication rates were 4.9% (14) and 8.8% (25) underwent mastoidectomy. Long term follow-up was available for 250 children with one child suffering a moderate bilateral mixed hearing-loss. There were no cases of neurological sequela.

Conclusions: Conservative management of acute mastoiditis, involving prompt myringotomy for all patients and postauricular needle aspiration for subperiosteal abscess, is safe, effective, and reduces the need for computed tomography and mastoidectomy. Conservative management obviates unnecessary radiation, general anesthesia and surgery, without increasing the risk of complications.

Define Professional Practice Gap & Educational Need: 1. No consensus regarding whether children with acute mastoiditis and a sub-periosteal abscess should be treated aggressively, i.e. with a computed tomography and a cortical mastoidectomy or conservatively, with a needle aspiration of the abscess. 2. No long term data showing that conservative treatment is safe.

Learning Objective: To create a better understanding of how to treat children with mastoiditis and a sub-periosteal abscess. To understand the safety of a conservative treatment.

Desired Result: When dealing with a child with acute mastoiditis with a subperiosteal abscess, a myringotomy and a post-auricular needle aspiration of the abscess are the first actions needed. All children should also receive a parenteral antibiotic treatment. Children who have signs of an intracranial complication on presentation, or those who fail to improve in 48 hours, under the initial treatment, should undergo a computed tomography and a cortical mastoidectomy.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Approved

Predicting Cochlear Implant Candidacy using Routine Audiometric Data

John Wilson IV, BS; Ashley Altman, MD; Jeffrey Yu, MD

Objective: To determine whether cochlear implant candidacy can be reliably predicted using data from routine audiograms.

Study design: Retrospective case review.

Setting: Ambulatory patients at a tertiary referral center.

Patients: 41 English speaking adults (62 ears) that received audiogram testing prior to formal cochlear implant evaluation using AzBio in quiet.

Main outcome measure(s): Receiver operating characteristic (ROC) curves, sensitivity, specificity, and negative/positive predictive values were compared among different prediction methods.

Result(s): The word recognition score (WRS) threshold of ≤ 20% had a sensitivity of 92% and a specificity of 93% for predicting cochlear implant candidacy in the ipsilateral ear (defined as scoring ≤ 40% on AzBio testing). The positive predictive value was 96% and the negative predictive value was 75%. The four-frequency pure tone average (4FPTA) threshold of 70 dB HL had a sensitivity of 96% and a specificity of 31%. The positive predictive value was 85% and the negative predictive value was 75%.

Conclusions: In our sample of adults with significant hearing loss, WRS represents the most useful screening method to determine cochlear implant candidacy in the ipsilateral ear.

Define Professional Practice Gap & Educational Need: 1. Lack of contemporary knowledge for when to refer patients with hearing loss to a cochlear implant center.

Learning Objective: 1. To inform clinicians on how to predict cochlear implant candidacy using routine audiograms.

Desired Result: 1. Clinicians will incorporate this information into their practice to improve referral patterns and avoid gaps in the cochlear implantation process in order to improve hearing outcomes in the population at large.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Approved

Cochlear Histopathology in Human Genetic Hearing Loss: Implications for Gene Therapy

Krishna Bommakanti, BA; Janani Iyer, BA
Konstantina M. Stankovic, MD, PhD

Background: Sensorineural hearing loss is the most common sensory deficit, disabling 466 million people worldwide. Everything we know about the cellular basis of human deafness comes from studies of human temporal bones *post mortem*. Because the inner ear is small and encased in the densest bone in the body, it evades cellular-level imaging *in vivo* and diagnostic biopsy. With over 6000 variants in over 150 deafness-causing genes identified, it is astounding that human cochlear histopathology has been reported for only 14 genes.

Objectives: Review all cases of human inner ear histopathology for all causes of genetic hearing loss. Compare and contrast human findings with cochlear histopathology in mouse models of the corresponding genetic hearing loss.

Study selection, data extraction, & synthesis: A review of literature was performed and relevant studies were identified by searching the PubMed database. Our search was completed in July 2018. In total, 42 human temporal bones have been studied for genetic causes of hearing loss. Fourteen genes underlying nonsyndromic and syndromic causes of hearing loss were identified. Of these 14 genes, ten have been studied in animal models.

Conclusion: This study presents a comprehensive account of human temporal bone histopathology that has been used to study genetic causes of hearing loss. Additionally, we compare and contrast this data to the corresponding mouse models. Our analysis highlights the major unmet medical need to develop tools for cellular-level diagnosis of hearing loss in living people, and to monitor responses to emerging genetic and pharmacologic therapies.

Define Professional Practice Gap & Educational Need: 1. Lack of awareness 2. Lack of contemporary knowledge

Learning Objective: We aim to review all cases of human inner ear histopathology for all causes of genetic hearing loss. We also compare and contrast human findings with cochlear histopathology in mouse models of the corresponding genetic hearing loss.

Desired Result: At the end of this presentation, attendees should recognize the limitations of current models to study human deafness and the need to develop tools for the diagnosis of hearing loss in living people.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Exempt

Pharmacological Prevention of Noise-Induced Hearing Loss: A Systematic Review and Meta-Analysis

Avigeet Gupta, BS; Sina Koochakzadeh, BS; Shaun A. Nguyen, MD, MA
Ted A. Meyer, MD, PhD; Paul R. Lambert, MD

Objective: Perform a systematic review and meta-analysis to assess and determine current pharmacological prevention regimens for noise-induced hearing loss (NIHL) with significant outcomes

Data sources: Full-text, English language articles in PubMed, Scopus, and Cochrane Database of Systematic Reviews were searched up to October 2018

Study selection: Prospective randomized clinical trials and non-randomized trials with pharmacological interventions administered to prevent NIHL

Data extraction: The following variables were extracted: number of patients, level of evidence, definition of threshold shift, type of noise exposure, duration of exposure, use of hearing protection devices, pharmacological regimens, pharmacological treatment complications, follow-up time, initial hearing thresholds, post-administration threshold shifts

Data synthesis: 10 articles with 1461 patients were included after searching the following terms in the English language: noise-induced hearing loss, acoustic trauma, NIHL, prevention, and protection. Different pharmacological regimens included administration of carbogen, cyanocobalamin, ebselen, magnesium aspartate, and n-acetylcysteine. Noise exposures that were included were over 85 dB caused by assault rifles, white noise, music, and machinery noises. A meta-analysis of proportions is currently being performed to determine significance among the various modalities of pharmacological preventions for NIHL.

Conclusions: This is the first known meta-analysis being conducted regarding the pharmacological prevention of NIHL. Conclusions from this study alongside more randomized clinical trials can potentially contribute to the generation of clinical practice guidelines to prevent NIHL.

Define Professional Practice Gap & Educational Need: There is currently no clinical practice guideline or consensus statement regarding the pharmacological prevention of noise-induced hearing loss

Learning Objective: This study aims to address the gap of knowledge regarding the pharmacological prevention of noise-induced hearing loss as it can be applied to future clinical practice.

Desired Result: This systematic review and meta-analysis will summarize the current evidence regarding the pharmacological prevention of noise-induced hearing loss for otologists to use in clinical practice.

Level of Evidence: LEVEL II - Small RCTs with unclear results

IRB - Exempt

Pre-Operative Criteria Predict Operative Time Variability within Tympanoplasty CPT Codes

Karissa L. LeClair, BS; Isabelle L. Magro, BA, MS
Peter W. Kahng, BA; Amy L. Hamilton, BS
James E. Saunders, MD

Objective: To identify pre-operative parameters that predict surgical duration in order to stratify variability in physician work within tympanoplasty CPT codes.

Study Design: Retrospective study.

Setting: Tertiary referral center.

Patients: 140 patients who underwent tympanoplasty (CPT code 69631) or tympanoplasty with ossicular chain reconstruction (CPT code 69633) over three years.

Intervention(s): The following complexity modifiers were pre-operatively assigned to each procedure: Level 1 for small or posterior perforations, Level 2 for large perforations or other factors requiring a post-auricular incision, and Level 3 for cases involving cholesteatoma.

Main Outcome Measure(s): Surgical duration (preparation time and operative time).

Results: Within each CPT code, the following parameters were assessed versus time: a] Pre-operative complexity level designation, b] Main hospital vs. outpatient surgery center (OSC) location, c] Use of facial nerve monitoring. When controlled for surgeon and other stated parameters, pre-operative complexity level designation was an accurate predictor of operative time variability ($p<0.0001$). Preparation time was significantly longer in the main hospital vs. OSC ($p< 0.0001$) and when facial nerve monitoring was utilized ($p=0.003$), with an average difference in facial nerve monitoring of 8.7 minutes.

Conclusions: There is significant surgical time variability within existing tympanoplasty CPT codes, which can be accurately predicted with pre-operative application of complexity level modifiers and consideration of factors affecting case preparation. Adding complexity modifiers leads to more efficient surgical scheduling and could result in more accurate reimbursement rates for physician work.

Define Professional Practice Gap & Educational Need: 1. Limited knowledge of factors that influence otologic surgery times 2. Lack of strategies to improve surgical scheduling efficiency and reimbursement accuracy

Learning Objective: To describe the variability in physician work and surgical time within CPT codes, making practices aware of factors that can be used to predict operative times in otologic surgery.

Desired Result: To encourage consideration of specific patient and procedural criteria in pre-operative scheduling as a means to promote workflow efficiency

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Approved

Effect of Spina Bifida and Congenital Hydrocephalus on Hearing Loss in Children

Charmee H. Mehta, BSPH; Michaela F. Close, BS; James R. Dornhoffer, MD
Yuan F. Liu, MD; Shaun A. Nguyen, MD
Teddy R. McRackan MD; Ted A. Meyer, MD PhD

Objective: To better understand the relation between spina bifida, congenital hydrocephalus, and hearing loss [HL] in children.

Study design: Retrospective review.

Setting: Tertiary referral hospital.

Patients: Children in the Audiological and Genetic Database with a diagnosis of spina bifida with or without hydrocephalus, or congenital hydrocephalus.

Interventions: None

Main outcome measures: Prevalence, type, severity (4-tone pure-tone average), and progression of HL.

Results: Of 740 children, 74.6% had HL, with 26.4% having at least moderate HL. We compared HL among three groups of children, those with: spina bifida and hydrocephalus [SBH], spina bifida without hydrocephalus [SB], and isolated congenital hydrocephalus [CH]. Children with CH had a higher prevalence of HL (80%) than children with SBH (67.5%, p=0.001) or SB (69% p=0.013). Conductive HL was more prevalent in children with SBH (28%, p=0.002) or SB (27%, p=0.008) than in children with CH (17%). Severity of hearing loss was not significantly different among the 3 groups. Further analysis of factors that influence severity and progression of hearing loss (e.g. shunt placement, neurologic disorders, seizures, congenital deformities) will be discussed.

Conclusions: HL is highly prevalent in children with spina bifida and particularly prevalent in children with congenital hydrocephalus, though severity of hearing loss may not be different between the disorders.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge of the relation between spina bifida, congenital hydrocephalus, and hearing loss in children.

Learning Objective: To better understand the relation between spina bifida, congenital hydrocephalus, and hearing loss [HL] in children.

Desired Result: Consideration of spina bifida and congenital hydrocephalus as an indicator of audiological screening.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Exempt

Postoperative Healthcare Utilization of Elderly Adults after Cochlear Implantation

Mallory J. Raymond, MD; Samir Ballestas Naissir, MD
Esther X. Vivas, MD

Objective: To determine whether geriatric age affects postoperative healthcare utilization after cochlear implantation

Study design: Retrospective chart review

Setting: Tertiary referral center

Patients: Older adults (>59 years) who underwent cochlear implantation from 2009 until 2017 with 3-month post-implantation speech recognition scores

Intervention(s): Cochlear implantation

Main outcome measure(s): Postoperative surgical and audiological visit rate after cochlear implantation for those aged 60-69, 70-79 and 80-90 years

Results: Of 40 older adult patients, the mean age was 71.9±6.8 years. The mean number of postoperative surgical visits over the first year was 1.8±1. The mean number of audiological visits over the first year was 4.8±1.3; this dropped significantly over the second year to 1.5±1 visits ($p < 0.001$). There was no significant difference in duration of hearing loss, preoperative and 3-month postoperative AzBio scores or postoperative visit rate between the three age groups. Additionally, on linear regression, 3-month postoperative AzBio scores did not predict greater postoperative healthcare utilization.

Conclusions: Older adults do not have higher than expected rates of postoperative healthcare utilization after cochlear implantation despite higher rates of frailty and comorbidity.

Define Professional Practice Gap & Educational Need: Lack of geriatric cochlear implantation outcomes and postoperative healthcare utilization

Learning Objective: The objective is to examine postoperative healthcare utilization among geriatric patients who have undergone cochlear implantation

Desired Result: Attendees will understand the postoperative healthcare utilization of elderly patients after cochlear implantation

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Exempt

Benign Paroxysmal Positional Vertigo in Young Adults: A Nine-Year Retrospective Review

David D. Walker, MD; Christopher A. Schutt, MD; Dennis I. Bojrab, MD
Michael LaRouere, MD; John Zappia, MD
Eric W. Sargent, MD; Seilesh Babu, MD

Benign paroxysmal positional **(**BPPV) classically affects older patients, and is significantly less common in children and young adults. We performed an IRB-approved retrospective chart review from 2008-2017. A total of 1,972 total patients with BPPV clinical encounters were identified.

All patients were positive by both history and Dix-Hallpike exam. The mean age of all patients reviewed was 64.2 (+/-14.72) with a range from 8.0 - 98.8. For purposes of this review, “young adult” was defined as 17-26. A total of 23 patients were identified with a mean age of 23.9 (+/-2.7). Seventeen of the patients were females (74%) and 6 were males (26%).

The most common associated comorbidities were migraine (n=3; 13%) and head trauma (n=3; 13%), while one patient (4%) had a prior episode of sudden sensorineural hearing loss one month prior to vertigo onset. The posterior semicircular canal was almost exclusively affected (n=22; 96%), however the superior semicircular canal was affected in one patient (n=1; 4%). In total, over 30% of patients (n=7) reviewed had symptom recurrence within six months of the first attack, one of which ultimately required surgical intervention via posterior semicircular canal plugging.

Our institutional review agreed with previous data suggesting BPPV in young adults is rare and comprised only 1.1% of all patients reviewed. Patients in this age rage commonly recurred within the first six months after initial treatment, underscoring the importance of careful follow up and appropriate patient counseling.

Define Professional Practice Gap & Educational Need: Lack of awareness Lack of contemporary knowledge

Learning Objective: The learning objective is to raise awareness regarding the potential for BPPV in adolescents as well as review potential pitfalls in the care of these patients

Desired Result: Attendees will be better able to approach the management of young patients with dizziness and vertigo.

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Approved

Review of the Safety and Efficacy of the Slot Middle Fossa Craniotomy Approach for Cerebral Spinal Fluid (CSF) Leak Repair Secondary to Tegmen Dehiscence

Naushad M. Khakoo, MD; Alex J. F. Tampio, MD; Charles I. Woods, MD

Objective: Review of the Safety and Efficacy of the Slot Middle Fossa Craniotomy Approach for Cerebral Spinal Fluid (CSF) Leak Repair Secondary to Tegmen Dehiscence.

Study Design: Retrospective case series.

Setting: Tertiary referral hospital.

Patients: A retrospective review was conducted from 2012-2017 of patients who received repair of a CSF leak from a tegmen defect that included a slot middle fossa craniotomy approach.

Intervention(s): All patients underwent a combined approach for repair with a trans-mastoid and a middle fossa slot craniotomy using a window approximately 3-5cm x 0.5cm (in anteroposterior and supero-inferior dimensions respectively).

Main Outcome Measures: Surgical outcomes as outlined by the American College of Surgeons Risk Calculator.

Results: 14 patients were identified. The average patient age was 60.5 years ranging 19-74 years. 79% (11/14) were right-sided defects and 21% (3/14) were left-sided. The tegmen defect averaged 9.5 mm in maximum dimension (range 3-15mm). Graft repair was with tragal cartilage in 85% (12/14), conchal bowl cartilage in 7% (1/14), and temporalis muscle in 7% (1/14). 3 patients had persistent otorrhea after surgery; 2 resolved within 1 month of surgery. Major complications included a pulmonary embolism and hypoxic respiratory failure in one patient requiring therapeutic anticoagulation and intubation. Minor complications included headache in 29% (4/14) and surgical site paresthesia in 21% (3/14). No patients experienced neurological sequelae, surgical site infections or readmission.

Conclusions: The slot craniotomy approach with cartilage graft is a safe and effective alternative to the traditional middle fossa approach for repair of tegmen tympani defects resulting in CSF leaks.

Define Professional Practice Gap & Educational Need: Lack of contemporary knowledge

Learning Objective: To communicate the efficacy and complications of a surgical technique

Desired Result: The attendees will be able to counsel patients on success rates and complications if a slot middle cranial fossa approach is used in the repair of tegmen defects

Level of Evidence: LEVEL V - Case series, studies with no controls

IRB - Exempt

Following Mild Traumatic Brain Injury Patients Have Auditory Symptoms Despite Normal Behavioral Audiometry

Renata M. Knoll, MD; Seth D. Herman, MD
Rory J. Lubner, BS; Aaron K. Remenschneider, MD, MPH
David H. Jung, MD, PhD; Elliott D. Kozin, MD

Objective: Emerging evidence related to cochlear synaptopathy indicates the potential for auditory symptoms from synaptic pathology despite normal behavioral pure tone threshold audiometry. We hypothesize that individuals following mild traumatic brain injury (mTBI) can experience bothersome auditory symptoms in the presence of normal audiometry.

Study Design: Prospective cohort study.

Setting: Tertiary care hospital.

Patients: Adults with history of mTBI.

Interventions: Determination of auditory symptomology, Hearing Handicap Inventory for Adults (HIIA), Tinnitus Handicap Inventory (THI), and behavioral pure tone audiometry (PTA) and word recognition scores (WRS).

Main outcome measure(s): Main outcomes included HHIA and THI scores, as well as PTA and WRS. Comparisons were made to mTBI patients with normal (Group A) and abnormal (Group B) PTA (>20 dB).

Results: Twenty-nine patients with mTBI met study criteria. Mean age was 54.2 years and 79.3% were female. Hyperacusis (72.4%), tinnitus (68.9%) and HL (62%) were commonly reported in study participants. Sixty-two percent (18/29) of patients showed normal hearing thresholds (Group A). In Group A, 55.5% (10/18) patients complained of subjective hearing loss. Mean HHIA scores were similar in Group A and Group B (40.8 and 39.5, respectively; p=0.829). No difference in mean THI scores was found between groups. (16.5 and 27.3 respectively; p=0.274). Patients in Group B had a mean WRS of 94.2% in the worse ear.

Conclusion: Auditory symptoms after mTBI can be present even in the setting of normal PTA. Findings have implications for auditory pathophysiology in mTBI.

Define Professional Practice Gap & Educational Need: Lack of understanding of auditory symptoms in civilian following traumatic brain injury.

Learning Objective: Determine patterns of auditory dysfunction in civilians following traumatic brain injury.

Desired Result: Improve screening and treating potentially overlooked auditory symptoms in this population.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

Internal Auditory Canal Diameter is a Marker of Hearing Loss Severity in CHARGE Syndrome

Kareem O. Tawfik, MD; Brittany A. Leader, MD; Daniel I. Choo, MD

Objectives: Determine whether small internal auditory canal (IAC) diameter is associated with worse hearing thresholds and cochlear nerve deficiency (CND) in CHARGE Syndrome. Determine whether asymmetric IAC dimensions are associated with asymmetric hearing and cochlear nerve (CN) status in patients with CHARGE Syndrome.

Study Design: Retrospective case review.

Setting: Tertiary referral center.

Patients: Children meeting diagnostic criteria for CHARGE Syndrome.

Interventions: High-resolution magnetic resonance imaging of the temporal bones and ear-specific audiometric testing.

Main outcome measures: IAC diameter, pure-tone average (5-point scale: (normal=0, mild=1, moderate=2, moderate-severe=3, severe=4, and profound=5), and CN development (normal, hypoplastic or aplastic CN).

Results: Twenty ears (10 patients) were analyzed. Mean IAC diameters at the porus, mid-point, and fundus decreased in relation to severity of hearing loss and degree of CN underdevelopment. Additionally, in all patients with asymmetric hearing or asymmetric CN development, within-subject comparison of the IACs showed universally smaller IAC diameters at the porus, mid-point, and fundus in the more affected ear.

Conclusions: In children with CHARGE Syndrome, small IAC diameter can serve as a useful indicator of sensorineural hearing loss. Importantly, in children in whom asymmetric hearing (and/or asymmetric CN development) is suspected, the smaller IAC can reliably indicate the more affected ear. As ear-specific audiometric testing of children with CHARGE Syndrome can be challenging, measuring the dimensions of the IAC can be a useful strategy for identifying a worse-hearing ear in this cohort.

Define Professional Practice Gap & Educational Need: Lack of awareness of the relationship of internal auditory canal diameter with severity of hearing loss in patients with CHARGE Syndrome.

Learning Objective: Understand the association between internal auditory canal diameter and severity of hearing loss in patients with CHARGE Syndrome.

Desired Result: Attendees will apply knowledge from the presentation in evaluation of children with CHARGE Syndrome and sensorineural hearing loss. Specifically, they may become aware that measuring the dimensions of the internal auditory canal can be a useful strategy for identifying a worse-hearing ear in this cohort.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Approved

Correlation of Preoperative Mini-MoCA Testing and Postoperative Speech Outcomes in Cochlear Implant Recipients

Karl W. Doerfer, MD; Benjamin S. Johnson; Caroline Ziegler, MS
Kristin Kozlowski, AuD; Michael S. Harris, MD

Objective: To assess the relationship between a preoperative cognitive screening measure and postoperative speech perception outcomes in adult cochlear implant (CI) recipients.

Study design: Retrospective chart review. Level IV

Setting: Tertiary referral center

Patients: Adults with post-lingual, profound, sensorineural hearing loss who qualify for cochlear implantation.

Intervention: Cochlear implantation

Main outcome measures: CI candidates underwent pre-operative testing using a validated, visual version of the Mini Montreal Cognitive Assessment (MoCA). Results were then analyzed in conjunction with postoperative speech testing to determine the presence and strength of correlation between the two.

Results: 51 patients completed pre-operative Mini MoCA assessments and and underwent postoperative speech testing. A moderate, positive correlation (R = 0.55) was found between preoperative Mini MoCA scores and 3-month post-operative AZBio scores. Weak but positive correlations were also found with 1-month AZBio scores (R = 0.39), 3-month CNC Words scores (R = 0.37), and 1- and 3-month CNC Phoneme scores (R = 0.31, R = 0.40).

Conclusions: Preoperative cognitive screening using a validated, visual version of the Mini MoCA correlates positively with post cochlear implantation speech perception scores on a variety of clinical speech measures. Brief, clinic-based, cognitive testing for CI candidates may help predict postoperative CI performance and allow patients and families to calibrate expectations.

Define Professional Practice Gap & Educational Need: There is currently a lack of knowledge regarding factors that determine the wide variability of cochlear implant (CI) outcomes. Preoperative cognitive status appears to play a role in CI performance. However, clinicians lack validated, practical, clinic-based testing strategies that can help predict postoperative performance for CI candidates.

Learning Objective: Attendees will learn that preoperative cognitive screening using a validated, visual version of the Mini MoCA correlates positively with post cochlear implantation speech perception scores on a variety of clinical speech measures.

Desired Result: Clinicians may opt to use brief, clinic-based, cognitive testing for CI candidates to help predict postoperative CI performance and to allow patients and families to calibrate expectations.

Level of Evidence: LEVEL IV - Historical cohort or case-control studies

IRB - Approved

Comparing Outcomes and Programming Parameters for Precurved and Straight Electrodes: A Matched Cohort Comparison Study

Jourdan T. Holder, AuD; Robert J. Yawn, MD; Ashley M. Nassiri, MD, MBA
Robert T. Dwyer, AuD; Alejandro Rivas, MD
Robert F. Labadie, MD, PhD; René H. Gifford, PhD

Objective: Characterize differences in adult cochlear implant (CI) outcomes and programming parameters for precurved, non-stylet electrode arrays (EA) versus straight EAs from a single manufacturer.

Study Design: Review of prospective database

Setting: CI program at tertiary otologic center

Patients: Fifty-eight adults—29 implanted with straight EA (Cochlear CI422/522) and 29 implanted with precurved EA (Cochlear CI532) using an external straightening sheath for insertion—were included. CI recipients from each group were matched with respect to age, preoperative hearing thresholds, and duration of CI use.

Interventions: CI
Outcome measures: Consonant-Nucleus-Consonant (CNC) words, AzBio sentences, and residual hearing thresholds were measured at least 6 months post activation. Pulse duration, maxima, impedances, and overall charge measurements were used to characterize programming parameters.

Results: Postoperative low frequency pure tone average was significantly lower (i.e. better) for the precurved EA group (94.71±14.79dB HL) than the straight EA group (102.13±9.57dB HL, p=0.028). CNC scores were significantly higher for the precurved group (56.97±21.47%) than the straight EA group (43.34±20.38%, p=0.016). Impedances and pulse durations were statistically significantly lower for the precurved group, but there was no difference in overall charge for upper stimulation levels between the two groups.

Conclusions: The precurved EA group (CI532) showed favorable or similar results on all measures when compared to the straight EA group (CI422/522). Results suggest that the precurved EA may be an advantageous substitute for straight EA, which exploits better perimodiolar positioning leading to decreased channel interaction and superior speech recognition.

Define Professional Practice Gap & Educational Need: 1. Matched, cohort comparison study design controls for variables such as age, preoperative hearing thresholds, and duration of CI use between groups of precurved and straight electrode arrays. Such variables have confounded many previous reports. 2. Lack of awareness that new precurved cochlear implant electrode arrays show favorable or similar rates of hearing preservation and superior speech recognition scores unlike previous generations of precurved arrays. 3. Lack of consideration for differences in audiologic programming parameters (pulse duration, impedances, and charge) between electrode types.

Learning Objective: 1. Describe differences in outcomes (hearing preservation and speech recognition scores) between the precurved (CI532) and straight (CI522) electrode arrays. 2. Explain differences in programming parameters (pulse duration, impedances, and charge) between precurved (CI532) and straight (CI522) electrode arrays and how these differences may affect a recipient's sound quality or experience with their cochlear implant.

Desired Result: Attendees will apply their new understanding of differences between the precurved (CI532) and straight (CI522) electrode arrays to their decision-making process for selecting electrode arrays for their patients. Attendees will consider selecting the new, precurved electrode array (CI532) instead of a straight array (CI522) with the insight that the precurved array offers favorable or similar results on all measures including hearing preservation.

Level of Evidence: LEVEL III - Cohort and case-control studies

IRB - Approved

AMERICAN OTOLOGICAL SOCIETY RESEARCH FOUNDATION
RESEARCH GRANT AWARDS & TRAINING FELLOWSHIPS

The American Otological Society is committed to the non-promotional advancement of knowledge and science and to a free exchange of medical education in otology and neurotology. The American Otological Society, through its Research Foundation, is offering Research Grant Awards, an Award for a Clinical Trial, full-time Research Training Fellowships, and a Clinician-Scientist Award. All of the AOS grant awards may involve research on any topic related to ear disorders. The research need not be directly on an otological disease but may explore normal functions of the cochlea, labyrinth or central auditory or vestibular systems. However, the applicant must describe how the proposed research will benefit our understanding, diagnosis or treatment of otological disorders.
Research supported by all of the grant mechanisms can relate to any aspects of the ear, hearing and balance disorders.

These grant awards and fellowships are for work conducted in *United States or Canadian institutions only*. Additional details may be found on the AOS website. www.americanotologicalsociety.org

If you would like to submit a grant for consideration of funding in 2020-2021, **a letter of intent and biosketch, including details regarding other existing support, must be submitted by November 1st** of the year prior to funding. The next funding cycle begins July 1, 2020. The letter of intent must state the desired grant mechanism for the proposal (CSA, Fellowship grant, Research Grant), the Principal Investigator and Institution(s), a working title and abstract and include Specific Aims and a proposal summary (2 page limit).

Complete applications will be invited from selected applicants based on the Research Advisory Board review of the letters of intent. Applicants will be notified whether they are invited to submit a full application the first week of December. Applications must be received by January 31st.

Applications are reviewed by members of the Research Advisory Board, made up of 7 AOS members and 3 consultants selected from a pool of highly respected otologic researchers. The Board makes recommendations regarding funding to the AOS Council. Final funding decisions are made by the AOS Council, which typically meets during the Combined Otolaryngology Spring Meetings, yielding decisions in May. Applicants are notified regarding a funding decision after the AOS Council has met.

Information may be obtained from:

Kristen Bordignon, Assistant to
John S. Oghalai, MD
Executive Secretary, Research Fund of the American Otological Society, Inc.
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American Otological Society
Fellowship Grant Funding Period: 7/1/2018 – 6/30/2019
Progress Report Date: 2/1/2019

Principal Investigator: Stacey M. Frumm
Project Title: Identifying molecular mechanisms underlying maintenance of the tympanic membrane epidermis

Background: The tympanic membrane (TM) conducts vibrations from the external auditory canal (EAC) to the malleus and is comprised of three basic tissue layers: epidermis, fibrous tissue, and mucosa. Epidermal keratinocytes proliferate only in central regions of the TM and migrate into the ear canal. The overarching goal of this work is to further elucidate mechanisms of TM homeostasis.

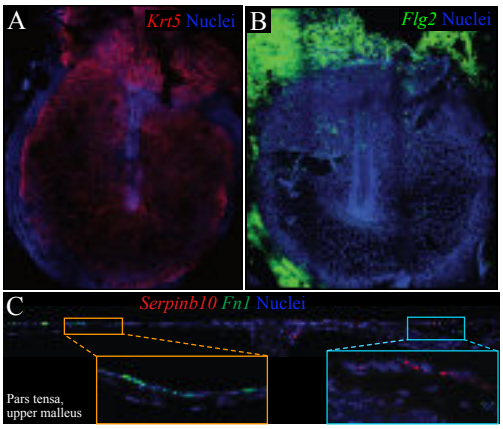


Figure 1: RNAScope in situ hybridization showing expression of (**A**) *Krt5* and (**B**) *Flg2* in whole-mount TMs, and of (**C**) novel markers *Serpinb10* and *Fn1* in a section.

Aim 1: *Describe the cellular architecture of the tympanic membrane.* To identify the resident cell types of the murine TM, we performed single-cell RNA sequencing (scRNA-Seq). In this aim, we sought to define specific molecular markers of the cell populations and determine their anatomical distribution by staining for protein and RNA.

Progress: We identified five clusters of TM keratinocytes and have validated both known and novel markers. *Krt5*, considered a marker of undifferentiated keratinocytes, is expressed diffusely throughout the TM epidermis, while *Flg2*, a known marker of differentiated keratinocytes, is predominantly expressed in the pars flaccida and only in rare patches on the pars tensa (Figure 1A-B). We identified two undifferentiated keratinocyte clusters, and we have validated *Serpinb10* and *Fn1* as markers that discriminate between these two (Figure 1C). *Fn1*+ keratinocytes predominantly reside in the pars tensa, and *Serpinb10*+ cells in the pars flaccida. In addition to visualizing keratinocyte populations, we also validated expression of *Gpx3* and *Igfbp3* as markers of distinct mesenchymal populations. Lastly, we utilized murine lineage tracing tools to validate that mucosal cells express *Krt19* and *Krt18*.

Aim 2: *Identify signaling molecules required for proliferation of tympanic membrane keratinocytes.* We determined that murine TMs cultured as explants in minimal media maintain proliferation in the same regions as seen in vivo, and we used this system to test 76 small molecule inhibitors at 40 μM for ones that ablated proliferation. Inhibitors of eight different proteins were identified as hits.

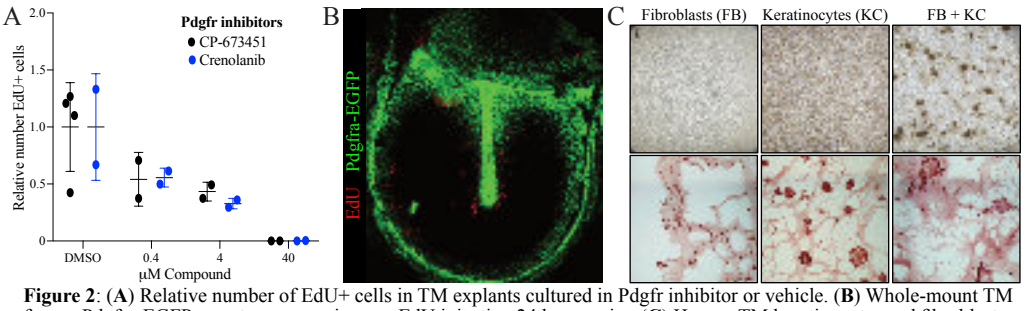


Figure 2: (**A**) Relative number of EdU+ cells in TM explants cultured in Pdgfr inhibitor or vehicle. (**B**) Whole-mount TM from a Pdgfra-EGFP reporter mouse given an EdU injection 24 hours prior. (**C**) Human TM keratinocytes and fibroblasts cultured independently and together in matrigel. Images are of the whole culture (top) and H&E stained sections (bottom).

Progress: We re-tested the hit compounds at multiple concentrations and discovered that Pdgfr inhibition causes a concentration-dependent decrease in proliferation (Figure 2A). From the scRNA-Seq dataset, we learned that Pdgfra is expressed by the mesenchyme. We confirmed that Pdgfra+ mesenchyme is in the regions of keratinocyte proliferation by giving EdU to a Pdgfra-EGFP reporter mouse (Figure 2B). We conducted in vivo inhibitor studies, but got variable results and were hindered by the lack of an assay for Pdgfra activity. So, we are moving towards genetic studies in which we will ablate Pdgfra. Additionally, we have asked if human TM fibroblasts support the growth of human TM keratinocytes by co-culturing the two populations. Indeed, the two cell types together form unique structures (Figure 2C). We are currently looking at whether Pdgfr inhibition decreases formation of these colonies.

Aim 3: *Elucidate the lineage relationships of tympanic membrane keratinocytes.* We demonstrated through continuous EdU labeling that the TM epidermis turns over in approximately three weeks. In this aim, we proposed experiments to further describe the dynamics of TM cell turnover and to visualize clonal architecture.

Progress: To determine if there is a slow-cycling label-retaining cell (LRC) population, we gave mice EdU for three weeks to label all the TM keratinocytes and then allowed the label to dilute over the subsequent four weeks. At that point, many LRCs could be identified; most were mesenchymal or mucosal cells, but some were keratinocytes. However, the TM keratinocytes are migratory, so we could not determine if these LRCs stably resided in the region where they were identified or if they had migrated from other areas.

To study the clonal architecture of the TM epidermis, we began by using Krt5-CreERT2;R26R-Confetti mice and inducing fluorescent protein expression throughout the TM (Figure 3A). Over the course of months, we see large single-color blocks of cells resolve. This coarsening is consistent with neutral drift in the stem cell pool. We wanted to visualize single clonal units but could not achieve sparse enough labeling with the Krt5-CreERT2 system, so we turned to a Ki67-CreERT2 driver line, again with the R26R-Confetti reporter. We induced low-level recombination and harvested samples after one, two, three, and four weeks, as well as two months (Figure 3B). The numbers of cells in distinguishable clones were quantified. We see expansion of the clone size distribution over time, which is also consistent with the neutral drift hypothesis. Furthermore, we determined that the cells in a clone do not remain contiguous, presumably due to keratinocyte migration. Lastly, we visualized clones at the umbo at one and two-week time-points but did not capture larger clones extending from the umbo at later time-points. We did observe larger clones elongating down the malleus at later time-points, consistent with the vertical orientation of the color blocks seen in the Krt5-CreERT2;R26R-Confetti system. Collection and analysis of samples for these lineage tracing studies is still ongoing.

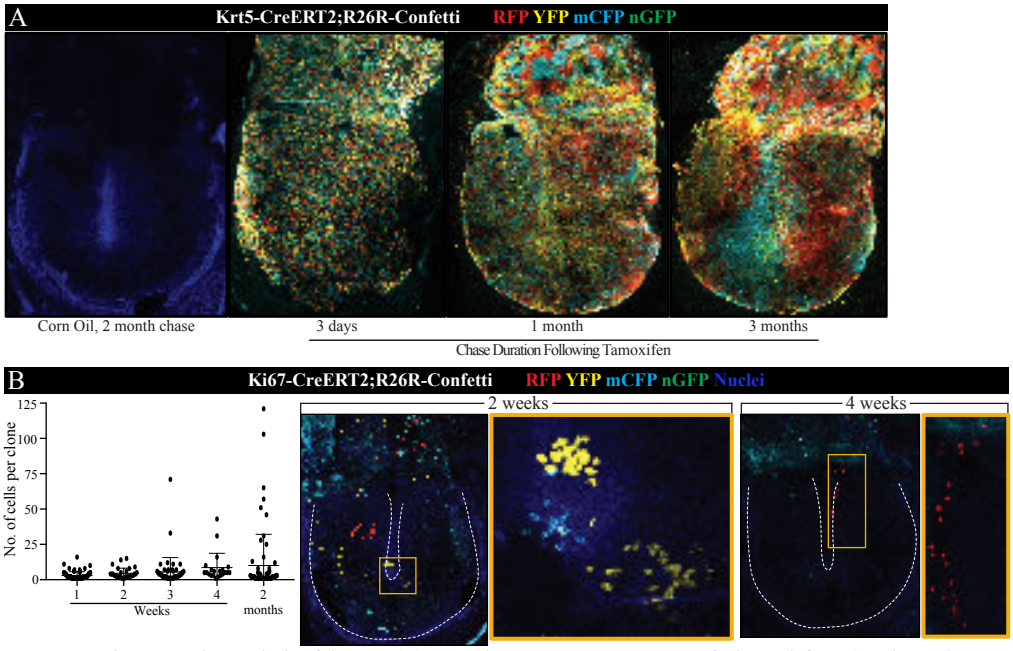


Figure 3: Lineage tracing analysis of the TM. (**A**) Control Krt5-CreERT2;R26R-Confetti TM (leftmost) and traced TMs from 3 days, 1 month, and 3 months following recombination. (**B**) Clone sizes from Ki67-CreERT2;R26R-Confetti TMs at the indicated time-points (left), and examples of clones observed at two weeks (middle) and four weeks (right).

American Otological Society Research Grant– Progress Report
Project title: *Virus based direct reprogramming of reactive glial cells into functional neurons in a mouse model of auditory neuropathy*
PI: Judith Kempfle

Based on our prior data obtained from transgenic animal experiments, we concluded that transient overexpression of proneural genes such as Sox2, Ascl1, Neurogenin and NeuroD would be conducive to reprogram inner ear glia into neurons.
Taking a step towards better translatability of our research, we decided to proceed with viral transduction of proneural genes rather than transgenic animals. In **aim 1** of this grant, we proposed to create Lentiviral vectors carrying these proneural genes together with a TetO system to allow for transient overexpression. In **aim 2**, we planned on using data gathered in aim 1 for *in vivo* transduction of inner ear glia after damage to the auditory nerve to promote neural transdifferentiation.

Aim 1: Direct reprogramming of spiral ganglion glia *in vitro* after lentiviral transduction of proneural genes
We are currently in the final production stages of 3 of the 4 proposed viruses: Sox2-GFP-TetO, Ascl1-GFP-TetO, Neurog1-GFP-TetO. In parallel, we have started with in vitro experiments. Sox2-TetO, Ascl1-TetO and Neurog1-TetO vectors and a GFP cassette was added. Based on our previous data, we assumed that Sox2 and Ascl1 had highest likelihood of successful neural conversion.
We therefore began using our *in vitro* stem cell (neurosphere) model system in parallel, and infected differentiating spiral ganglion spheres of wildtype and PLP-tdtm mice (a mouse line that traces Plp positive glial cells) with lentivirus carrying either Sox2-GFP, Ascl1-GFP, or GFP control vector alone. After viral transfection for 24 hours, we assessed efficiency of reprogramming based on GFP expression. We found a transfection efficiency of roughly 50% for primary inner ear cells.

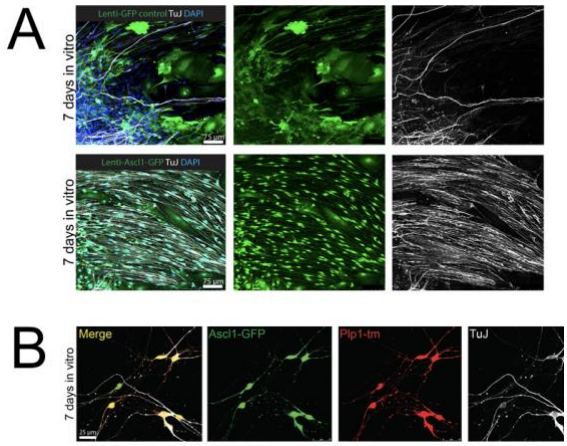


Fig. 1: A) SGN glial cells *in vitro* infected with Lenti-GFP or Lenti- Ascl1-GFP for 48 hrs. B) Lineage tracing of Plp1 glial cells (tdtm, red) after infection with Lenti-Ascl1-GFP for 48 hours.

For neural conversion experiments, floating spheres were generated from mouse spiral ganglion obtained at postnatal days 1 to 3. We propagated these neurospheres up to the 3rd generation at a density of 300 spheres per well in culture medium containing a cocktail of growth factors (IGF-I, FGF-2 and EGF). Spheres were plated for differentiation and lentiviral vectors carrying reprogramming genes Sox2 or Ascl1 or lenti-GFP control vector were added on day 1 of differentiation for 24 hours. Cells were harvested after 7 days. Reprogramming efficiency was assessed separately for Sox2 or Ascl1, after immunohistological staining for neural or glial markers in wildtype or PLP positive cells (Sox10, S100, GFAP) and neural markers (TuJ).

Our goal was to gain insight into efficiency of direct glial conversion after viral transduction and overexpression of proneural genes for further *in vivo* experiments. Initial experiments revealed a marked increase of cells with neural morphology and positive neural markers (TuJ) after transduction of Lenti-Ascl1-GFP (**Fig. 1A),** but not after transduction with Sox2 (Data not shown)**.** Lineage tracing revealed that neurons were derived from Plp1 positive glial cells **(Fig. 1B).** Given that these viruses do not yet allow for transient upregulation of genes, it is likely that continued overexpression of early neural stem cell marker Sox2 prohibits differentiation into differentiated neurons and instead promotes stemness and proliferation.

Aim 2: Direct reprogramming of spiral ganglion glia *in vivo* after stereotaxic transduction of proneural genes

After these promising *in vitro* results for Ascl1, we moved on to evaluate the *in situ* conversion of spiral ganglion progenitors to neurons after ouabain induced neural death. The degree of glial reprogramming and neural regeneration *in vivo* was assessed by quantification of new neurons by immunohistochemistry and functional recovery (ABR and DPOAE).

We employed our novel stereotaxic approach to inject 5µl of Lenti-Ascl1-GFP into the auditory nerve of adult wiltype mice 7 days after ouabain induced selective SGN damage. Only surviving glial cells were present in Rosenthal's canal at this point. A subset of cells expressed GFP, indicating transduction with Lenti-Ascl1- GFP, and co-labeled with TuJ, which suggested successful conversion into a neural phenotype **(Fig. 2A).**

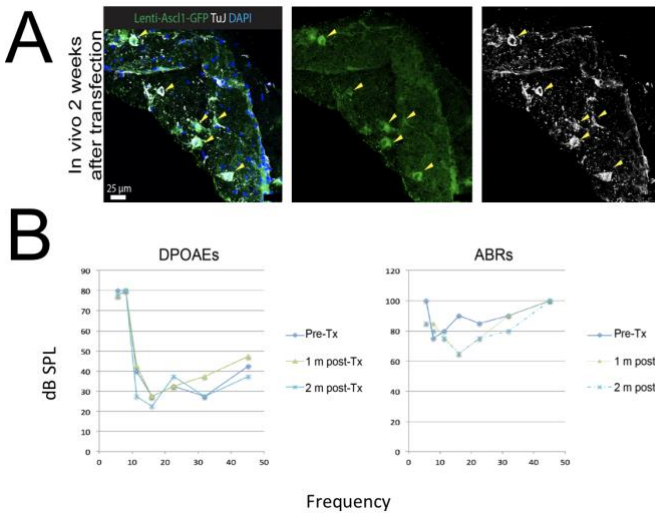


Fig. xx: A) Stereotaxic injection of Lenti-Ascl1-GFP into Rosenthal's canal after Ouabain induced SGN death. A subset of remaining glial cells co-expresses GFP and TuJ. B) Preliminary recordings of 2 animals 4 weeks after Lenti-Ascl1-GFP injection.

We only have preliminary data at this point, but two animals underwent functional testing with DPOAEs and ABRs 4 weeks after viral injection into the auditory nerve. A preliminary improvement of 20-10 dBs in the ABR threshold at mid- to high frequencies after 4 weeks may indicate functional recovery after neural conversion of inner ear glial cells **(Fig. 2A)**. We are currently processing the animals for histology.

We assume that our TetO lentiviruses will be ready for *in vitro* experiments similar to experiments above in about 1 month. After we have gained preliminary insight into transfection efficiency and neural conversion rate after transient overexpression with Doxycycline, the viruses will have to undergo a further concentration step (with ultracentrifuge) to allow use *in vivo*. We will then employ our *in vivo* auditory neuropathy model and stereotaxic approach as above to analyze glial conversion into neurons.

AOS Progress Report

PI: Alexander Markowitz

Graduate Student at the University of Southern California

Title: The role of ion channels in encoding sound-intensity at the auditory nerve.

Background:

During normal hearing, the cochlear inner hair cell conveys intensity information to auditory neurons which can be roughly separated into three groups encoding low-, medium-, and high-intensity sounds. These subgroups of auditory neurons differ based on in vivo properties such as the spontaneous discharge rate (SR), threshold, and connectivity patterns to the presynaptic inner hair cell (that is, by their morphology). Although the mechanisms that drive this functional diversity remain poorly understood, it is known that the low-SR (high-intensity coding) auditory neurons are preferentially vulnerable to cochlear synaptopathy, which suggests they may be intrinsically different from the high-SR (low-intensity coding) auditory neurons.

Within the field, it has been hypothesized that differential cellular properties amongst individual auditory neurons play a role in shaping the differential activity of auditory neuron subtypes. In particular, the biophysical properties of auditory neurons are highly diverse, and therefore, are hypothesized to play a physiological role in differentiating the thresholds and excitability of auditory neurons. The objective of my research project is to test if the biophysical properties of auditory neurons are systematically linked to their intensity-coding function.

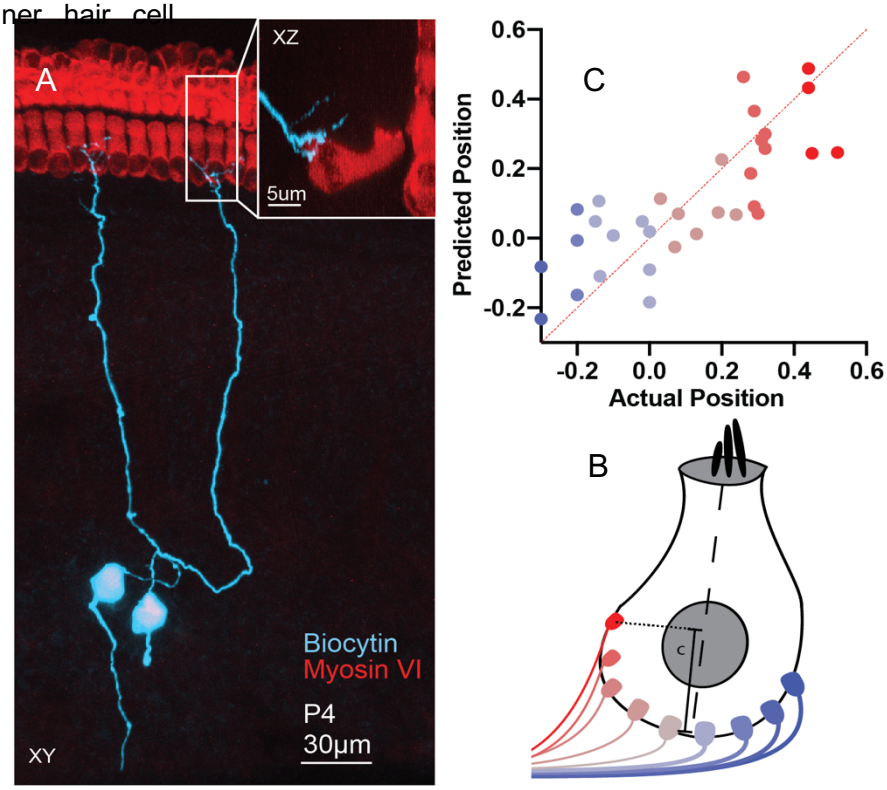


Figure 1: A) A confocal image of the connectivity pattern of two spiral ganglion neurons (blue) with cochlear hair cells (red). B) A schematic of the innervation map of afferent fibers onto a single inner hair cell. C) A multi-linear regression indicating that the biophysical properties are correlated with the terminal position of the afferent fiber of the neuron.

I have developed a methodical and analytical approach that combines patch clamp electrophysiology and single-cell labelling to simultaneously measure the biophysical and morphological properties of auditory neurons (Figure 1A). By acquiring the morphological properties of these neurons, I can exploit a previously established spatial axis that separates the auditory neuron subtypes by where their synaptic terminals are located on the inner hair cell.

During my time as a fellow of the American Otological Society Research Fund, I have made significant progress on my research objectives. I have continued my experimental approach and collected data that has supported my hypothesis that the biophysical properties of auditory neurons are correlated with where they terminate onto the inner hair cell.

Aim 1: Test whether biophysical properties of auditory neurons are systematically linked to where their afferent fibers terminate on the inner hair cell.

- I have continued to improve in my experimental skills which has allowed me to more precisely measure where the connection is located on the inner haircell. Initially, I was only able to assign neurons as either contacting the abneural (modiolar) or adneural (pillar) side of the inner haircell. Now with more experimental skills, I can measure along a linearly-continuous scale from the basal pole to the cuticular plate of the inner hair cell (Figure 1B).

- I have advanced my analytical skills as a result of moving from categorical data to continuous data of terminal locations. By having a continuous scale, I have learned how to perform multi-variable linear regressions to test for correlations of multiple biophysical properties with their synaptic position.

- The results of my research reveal that the biophysical properties of auditory neurons are linearly correlated with the location of their synaptic terminals onto the inner hair cell (Figure 1C). Overall, we observe that in vitro current thresholds increase as the location of the terminal approach the abneural side, up towards the cuticular plate of the inner hair cell. These results are in line with the in vivo measurements of which high-threshold neurons are also located on the abneural side of the inner hair cell.

- The data I have collected is the first to link cellular biophysics to perspective intensity-coding subtypes.
- I am currently working on drafting a manuscript with these results

Future Directions:

- In the future, we plan to further advance our analytical approach. We have started applying machine learning protocols to establish an advanced model to identified auditory neurons subtypes based solely on their biophysical properties. Our model takes inputs from multiple variables collected by patch clamp electrophysiology and accurately predict the position of synaptic terminal within a 18% error margin. This model has potential to impact the field by supplying an identification scheme for auditory neurons subtypes in absence of synaptic connections, such as in neuronal dissociation preparations, or as a comparative model for transgenic mouse models with auditory neuron subtype biomarkers. Future work will continue to build on this dataset by experimenting on model animals throughout post-natal development.

Professional Development

- In addition to the progress I have made on my research project, I have progressed in my personal training plan. With the funds provided by the AOS Research Fund fellowship, I have been enrolled in interactive programming lessons that focus on statistical analyses programmed in R. These additional statistics lessons have advanced my analytical skills when working with my the data of my current project.

- I am writing my first first-authored manuscript of these results

- I am continuing my role in extracurricular activities in the University of Southern California Neuroscience Graduate Program student government. I have been an organizing committee member for our annual Student Research Symposium and Perspective Student Recruitment committee.

American Otological Society, Fellowship grant (2018-2019)

Progress Report

Primary Investigator: Stefan Raufer, Harvard Medical School

Mentors: Hideko Heidi Nakajima, Sunil Puria

Project Title: Revisiting Human Cochlear Mechanics Using Modern Methodologies and Tools

Introduction. The direct study of human cochlear mechanics has not progressed as rapidly as in animal models, leaving fundamental questions concerning human hearing mechanisms unresolved. In this project we showed that the motion of the human cochlear partition (CP) differs in key ways from that of laboratory animals. We determined the acoustic impedance and stiffness of the human basilar membrane (BM, Aim 1), measured the displacement of the CP across its width (Aim 2) and described the tuning at multiple radial locations of the CP (Aim 3).

Results. *Specific Aim 1: Measure the acoustic impedance and stiffness of the human basilar membrane*

Progress: We obtained the specific acoustic impedance of the BM, 1.2 mm from the base from six fresh human cadaveric temporal bones. We simultaneously measured intracochlear pressures in the vestibule (P_{SV}) with micro fiberoptic sensors and the velocity of the BM (v_{BM}) with laser-Doppler velocimetry, i.e. . In Fig. 1a, a summary plot of the magnitude and phase of of the BM are shown. At low frequencies (400 Hz to 10 kHz), decreased by approximately 6 dB per octave, characteristic of a stiffness-dominated structure such as the BM. Figure 2b shows the real and imaginary parts of Z_A^S. The real part was mostly positive and increasing at low frequencies, characteristic of viscous losses at very low frequencies. The magnitude of the imaginary part, decreasing at low frequencies, was dominating the impedance, leading to the observed -0.25 phase of the impedance in Fig. 2a. The specific acoustic stiffness, plotted in Fig. 2c, was calculated by multiplying the magnitude of the imaginary part of by the radian frequency ω. The average stiffness of the BM shown in Fig. 2c was 0.85 GPa/m ±0.3 GPa/m for the measurement location 1.2 mm from the cochlear base.

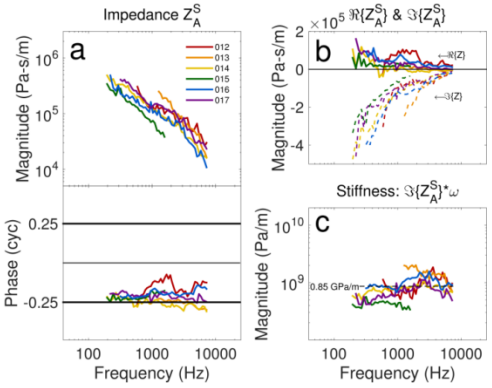


Figure 1: (a) Magnitude and phase of the specific acoustic impedance of six specimens. (b) Real (solid lines) and imaginary part (dashed lines) of the impedance. (c) Specific acoustic stiffness derived from the imaginary part of the impedance.

Specific Aim 2: Determine the radial displacement characteristics of the human cochlear partition.

Progress: A representative example of the normalized tympanic surface velocity of the CP, measured at 37 radial locations and frequencies well below and near the BF, is shown in Fig. 2. The measurements showed that the human osseous spiral lamina (OSL) was not stationary as in laboratory animals, but moved considerably. Previously, motion of the OSL at one radial location in one specimen was noted by Stenfelt (2003). We detailed the OSL motion throughout its radial width. We found that the OSL was pivoting near the modiolus (x = -600 μm in Fig. 2A) and the displacement of the OSL increased linearly with the radial distance from the modiolus. This behavior was observed in all six tested specimens and confirmed that the OSL greatly contributes to the overall CP motion. We also identified a new soft-tissue region between the OSL and BM, which

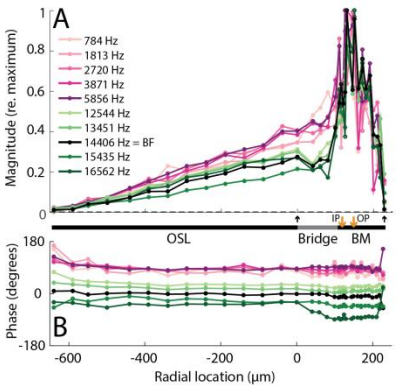


Figure 2. Representative example of CP velocity across the width of the partition. (A) Magnitude and (B) phase. The osseous spiral lamina (OSL) and bridge region move substantially in human (submitted for publication).

we named the CP "bridge", non-existent in laboratory animals. This CP bridge moved as much as the BM. The BM accounted for 27.2 ±7.7% standard deviation (SD) of the total transverse-area displacement of the CP for frequencies below the best frequency (BF), and 42.7 ±26.6% SD of the CP area displacement at the BF. This contrasts with laboratory animals, in which BM motion accounts for almost 100% of the CP area displacement.

Specific Aim 3: Describe the frequency selectivity of the human cochlear partition at different radial locations.

Progress: A representative example of tuning curves from several radial locations on the CP is shown in Fig. 3. Apart from the large displacements of the OSL and CP bridge, these structures also had similar frequency responses compared to the BM. The measured BFs of the BM across specimens ranged from 9.5 kHz to 14.4 kHz. On average, the passive tuning sharpness Q_{10} of the human BM was 1.61 ±0.51 SD (n=5), similar to the passive BM of other species. The human tuning sharpness of the bridge was 1.16 ±0.34 SD, and the tuning sharpness of the OSL was 1.10 ±0.27 SD. Although there is a trend across specimens that tuning slightly sharpened from OSL to bridge to BM, statistical significance was not observed in our small population ($p>0.05$). Similarly, the BF of the OSL was slightly lower compared to that of the BM, but no significant difference was found. The phase of the tuning curves was characteristic of a traveling wave on the CP. Not only are the traveling waves observed on the BM, but also on the OSL and the bridge. In some specimens the phase of the BM was lagging the phase of the OSL at higher frequencies, possibly leading to differential motion between the OSL, bridge, and BM near the BF.

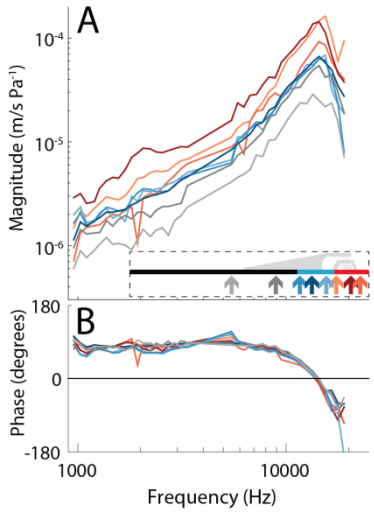


Figure 3. Example of tuning curves (A) and phase (B) of one temporal bone from different radial location (indicated by illustration in panel A (submitted for publication).

Conclusion. We have identified important differences in the human CP anatomy and motion, which we will investigate more closely in the future.

References. Stenfelt S, Puria S, Hato N, Goode RL (2003) Basilar membrane and osseous spiral lamina motion in human cadavers with air and bone conduction stimuli. *Hearing Research* 181(1–2):131–143.

Publications resulting from the Fellowship grant

Stefan Raufer, John J. Guinan Jr., Hideko H. Nakajima. Cochlear partition motion differs substantially between humans and laboratory animals. (submitted Jan. 16, 2019)

Conference podium presentation: Stefan Raufer, John J. Guinan Jr., Hideko H. Nakajima (2019). Measurements of Cochlear-Partition Motion in Human Cadavers Challenge the Classic Model of Basilar Membrane Motion. 42nd Annual MidWinter Meeting of the Association for Research in Otolaryngology, Baltimore, MD, USA.

Progress Report
PI: Jesse M. Resnick **Mentor:** Jay T. Rubinstein, M.D., Ph.D.
Grant Title: Peripheral Limitations in Cochlear Implant Performance: Computational Exploration of the Impacts of Demyelination and Degeneration on Neural Electrophysiology and Signal Encoding
Reporting Project Period: 07/01/2018 – 06/30/2019

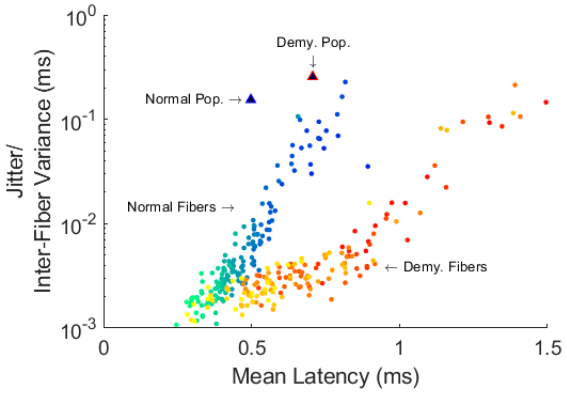
A. Introduction

This project explores the question of whether pathological demyelination and degeneration of spiral ganglion neuron (SGN) processes might contribute to the variance of patient-to-patient cochlear implant (CI) performance. Since SGNs rely upon both electrical and chemical inputs from hair cells (HC) and support cells (SC) in the organ of Corti, it is unsurprising that SGNs undergo degeneration during SNHL. Electron microscopy and immunofluoresence studies of SGN axons have observed demyelination that affects the peripheral axon before progressing to the cell soma and central axon. Importantly, these changes are observed at time-points before significant soma loss manifests. Despite these insights, a theoretical analysis of how these changes impact the dynamics of electrical stimulation has not been performed. In this work, we are leveraging a biophysical model of extracellular stimulation of SGN axons modified to simulate gradations of SNHL-induced demyelination or degeneration. Properties of simulated single fiber responses to single-pulse stimuli, including response sensitivity and timing, were shown to vary with myelination state. Marked, and previously unappreciated, relationships between the sensitivity of fibers to pulses of different polarities, timing of action potentials, and the distribution of myelin along simulated axons were demonstrated. The aim of our work in progress is to expand upon this approach by simulating populations of spiral ganglion nerve fibers with axolemma calibers distributed as in a healthy nerve but varying degrees of heterogenous demyelination or degeneration.

B. Results

Specific Aim 1. Fiber temporal integration and refractoriness. Using paired pulses, pulses with variable widths, variable inter-pulse intervals, and pulse trains, we assessed how populations' temporal integration and refractoriness are impacted by simulated demyelination. Since myelin loss leads to increased internodal capacitance without altering resistance (at least in the absence of changes in channel expression) this loss leads to an increase in static time constants.

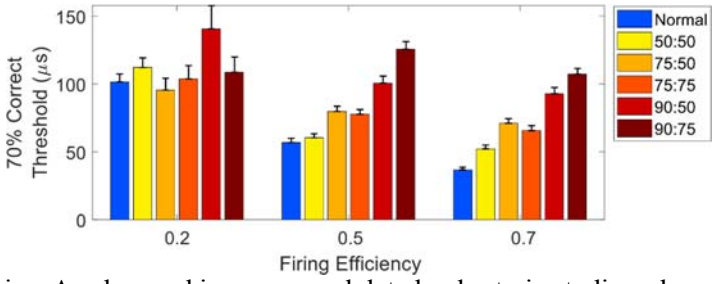
Progress: We have produced simulations of both normal and demyelinated neural population responses to single biphasic pulse stimuli varying in phase duration and interphase gap. We identified some surprising population level dynamics introduced by within-population myelination variability, including reduced slope and elevated threshold of population input-output relationships and broadening of inter-fiber response latency distributions. Demyelinated populations exhibit nearly normal response efficiencies to long phase-duration stimuli but greatly elevated thresholds and reduced asymptotic firing efficiency to those with short ones. Similarly, short inter-phase gaps yielded reduced asymptotic firing efficiencies in demyelinated populations, consistent with greater interference between opposing polarity pulses. We have also developed a strategy for production of simulated electrically evoked compound action potentials (eCAPs) for our populations. Consistent with the observed increase in inter-fiber latency variance, demyelinated populations produced eCAPs with broader N1 and P2 peaks compared to normally myelinated populations. Importantly, the differences in relative sensitivity to different phase durations and inter-phase gaps observed at the neural spiking level appear to correspond with growth function changes observed in long-term deafened animals in the experimental eCAP literature. We also stimulated normal and demyelinated populations with pulse trains of different frequencies. While all populations desynchronized at sufficiently high pulse rates, demyelinated populations exhibited significantly lower minimum desynchronization frequencies.



Specific Aim 2: Fine and coarse temporal information encoding within populations. Even with stimulation paradigms optimized to convey fine temporal information, CI patients typically struggle to detect physiologically plausible interaural timing differences. In contrast, many CI patients have quite low thresholds for detecting low frequency envelope modulations of a carrier signal. This latter ability shows significant correlation with speech recognition performance. In this aim, we seek to explore whether the variability in the time constants within a population of heterogeneously demyelinated fibers may differentially degrade the ability to encode temporal features on these different time scales.

Progress:

2.1- While attempting to replicate previous studies regarding simulation of modulation detection, we found vector strength and max-min rule-mediated analysis of population spiking extremely sensitive to windowing and introduction of jitter. Population responses appeared to predict an ability to detect modulations that exceeds that observed in CI users. One reason we may have observed this is that we performed analysis on entire spike trains. As observed in our unmodulated pulse train studies, phase locking begins high even at high pulse rates before desynchronizing at steady state. We will explore simulating MDTs using only steady state responses and anticipate poorer phase locking to high frequency stimuli.



2.2 Our receiver-operator characteristic analysis of population spike timing, yielded detection of ITDs that differed with population demyelination state. Severely demyelinated populations (75% myelin loss) exhibit significantly elevated ITD detection thresholds compared to normal populations.

Specific Aim 3: Encoding of phonetic information in speech. We will assess the ability of our fiber population models to encode phonetic information by performing pattern classification on responses of normal and pathologically altered fiber populations to carefully chosen speech stimuli. This modeling will provide insight into how phoneme recognition could be limited by the peripheral factors outlined.

Progress: We have generated series of stimuli that span the range between two different vowel and consonant formant pairs. These will be presented to model populations with different degrees of pathology and their ability to encode this spectrum of stimuli interrogated using a Metric-Space Analysis strategy.

C. Funding:

The work that formed part of the AOS grant helped the PI successfully compete for a National Institute of Deafness and Other Communication Disorders NRSA F31 Fellowship.

D. Publications:

Resnick, J.M., O'Brien, G., Rubinstein, J.T., 2018. Simulated auditory nerve axon demyelination alters sensitivity and response timing to extracellular stimulation. *Hear. Res.* 361, 121–137. doi:10.1016/j.heares.2018.01.014

Two additional publications in preparation to be submitted before April, 2019.

E. Posters and Presentations:

- Heterogenous Demyelination Alters Response Properties of Simulated Neuron Populations to Implant Stimulation, *Association for Research in Otolaryngology MidWinter Meeting*, 2018.
- Demyelination Degrades Temporal Precision of Simulated Neural Responses to Cochlear Implant Stimulation, *NeuroFutures Meeting*, 2018.
- Neural Time Constants Drive Electrically Evoked Compound Action Potential Inter-phase Gap Effect, *North-West Auditory and Vestibular Research Meeting*, 2018.
- Neural Time Constants are Key Determinants of Simulated Electrically Evoked Compound Action Potential Growth Function Shape, *Association for Research in Otolaryngology MidWinter Meeting*, 2019.

American Otological Society Research Grants
6 Month Progress Report
Reporting Period 7/1/2018 – 6/30/2019

PI: Christopher Spankovich, Au.D., Ph.D., M.P.H
Grant Title: Application of Modified Cool Vestibular Caloric for Prevention of Cisplatin Induced Hearing Loss

Progress Report

A. Introduction

The incidence of hearing loss related to platinum-based chemotherapeutic induced ototoxicity has been reported to be as high as 75-100% of patients, depending on the dosage and age of the patient. Though numerous pharmacological agents have been studied for their protective effects against ototoxicity, the implementation of these agents may be limited due to the potential compromise of anti-tumor efficacy and/or invasiveness of treatment delivery. Recently, we showed that a modified vestibular caloric treatment (i.e. irrigation of ear canal with temperature-controlled water, without change in core body temperature) alters cisplatin induced hearing loss (CIHL) in a diametric manner; hearing loss is reduced with cooling and potentiated with warming (Spankovich et al. 2016). *The purpose of this research is to assess otoprotection using a modified cool vestibular caloric in a single and repeated dosing cisplatin paradigm. In addition, we will determine potential mechanisms that mediate the effects of the localized cooling on CIHL. Finally, we will examine a novel device for caloric delivery using a static caloric system that delivers cooling via ear bars. The development of an otoprotection strategy based on currently applied vestibular assessment methods would have significant benefit including improved quality of life for patients and decreased auditory rehabilitation costs.*

B. Results

Aim 1. Assess the effects of ear canal irrigation with cool water and static caloric system on CIHL induced by repeated cisplatin injections at acute and delayed times. The purpose of this aim is to compare two methods of temperature delivery for protection from CIHL and if protection can be observed with repeated cisplatin exposure and sustained at later time points.

Progress:

I. We have acquired all equipment for thermal treatment and obtained IACUC approvals. The temperature delivery systems (i.e. water and static) were acquired, modified for guinea pig application, and calibrated for temperature accuracy. A custom support structure was created to cradle animals during treatment.
II. We completed an experiment examining thermal transference to the round window niche. In this experiment, guinea pigs were deeply anesthetized and a small opening was made in the bulla. A temperature probe was then placed at the round window of the cochlea. The animal was then placed in a custom support structure housing a temperature pad to maintain body temperature and temperature readings were recorded. The ear canal of the animals was then irrigated with temperature-controlled water followed by the static caloric system or vice versa. We found that a water delivered at 7°C below the starting temperature resulted in a mean change of 1.5°C at the round window. This was consistent with our previous findings. To achieve the same 1.5°C using the static caloric system required a change of 12°C. These data were important to inform our temperature selection for further experiments in Aim 1.

III. Twelve guinea pigs have been initiated in the repeated cisplatin exposure experiment. Preliminary baseline auditory brainstem response thresholds and distortion product otoacoustic emission thresholds are shown in Figure 1 (A and B). Threshold shift for control animals (cisplatin only + sham) are shown in Figure 2 (A and B); only a single cycle of 4 consecutive days of 3 mg/kg cisplatin was necessary to elicit greater than a 20-dB threshold shift in both ABR and DPOAEs at higher frequency basal regions.
IV. Our experimental treatments (cooling with water and static systems) are underway. We anticipate aim 1 physiological and anatomical studies to be completed by the end of March.

Aim 2. Assess the effects of cool and warm water ear canal irrigation on CIHL pathways. The purpose of aim 2 is to examine several candidate mechanistic pathways for effects of cooling and warming of the ear canal on CIHL.

Progress:

I. We have acquired a fluorescently tagged cisplatin from the NIH-NIDCD as of January. The BODIPY FL-cisplatin is a conjugate of cisplatin and the low molecular weight fluorophore BODIPY FL. The BODIPY FL-cisplatin and free-dye (no cisplatin) compound BODIPY FL-Boc were synthesized by the Imaging Probe Development Center of the National Heart, Lung, and Blood Institute Intramural Program and provided to our lab by Lisa Cunningham, Ph.D (NIH-NIDCD). The BODIPY FL-cisplatin was synthesized in order to enable visualization of the cellular location of cisplatin. In addition to the BODIPY-FL cisplatin we will examine level of cisplatin in the cochlea via perilymph sampling. These experiments will be completed in controls and guinea pigs undergoing cool and warm irrigation to examine the effect on cochlear uptake.
II. We also plan to assess upstream and downstream cell signaling pathways (e.g. evidence of lipid peroxidation and caspase 3).
III. We plan to complete Aim 2 between the months of April and June.

References

Spankovich, C., Lobarinas, E., Ding, D., Salvi, R., and Le Prell, C.G. (2016). Assessment of thermal treatment via irrigation of external ear to reduce cisplatin induced hearing loss, *Hear Res*. 332, 55-60.

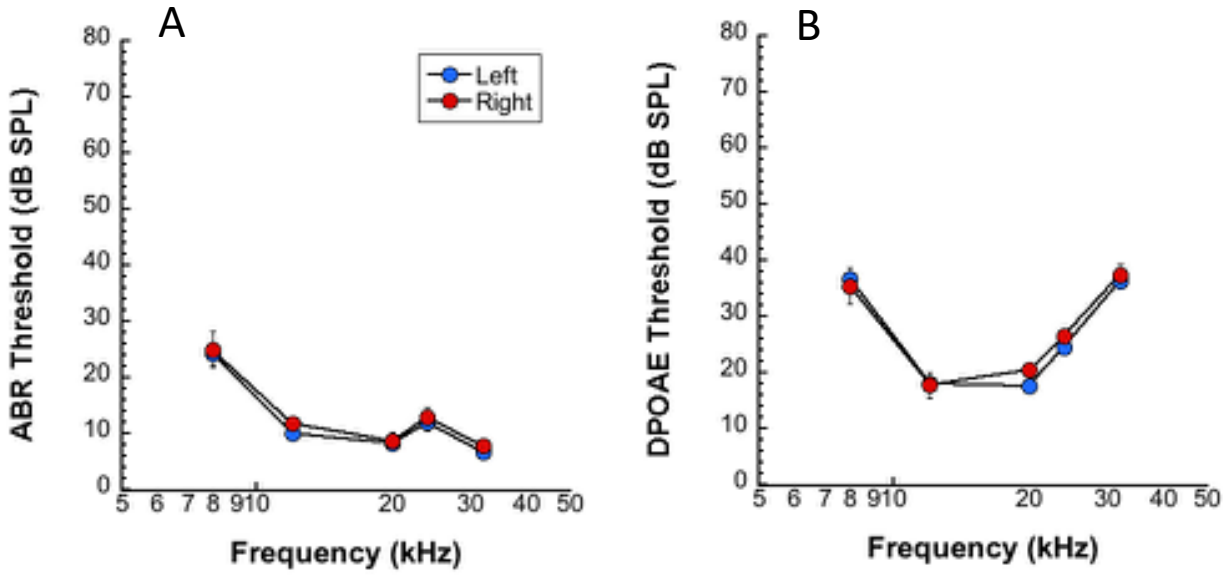


Figure 1. ABR and DPOAE Threshold. A. ABR baseline thresholds and B. DPOAE baseline thresholds. Blue = left ear and Red = right ear.

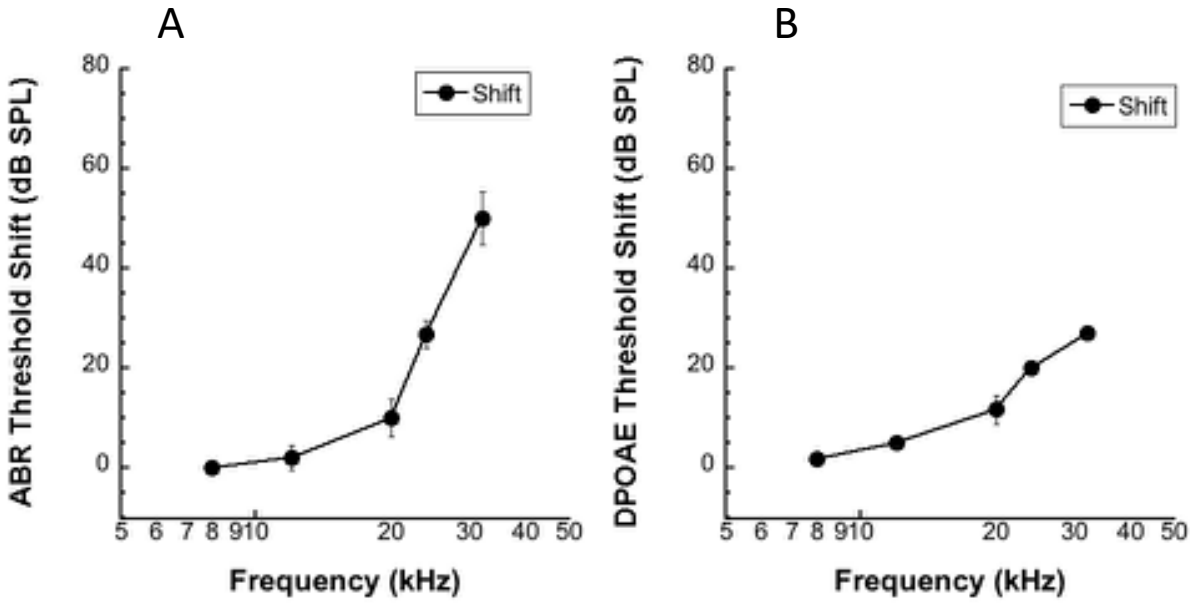


Figure 2. ABR and DPOAE Threshold Shift. Threshold shift for control animals and single cycle of cisplatin are shown for ABR (A) and DPOAEs (B).

Progress Report: Developing a gene expression atlas of the normal human inner ear.
PI: Aaron Tward M.D. Ph.D. UCSF

Disorders of the inner ear are prevalent and cause a substantial burden on individual patients, the health care system, and society as a whole. Although some excellent work has been done to understand the cellular heterogeneity and physiology of model animals, our understanding of the cellular heterogeneity and physiology of the mammalian and especially human inner ear is grossly incomplete. This is a consequence of a few key problems. First, the inner ear of mammals contains many different individually rare cell types, hence making analysis of any individual cell type challenging. Second, because the inner ear begins to degrade rapidly after death or explant, human tissue needs to be processed and analyzed rapidly following harvest. The availability of such specimens is severely limiting. Using cutting edge single cell RNA-sequencing technologies and novel analysis algorithms, this proposal aims to discover novel cell subtypes of the human inner ear, describe their complete transcriptional profiles, and validate their existence and locations using orthogonal technologies.

Specific Aim 1: Develop a cellular atlas of human inner ear using single cell RNA sequencing
We will obtain samples of fresh fetal human inner ear tissue from various ages, and microdissect the semicircular canals, otolith organs, and cochlea. We will perform a similar analysis on additional samples obtained from adult human inner ear soft tissue isolated at the time of transpetrosal/translabyrinthine approaches to skull base masses where hearing cannot be preserved. Then we will then dissociate the tissue generate single cell suspensions. Cells will then be sorted using magnetic bead based sorting. The cells will then be loaded onto the 10x genomics machine for library generation and sequenced using the Illumina HiSeq 4000. We will then use our novel CellfindR algorithm to identify all cells present within these samples, as well as their gene expression patterns. This will therefore create a transcriptional map of all of the cells within the human inner ear.

Progress:
We obtained specimens and completed single cell sequencing of human fetal inner ear from three individual timepoints: 15 weeks, 17 weeks, and 23 weeks post conception. In addition, we completed single cell sequencing of adult human inner ears from two individuals: one undergoing a transcochlear/translabyrinthine resection of a massive skull base meningioma and a second from an individual undergoing a translabyrinthine resection of a vestibular schwannoma. From the 15 week inner ear, we ran three separate experiments: unsorted vestibule, and Epcam positive and Epcam negative sorted cochlear cells. All of the 17 week inner ear experiments were run unsorted: vestibular apparatus, microdissected organ of corti, remainder of cochlea, and spiral ganglion and 7/8 nerve complex. From the 23 week fetal specimens there were two separate specimens obtained for a total of four inner ears that were pooled. These were split into seven separate experiments: Epcam positive and epcam negative organ of corti, cochlea, and vestibular apparatus, and unsorted spiral

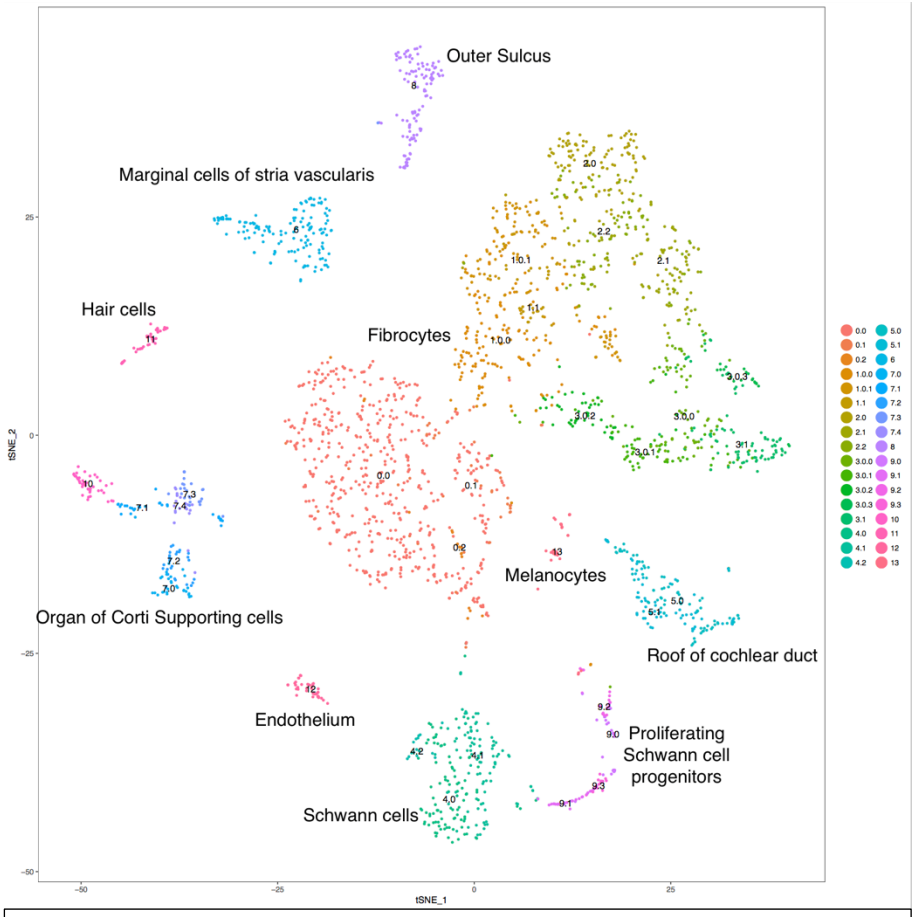


Figure 1: tSNE representation of groups of cells identified by CellfindR from 15 week human fetal cochlea, epcam sorted. 34 independent groups of cells were identified (see legend on the right).

ganglion and 7/8 nerve complex. For all of these specimens high quality sequence was obtained, and almost all experiments listed above captured greater than 1000 cells. The viability of the cells was high as indicated by low fractions of cells with mitochondrial fraction greater than 5%. We ran our clustering algorithm, CellfindR on all of the samples and identified novel clusters of cells. As one example of one of these datasets, from our 15 week epcam sorted cochlea we captured 2498 cells, with an average of approximately 3000 genes per cell. We were able to readily identify known cell groups as well as identify previously uncharacterized subgroups of cells. We identified 34 independent subclusters of cells in all (Figure 1). We now have complete gene expression profiles for all of these cells and have identified novel markers of all of these cell types as well as previously uncharacterized progenitor cells. We are in the process of analyzing these massive datasets now.

Specific Aim 2: Determine the microanatomic localization of cells in human inner ear

We are currently completing a cell based transcriptional map of the mouse inner ear, and hope to create something similar for the human inner ear with the experiments in specific aim 1. Once these cells are identified, the predictions made with the single cell RNA seq data will need to be validated using an orthogonal technique, and the locations of the cell types will need to be identified within the inner ear. Using a combination of immunohistochemistry and multiplex RNAScope RNA in situ hybridization, we will select characteristic markers of the different identified cell types within the inner ear, and stain sections from human temporal bones in order to identify the microanatomic localizations of the different cell types we have identified. For example, we have identified at least six distinct types of fibrocytes within the mouse cochlea, but where precisely they are located relative to each other is unknown. Using these techniques, we will be able to create a spatial map of subtypes of cells within the inner ear to match our transcriptional map created with the single cell RNA seq data.

Progress:

Prior to using valuable sections of human fetal inner ears for staining, we have optimized protocols for multiplex in situ hybridization using adult mouse cochlea. We have now successfully generated a protocol that permits four channel fluorescence imaging of stained sections of adult mouse P36 cochlea (Figure 2). Using mouse cochlea, we have performed staining and localization of at least 20 distinct cell types in the cochlea. We have optimized protocols for sections (Figure 2A-G), as well as whole mounts of the organ of corti (Figure 2H). In many cases, the cell types are analogous to those found in the human. We anticipate commencing staining on human fetal cochleas within the next few months.

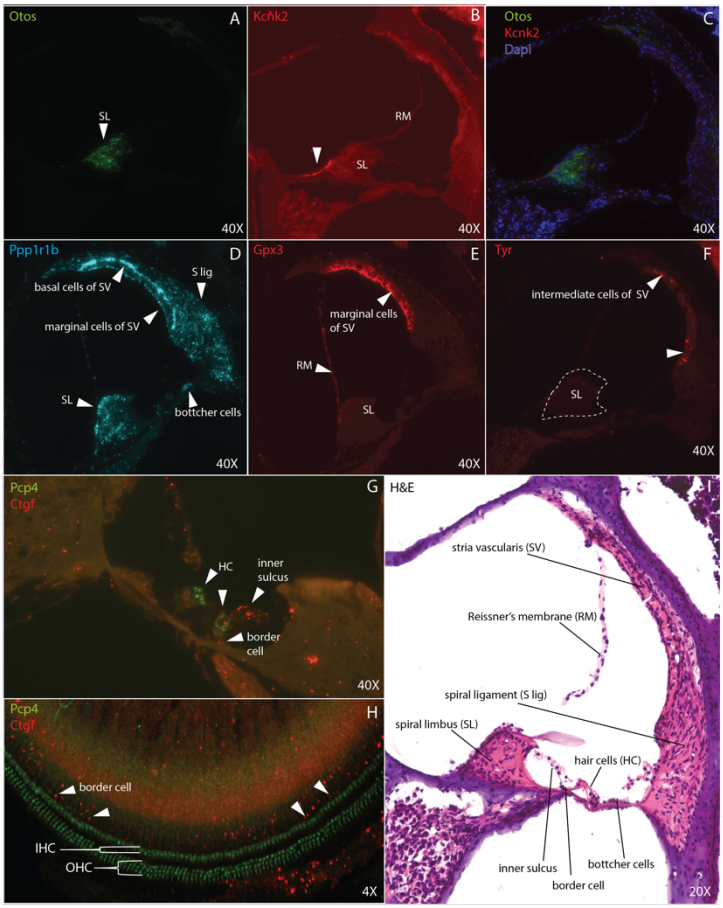


Figure 2: Localization of distinct cell populations in the adult mouse cochlea. A-G: novel markers of distinct cell populations in sections of mouse cochlea. H: Whole mount imaging of mouse cochlea. I. H and E section of adult mouse cochlea.

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Richard R Gacek, MD - Emeritus
Worcester, MA

Bruce J Gantz, MD - Active
Iowa City, IA

L Gale Gardner, Jr, MD - Senior
Shreveport, LA

George A Gates, MD - Emeritus
Boerne, TX

*Soha N Ghossaini, MD - Active
Astoria, NY

Gerard J Gianoli, MD - Active
Covington, LA

Paul W Gidley, MD - Active
Houston, TX

Joel A Goebel, MD - Senior
St Louis, MO

Robert A Goldenberg, MD - Senior
Dayton, OH

Jerome C Goldstein, MD - Honorary
Lake Worth,

Richard L Goode, MD - Emeritus
Stanford, CA

Malcolm D Graham, MD - Emeritus
Atlanta, GA

J Douglas Green Jr, MD - Active
Jacksonville, FL

John H Greinwald Jr, MD - Active
Cincinnati, OH

Andrew J Griffith, MD, PhD – Associate
Bethesda, MD

Samuel P Gubbels, MD - Active
Denver, CO

A Julianna Gulya, MD - Emeritus
Locust Grove, VA

Thomas J Haberkamp, MD - Active
Cleveland, OH

Paul E Hammerschlag, MD - Senior
New York, NY

Marlan R Hansen, MD - Active
Iowa City, IA

Lee A Harker, MD - Emeritus
Omaha, NE

Jeffrey P Harris, MD, PhD - Senior
San Diego, CA

Cecil W J Hart, MD - Emeritus
Palm Springs, CA

George T Hashisaki, MD - Active
Charlottesville, VA

David S Haynes, MD - Active
Nashville, TN

Keiko Hirose, MD - Active
St Louis, MO

Barry E Hirsch, MD - Senior
Pittsburgh, PA

Michael E Hoffer, MD - Active
Miami, FL

Ronald A Hoffman, MD - Senior
New York, NY

James J Holt, MD, MS - Emeritus
Marshfield, WI

Karl L Horn, MD - Active
Santa Fe, NM

John W House, MD - Senior
Los Angeles, CA

Timothy E Hullar, MD - Active
Portland, OR

Makoto Igarashi, MD - Senior Associate
Tokyo, Japan

S Armagan Incesulu, MD - Corresponding
Eskisehir, Turkey

*Brandon Isaacson, MD - Active
Dallas, TX

Akira Ishiyama, MD - Active
Los Angeles, CA

Juichi Ito, MD - Corresponding
Sakyo-Ku, Kyoto, Japan

Salvatore J Iurato, MD - Senior Associate
Bari, Italy

Robert K Jackler, MD - Active
Stanford, CA

Carol A Jackson, MD - Active
Newport Beach, CA

Abraham Jacob, MD - Active
Tucson, AZ

Adrian James, MD - Active
Toronto, Canada

Herman A Jenkins, MD - Active
Aurora, CO

Lars-Goran Johnsson, MD - Senior Associate
Finland

Raleigh O Jones Jr, MD - Active
Lexington, KY

L B W Jongkees, MD- Honorary
Amsterdam, The Netherlands

Steven K Juhn, MD - Senior Associate
Minneapolis, MN

Timothy K Jung, MD - Active
Riverside, CA

Donald B Kamerer, MD - Emeritus
Pittsburgh, PA

David M Kaylie, MD - Active
Durham, NC

Bradley W Kesser, MD - Active
Charlottesville, VA

Nelson Y S Kiang, PhD - Emeritus
Boston, MA

Paul R Kileny, PhD - Senior Associate
Ann Arbor, MI

Hung Jeffrey Kim, MD - Active
Washington, DC

Ana H Kim, MD - Active
New York, NY

Harold H Kim, MD - Active
Portland, OR

Sam E Kinney, MD - Senior
Moreland Hills, OH

Horst R Konrad, MD - Senior
Naples, FL

Richard D Kopke, MD - Active
Oklahoma City, OK

Arvind Kumar, MD - Emeritus
Hinsdale, IL

*J Walter Kutz, MD - Active
Dallas, TX

Robert F Labadie, MD, PhD - Active
Nashville, TN

Anil K Lalwani, MD - Active
New York, NY

Paul R Lambert, MD - Active
Charleston, SC

Daniel J Lee, MD - Active
Brookline, MA

Kenneth H Lee, MD, PhD - Active
Plano, TX

Keat-Jin Lee, MD - Emeritus
Guilford, CT

John P Leonetti, MD - Active
Maywood, IL

S George Lesinski, MD - Emeritus
Cincinnati, OH

Samuel C Levine, MD - Active
Minneapolis, MN

Charles J Limb, MD - Active
San Francisco, CA

Vincent Y W Lin, MD - Active
Toronto, Canada

Roger C Lindeman, MD - Emeritus
Mercer Island, WA

Thomas E Linder, MD - Corresponding
Luzern, Switzerland

Fred H Linthicum Jr, MD - Emeritus

William H Lippy, MD - Emeritus
Warren, OH

Phillip D Littlefield, MD - Active
Kaneohe, HI

Ward B Litton, MD - Emeritus
Bonita Springs, FL

Brenda Lonsbury-Martin, PhD – Associate
Loma Linda, CA

Charles M Luetje, MD - Senior
Olathe, KS

Larry B Lundy, MD - Active
Ponte Vedra Beach, FL

Lawrence R Lustig, MD - Active
New York, NY

John D Macias, MD - Active
Phoenix, AZ

Charles A Mangham Jr, MD - Senior
Hailey, ID

Wolf J Mann, MD - Emeritus
Mainz, Germany

Sam J Marzo, MD - Active
Maywood, IL

Douglas E Mattox, MD - Active
Atlanta, GA

John T McElveen Jr, MD - Active
Raleigh, NC

Michael McGee, MD - Active
Oklahoma City, OK

Michael J McKenna, MD - Active
Boston, MA

Brian J McKinnon, MD - Active
Philadelphia, PA

Sean O McMenomey, MD - Active
Seattle, WA

Cliff A Megerian, MD - Active
Cleveland, OH

Michael Merzenich, PhD - Senior Associate
San Francisco, CA

William L Meyerhoff, MD - Emeritus
Dallas, TX

Alan G Micco, MD - Active
Chicago, IL

Lloyd B Minor, MD - Active
Stanford, CA

Richard T Miyamoto, MD - Senior
Indianapolis, IN

David A Moffat, MA - Corresponding
Cambridge, England

Edwin M Monsell, MD, PhD - Senior
Rochester Hills, MI

Gary F Moore, MD - Active
Omaha, NE

William H Moretz Jr, MD - Active
Augusta, GA

Tetsuo Morizono, MD DMS - Senior Associate
Fukuoka City, Japan

Terrence P Murphy, MD - Active
Atlanta, GA

Eugene N Myers, MD - Emeritus
Pittsburgh, PA

Joseph B Nadol Jr, MD - Emeritus
Boston, MA

Hideko Heidi Nakajima, PhD - Associate
Boston, MA

Julian M Nedzelski, MD - Emeritus
Toronto, Ontario, Canada

Brian A Neff, MD - Active
Rochester, MN

Erik G Nelson, MD - Active
Lake Forest, IL

Ralph A Nelson, MD - Emeritus
Manchester, WA

Yasuya Nomura, - Honorary
Tokyo, Japan

John S Oghalai, MD - Active
Los Angeles, CA

Carlos A Oliveira, MD, PhD – Associate
Brasil

Robert C O'Reilly, MD - Active
Philadelphia, PA

Michael M Paparella, MD - Senior
Minneapolis, MN

Dennis Pappas, MD - Emeritus
Birmingham, AL

Dennis G Pappas Jr, MD - Active
Birmingham, AL

Blake C Papsin, MD - Active
Toronto, Ontario, Canada

Simon C Parisier, MD - Senior
New York, NY

James L Parkin, MD - Emeritus
Salt Lake City, UT

Lorne S Parnes, MD - Active
London, Ontario, Canada

Steven M Parnes, MD - Active
Albany, NY

Myles L Pensak, MD - Active
Cincinnati, OH

Rodney Perkins, MD - Senior Associate
Woodside, CA

Brian P Perry, MD - Active
San Antonio, TX

Harold C Pillsbury, MD - Active
Chapel Hill, NC

Dennis S Poe, MD - Active
Boston, MA

Leonard R Proctor, MD - Emeritus
Bel Aire, MD

G Mark Pyle, MD - Active
Madison, WI

J H Thomas Rambo, MD - Emeritus
New York, NY

Steven D Rauch, MD - Active
Watertown, MA

Miriam I Redleaf, MD - Active
Chicago, IL

Jose Antonio Rivas, MD - Corresponding
Bogota, Colombia

Peter S Roland, MD - Senior
Eden, UT

J Thomas Roland Jr, MD - Active
New York, NY

Max L Ronis, MD - Emeritus
Philadelphia, PA

Seth Rosenberg, MD - Active
Sarasota, FL

John J Rosowski, PhD – Associate
Boston, MA

Edwin W Rubel, PhD - Senior Associate
Seattle, WA

Robert J Ruben, MD - Senior
Bronx, NY

Allan M Rubin, MD, PhD - Senior
Perrysburg, OH

Jay T Rubinstein, MD, PhD - Active
Seattle, WA

Michael J Ruckenstein, MD - Active
Philadelphia, PA

*Christina L Runge, PhD -Associate
Milwaukee, WI

Leonard P Rybak, MD, PhD - Active
Springfield, IL

Masafumi Sakagami, MD, PhD - Corresponding
Hyogo, Japan

Alec N Salt, PhD - Associate
St Louis, MO

Clarence T Sasaki, MD - Senior
New Haven, CT

Robert T Sataloff, MD - Active
Philadelphia, PA

James E Saunders, MD - Active
Lebanon, NH

Jochen Schacht, PhD - Senior Associate
Ann Arbor, MI

Arnold G Schuring, MD - Emeritus
Warren, OH

Mitchell K Schwaber, MD - Senior
Nashville, TN

Michael D Seidman, MD - Active
Celebration, FL

Samuel H Selesnick, MD - Active
New York, NY

Clough Shelton, MD - Senior
Salt Lake City, UT

Neil T Shepard, PhD - Associate
Rochester, NY

Jack A Shohet, MD - Active
Newport Beach, CA

Herbert Silverstein, MD - Senior
Sarasota, FL

George T Singleton, MD - Emeritus
Gainesville, FL

Aristides Sismanis, MD - Senior
Richmond, VA

Henryk Skarzynski, MD, PhD - Corresponding
Nadarzyn, Poland

William H Slattery III, MD - Active
Los Angeles, CA

Richard J H Smith, MD - Honorary
Iowa City, IA

Eric E Smouha, MD - Active
New York, NY

James B Snow Jr, MD - Emeritus
West Grove, PA

Gershon Jerry Spector, MD - Emeritus
St Louis, MO

Hinrich Staecker, MD, PhD - Active
Kansas City, KS

Konstantina M Stankovic, MD, PhD - Active
Boston, MA

Olivier Sterkers, MD, PhD - Corresponding
Paris, France

Steven A Telian, MD - Active
Ann Arbor, MI

Fred F Telischi, MD - Active
Miami, FL

Norman Wendell Todd Jr, MD - Active
Atlanta, GA

Daniel J. Tollin, PhD - Associate
Aurora, CO

Debara L Tucci, MD - Active
Durham, NC

*Andrea Vambutas, MD - Active
New Hyde Park, NY

Jeffrey T Vrabec, MD - Active
Houston, TX

P Ashley Wackym, MD - Active
New Brunswick, NJ

George B Wanna, MD - Active
New York, NY

Jack J Wazen, MD - Senior
Sarasota, FL

Peter C Weber, MD, MBA - Active
Boston, MA

Roger E Wehrs, MD - Emeritus
Tulsa, OK

D Bradley Welling, MD, PhD - Active
Boston, MA

Stephen J Wetmore, MD - Senior
Morgantown, WV

Richard J Wiet, MD - Emeritus
Sawyer, MI

Eric P Wilkinson, MD - Active
Los Angeles, CA

Robert J Wolfson, MD - Emeritus
Philadelphia, PA

Sabina Regina Wullstein, MD - Senior Associate
Wurzburg, Germany

Thomas PU Wustrow, MD - Corresponding
Munchen, Germany

Naoaki Yanagihara, MD - Honorary
Matsyama, Japan

Eiji Yanagisawa, MD - Emeritus
New Haven, CT

Nancy M Young, MD - Active
Chicago, IL

Joseph J Zwislocki, ScD - Senior Associate
Syracuse, NY

in Memoriam

The AOS Administrative office was notified of the
following members death since the last Spring meeting.

Please take a moment of silence to remember these outstanding colleagues & friends.
(in alphabetical order)

Warren Y. Adkins, MD

Noel L. Cohen, MD

David A. Hilding, MD (passed in 2016)

C. Gary Jackson, MD

David J. Lim, MD

William H. Saunders, MD

G. Dekle Taylor, MD (passed in 2015)

Ruediger Thalmann, MD

Galdino Valvassori, MD

David Wilson, MD