PROGRAM and ABSTRACTS

of the

AMERICAN NEUROTOLOGY SOCIETY

58th Annual Spring Meeting

May 5 - 6, 2023
Hynes Convention Center
Sheraton Boston
Boston, MA

Table of Contents

(ANS 2023 Program Book)

AMERICAN NEUROTOLOGY SOCIETY
2022-2023 EXECUTIVE COUNCIL

President
Fred F. Telischi, MD
Miami, FL

President-Elect
Elizabeth H. Toh, MD, MBA
Burlington, MA

Secretary-Treasurer
David S. Haynes, MD, MMHC
Nashville, TN

Immediate Past President
Craig A. Buchman, MD
St. Louis, MO

Education Director
Yuri Agrawal, MD, MPH
Baltimore, MD

ANS Diversity/Inclusion Chair
Stephanie A. Moody Antonio, MD
Norfolk, VA

Members at Large

Hussam K. El-Kashlan, MD
Ann Arbor, MI

Sarah Mowry, MD
Cleveland, OH

Alan G. Micco, MD
Chicago, IL

AMERICAN NEUROTOLOGY SOCIETY
MISSION STATEMENT

PURPOSE

The American Neurotology Society (ANS) is committed to improving public health care related to disorders of the ear, hearing and balance primarily through the provision of high-quality continuing medical education (CME) to our members. The overall goals of the ANS educational programs are to organize CME activities addressing the knowledge gaps and enhancing the clinical competence of the participants. The ANS is dedicated to improving public health care through the development, dialogue and dissemination of advances in evidence-based diagnosis and management of neurotologic and related skull base disorders.

Furthermore, the ANS is committed to fulfilling its purpose by encouraging and funding research that promotes the health and wellness of our patients, members, and their communities. Novel information, such as that presented at the annual conferences, as well as solicited and unsolicited manuscripts, are considered for publication in the ANS supported, peer reviewed and evidence-based content of the *Otology & Neurotology* (original and open access) Journals. The focus on the scientific advances in the field of neurotology is translated into approaches to quality care that are consistent with ACGME/ABMS general competency areas and the Institute of Medicine recommendations.

The ANS fully supports a culture of both unbiased, civil dialogue among its members and diversity in all aspects of the field, including education, research and clinical practice. Equally important to our mission is equity of access to the highest quality neurotological healthcare for all patients requiring our services. Our society considers the needs of trainees at all levels interested in learning neurotology in order to develop the next generation of practitioners from among the best and brightest among their peers with the broadest representation of all backgrounds and personal characteristics.

TARGET AUDIENCE

The primary target audience includes members of both the American Neurotology Society and our sister Society, the American Otological Society as well as healthcare professionals in the fields of otology, otolaryngology neurotology and skull base research and healthcare. The members served include physicians, otologists, neurotologists, residents, fellows, researchers, audiologists, and other healthcare professionals who are involved in the care of patients with otologic and neurotologic conditions.

TYPES OF ACTIVITIES PROVIDED

In order to accomplish the goals of the ANS CME program, the Education committee will offer a range of activities with specific educational outcomes in mind. Current offerings include:

- Scientific symposia, delivered twice per year at national venues, showcasing the latest research in the field and featuring national and international experts on related clinical topics.
- Study groups & mini-seminars offered at the annual meeting of the American Academy of Otolaryngology-Head and Neck Surgery.
- Facilitation of manuscript submission on presented materials for publication in a peer reviewed journal (Otology & Neurotology and Otology/Neurotology Open)
- The Otology & Neurotology Journal, and the Otology/Neurotology Open Access publications, provide additional vehicles for further collaboration and dissemination of new information, science and standards of care.

CONTENT

The content of the ANS CME program centers on clinical issues related to Neurotology and disorders of the skull base. The ANS also strives to respond to our members' educational needs that are not being met by other organizations, and therefore also offers activities in the areas of risk management, patient safety, physician-patient communications, coding, HIPAA compliance, and other regulatory issues as they relate to Neurotology. The educational efforts will also highlight the ACGME/ABMS general competencies within the context of this field and relate the significance of communication, professionalism, patient safety and systems-based practice within these workplace environments.

EXPECTED RESULTS

The CME program of the ANS strives to enhance the participants' knowledge and clinical competence in subject areas relevant to the field of Neurotology. The other expected outcome from this CME program is continued development of new evidence-based science, dissemination of ongoing research in the clinical area of Neurotology.

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.

Program Objectives / Educational Activity Details

What are the practice or patient care problems being addressed by this activity?

Overall, this activity addresses gaps in knowledge and practice that reflect evolving understanding and perspectives in the diagnosis and management of health conditions of the ear and skull base. These sessions highlight the core principles of standard practice while challenging commonly held assumptions that create opportunities for further clarification or research. The scope of the gaps addressed by the following activities are indicated:

Lecture: "Found in Translation: At the Intersection of Biomedical Engineering, Audiology and Neurotology": This lecture will assess gaps in knowledge about novel engineering technology to advance health care and outcomes in audiology and neurotology.

Cochlear Implant Scientific Sessions – With broadening candidacy criteria, cochlear implant has become a viable option for management of hearing loss with greater degrees of residual hearing. A growing experience by presenting clinicians will provide early and preliminary experience and performance outcomes for the expanded indications for implantation.

Panel- Treating Meniere's Disease as a Migraine-Variant: New Paradigm or Temporary Fad? – This panel will showcase evolving clinical practice related to the management of these two common and sometimes vexing vestibular disorders.

Panel- Treatment of the Facial Nerve: from Inside Out – This inter-disciplinary panel will discuss contemporary management of the facial nerve in the temporal bone, from the standpoint of management of primary facial nerve pathology, and also rehabilitation of facial nerve paralysis.

Vestibular Schwannoma Scientific Session – This session will address evolving studies related to novel biomarkers predicting the biology and natural history of vestibular schwannomas.

Lecture: "Chemotherapy for Vestibular Schwannoma: Finding the Right Niche": This lecture will assess gaps in knowledge about evolving indications for chemotherapy in the management of vestibular schwannoma and neurofibromatosis type 2 chemotherapy trial outcomes.

Vestibular Disorders Scientific Sessions – This session will address knowledge gaps in the management of vestibular disorders, including pediatric vestibular disorders, and vestibular migraine.

How will this activity improve the learners' competence (knowledge in action), performance (skill set) and/or patient outcomes (impact of care)?

- **Competence**:
  The educational program is designed to address the topics identified as practice gaps through individual presentations and in-depth panel discussions. The panels will emphasize case-based learning and the opportunity to demonstrate the application of core principles and new information to clinical decision making.

- **Performance**:
  All activities will review established knowledge, present areas of controversy and define skills that require additional development within our field or in consultation with other disciplines. Means by which these skills can be acquired or improved will also be presented.

- **Patient Outcomes**:
  The impact of clinical decision making, professionalism and health system structures on clinical outcomes will be presented and discussed with assistance of the moderators. Improvement in recognizing, diagnosing, and managing disorders of the inner ear.

State the learning objectives for this activity:

1. To describe the evolution of technology and clinical knowledge that have led to advances in audiologic and neurotologic care of patients.

2. To demonstrate and discuss the implementation of expanded CI candidacy in the clinical management of sensorineural hearing loss.

3. To draw from the latest clinical experience and cutting-edge research when managing patients with vestibular schwannoma.

4. To explain the future directions of cochlear implant device and service delivery; new technologies and possible impact on patient-performance and satisfaction.

5. To examine the latest approaches in managing two common and frequently confounded vestibular disorders, vestibular migraine and Meniere's disease.

6. To assess new techniques for the diagnosis of vestibular disorders, and to differentiate among vestibular disorders with overlapping features.

7. To evaluate and manage pathology of the facial nerve, from the perspective of neurotologists in managing the facial nerve during temporal bone surgery and the perspective of facial plastic surgeons in rehabilitation of the paralyzed facial nerve.

Continuing Medical Education Credit Information

CONTINUING MEDICAL EDUCATION CREDIT INFORMATION

Accreditation

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of American College of Surgeons and American Neurotology Society. The American College of Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

AMA PRA Category 1 Credits™

The American College of Surgeons designates this live activity for a maximum of **7.00** *AMA PRA Category 1 Credits™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ACS AMERICAN COLLEGE OF SURGEONS

ACCME ACCREDITED WITH COMMENDATION

AMERICAN COLLEGE OF SURGEONS
DIVISION OF EDUCATION

ABOHNS MOC Recognition Statement

Successful completion of this CME activity, which includes participation in the evaluation component, enables the participant to meet the expectations of the American Board of Otolaryngology's Maintenance of Certification (MOC) program. It is the American College of Surgeon's (the CME provider) responsibility to submit participant completion information to ACCME for the purpose of recognizing participation.

ABOHNS MOC Participant Data Privacy Information

If you are a Diplomate of the American Board of Otolaryngology-Head and Neck Surgery (ABOHNS) and would like to claim CME for MOC points for this educational activity (optional), you will be asked to provide personal information (Diplomate ID, first and last name, and month and day of birth) as part of the registration and/or evaluation process. The American College of Surgeons will only use this information to transmit your CME for MOC points to the ACCME on your behalf, upon successful completion of the activity.

Disclosure Information

In accordance with the ACCME Accreditation Criteria, the American College of Surgeons must ensure that anyone in a position to control the content of the educational activity (planners and speakers/authors/discussants/moderators) has disclosed all financial relationships with any commercial interest (termed by the ACCME as "ineligible companies", defined below) held in the last 24 months (see below for definitions). Please note that first authors were required to collect and submit disclosure information on behalf all other authors/contributors, if applicable.

Ineligible Company: The ACCME defines an "ineligible company" as any entity producing, marketing, re-selling, or distributing health care goods or services used on or consumed by patients. Providers of clinical services directly to patients are NOT included in this definition.
Financial Relationships: Relationships in which the individual benefits by receiving a salary, royalty, intellectual property rights, consulting fee, honoraria, ownership interest (e.g., stocks, stock options or other ownership interest, excluding diversified mutual funds), or other financial benefit. Financial benefits are usually associated with roles such as employment, management position, independent contractor (including contracted research), consulting, speaking and teaching, membership on advisory committees or review panels, board membership, and other activities from which remuneration is received, or expected. ACCME considers relationships of the person involved in the CME activity to include financial relationships of a spouse or partner.
Conflict of Interest: Circumstances create a conflict of interest when an individual has an opportunity to affect CME content about products or services of a ineligible company with which he/she has a financial relationship.

The ACCME also requires that ACS manage any reported conflict and eliminate the potential for bias during the educational activity. Any conflicts noted below have been managed to our satisfaction. The disclosure information is intended to identify any commercial relationships and allow learners to form their own judgments. However, if you perceive a bias during the educational activity, please report it on the evaluation.

In accordance with the ACCME Accreditation Criteria, the American College of Surgeons must ensure that anyone in a position to control the content of the educational activity (planners and speakers/authors/discussants/moderators) has disclosed all financial relationships with any ineligible company held in the last 24 months. Please note that first authors were required to collect and submit disclosure information on behalf all other authors/contributors, if applicable.

Please see pages 118-120 for the complete disclosure list.

PUBLICATION STATEMENT: The material in these abstracts must not have been published or presented previously at another national or international meeting and may not be under consideration for presentation at another national or international meeting including another COSM society. The study detailed in these abstracts *may be submitted* for consideration for publication to *Otology & Neurotology* at any time after this call for papers begins. However, should the abstract be selected as a poster or an oral presentation, publication of the manuscript will be delayed until after the 2023 COSM meeting takes place. If this policy is violated, the ANS will prohibit presentation at the COSM meeting and the manuscript will be withdrawn from publication in print or online. The penalty for any duplicate presentation/publication is prohibition of the author from presenting at a COSM society meeting for up to three years. Duplicate submission to AOS or another participating COSM Society will disqualify your abstract immediately.

COPYRIGHT TRANSMITTAL: Abstracts are received with the understanding that they are not under simultaneous consideration by another publication and that they are original contributions that have not been previously published. Accepted abstracts become the permanent property of *Otology & Neurotology* and may not be published elsewhere without permission from *Otology & Neurotology**

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

Journal Requirements/Instructions to Primary Authors
Manuscripts are required of ALL ORAL & POSTER 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 Journals of *OTOLOGY & NEUROTOLOGY* or *ONO (O&N OPEN)* do not accept paper manuscripts. Manuscripts are reviewed prior to the Annual meeting for conflict of interest and resolution.

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

MARK YOUR CALENDAR!
The 58th Annual ANS Fall Meeting
"SUPER SATURDAY"
September 30, 2023
Renaissance Nashville (611 Commerce St)
Nashville, TN

The Abstract deadline for the ANS 59th Annual Spring meeting in Chicago on May 17–19, 2024, is Sunday, October 15, 2023. Abstract Instructions and submission form will be available on the website September 1st.

For Society business, please forward all inquiries to:
Kristen Bordignon, Executive Administrator
Ashley Eikenberry, ANS Co-Administrator
ANS Administrative Office
5830 1st St. North
St. Petersburg, FL 33703

Ph: 217-638-0801
Fax: 727-800-9428
Email: administrator@americanneurtologysociety.com
Website: www.americanneurtologysociety.com

THE AMERICAN NEUROTOLOGY SOCIETY WOULD LIKE TO THANK THE FOLLOWING MEMBERS FOR THEIR CONTRIBUTION TO THE 2023 ANS SCIENTIFIC PROGRAM

SCIENTIFIC PROGRAM COMMITTEE

Fred F. Telischi, MD, ANS President, Chair
Yuri Agrawal, MD, MPH, ANS Education Director

(in alphabetical order)
Meredith Adams, MD
Syed Ahsan, MD
Mark Bassim, MD
Greg Basura, MD
Eleanor Chan, MD
Christine Dinh, MD
Susan Emmett, MD, MPH
Brian Nicholas, MD
J. Thomas Roland Jr., MD
Daniel Sun, MD
Alex Sweeney, MD
Courtney Voelker, MD
Peter Weber, MD, MBA
Cameron Wick, MD
Sean Wise, MD

ANS EDUCATION COMMITTEE

Yuri Agrawal, MD - Education Director
Fred F. Telischi, MD, ANS President, Chair
Brian P. Perry, MD
Esther X. Vivas, MD
Brandon Isaacson, MD
Marc Eisen, MD
Selena Briggs, MD
Laura Brainard, MD
Matthew Stewart, MD, PhD
Erika M. Walsh, MD
Nael Shoman, MD
Daniel M. Zeitler, MD
R. Mark Wiet, MD
Stephanie Moody Antonio, MD
Jeffrey J. Kuhn, MD
Shawn M. Stevens, MD
Ronna Hertzano, MD, PhD

POSTER JUDGES

Meredith Adams, MD
Syed Ahsan, MD
Shawn Stevens, MD
Courtney Voelker, MD, PhD

AMERICAN NEUROTOLOGY SOCIETY
58th Annual Spring Meeting
PRELIMINARY PROGRAM
May 5 - 6, 2023
Boston, MA

FRIDAY, MAY 5, 2023

1:00 **BUSINESS MEETING** *(Treasurer's report/New member induction)*
(Members Only)

1:30 **SCIENTIFIC SESSION**
(Open to registered Members and Non-members – Badge required for admittance)

1:30 **WELCOME & OPENING REMARKS BY THE PRESIDENT**
Fred F. Telischi, MD

1:32 **PRESIDENTIAL CITATIONS**
Thomas Balkany, MD
Jacques Morcos, MD
Donna Sorkin, MA
Krzysztof Morawski, MD, PhD
Michal Luntz-Kaminski, MD
Brenda Lonsbury-Martin, PhD

1:40 **4th ANNUAL NOEL L. COHEN AWARD FOR SIGNIFICANT CONTRIBUTIONS TO OTOLOGY AND NEUROTOLOGY**

1:45 **INTRODUCTION OF WILLIAM F. HOUSE MEMORIAL LECTURE**
Fred F. Telischi, MD

1:46 **WILLIAM F. HOUSE MEMORIAL LECTURE**
"Found in Translation: At the Intersection of Biomedical Engineering, Audiology and Neurotology"
Suhrud M. Rajguru, PhD
Professor of Biomedical Engineering and Otolaryngology
University of Miami
Director, Miami CTSI Workforce Development
Co-director, Institute for Neural Engineering at Miami
Research Health Scientist, Bruce W. Carter Department of Veterans Affairs Medical Center
Miami, FL

2:16 **INTRODUCTION OF ABSTRACTS - COCHLEAR IMPLANTS: HEARING PRESERVATION**
Meredith E. Adams, MD, Moderator

2:17 **Add-on Flexible Sensor Arrays for Real-time Monitoring of Cochlear Implant Electrode Insertion**
Jay W. Reddy, PhD
Mohsen Tabrizi, PhD
Douglas A. Chen, MD
Abraham Jacob, MD
Maysam Chamanzar, PhD

2:24 NEUROTOLOGY FELLOW AWARD
Application of Spectral Domain Optical Coherence Tomography to Visualize Cochlear Microanatomy
Pawina Jiramongkolchai, MD
Marcello M. Amaral, PhD
Yilin Li
Timothy Holden, BSE
Chao Zhou, PhD
Craig A. Buchman, MD

2:31 The Local Relationship between Acute Insertion Trauma and Chronic Intracochlear Ossification and Fibrosis after Cochlear Implantation: A Human Temporal Bone Study
Alexander R. Geerardyn, MD
MengYu Zhu, MS
Joseph B. Nadol Jr., MD
Nicolas Verhaert, MD, PhD
Alicia M. Quesnel, MD

2:38 Incidence of Electrode Contacts in The Functional Acoustic Region for Cochlear Implant Recipients with Hearing Preservation
Evan P. Nix, MD, MBA
Nicholas J. Thompson, MD
Margaret T. Dillon, AuD, PhD
Matthew M. Dedmon, MD, PhD
Morgan Selleck, MD
Kevin D. Brown, MD, PhD

2:45 DISCUSSION

2:50 BREAK WITH EXHIBITORS

3:20 INTRODUCTION OF ABSTRACTS - COCHLEAR IMPLANTS: PERFORMANCE OUTCOMES
J. Thomas Roland Jr., MD, Moderator

3:21 Factors Affecting Performance in Adults with Cochlear Implants: A Role for Cognition and Residual Cochlear Function
Amit Walia, MD
Matthew A. Shew, MD
Amanda Ortmann, PhD
Jordan Varghese, MD
Shannon Lefler, AuD
Jacques A. Herzog, MD
Craig A. Buchman, MD

3:28 Early Datalogging Predicts Cochlear Implant Performance: Building a Recommendation for Daily Device Usage
Nathan R. Lindquist, MD
Mary S. Dietrich, PhD, MS
Ankita Patro, MD, MS
René H. Gifford, PhD
David S. Haynes, MD
Elizabeth L. Perkins, MD
Jourdan T. Holder, AuD, PhD

3:35 **Responsible Imputation of Missing Speech Perception Testing Data**
Cole Pavelchek, BS
David S. Lee, MD
Amit Walia, MD
Amanda Ortmann, PhD
Jacques A. Herzog, MD
Craig A. Buchman, MD
Matthew A. Shew, MD

3:42 **Age of Cochlear Implantation within the Pediatric Population with Congenital Sensorineural Hearing Loss**
Ashley M. Nassiri, MD, MBA
John P. Marinelli, MD
Christine M. Lohse, MS
Matthew L. Carlson, MD

3:49 **DISCUSSION**

3:54 **INTRODUCTION OF THE ANS RESEARCH GRANT**
Fred F. Telischi, MD

3:55 **ANS RESEARCH GRANT PRESENTATION**
"Molecular Mechanisms of Hypofractionation and Radiation Resistance in Vestibular Schwannoma."
Aida Nourbakhsh, MD, PhD
ANS 2022 Research Grant Recipient
University of Miami Miller School of Medicine

4:05 **INTRODUCTION OF PANEL**
Fred F. Telischi, MD

4:06 **PANEL**
Treating Meniere's Disease as a Migraine-Variant: New Paradigm or Temporary Fad?
J. Walter Kutz, MD (Moderator)
Hamid Djalilian, MD
Jeffrey Kuhn, MD
Jennifer Maw, MD
Jeffrey Sharon, MD
Kristen Steenerson, MD

5:06 **ANNOUNCEMENT OF ANS & AOS POSTER WINNERS**
Yuri Agrawal, MD - ANS Education Director
Nancy Young, MD - AOS Education Director

5:10 **CLOSING REMARKS/ADJOURNMENT**
Fred F. Telischi, MD

SATURDAY, MAY 6, 2023

7:00 **BUSINESS MEETING** *(O&N/Committee Reports)*
(Members Only)

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

7:30 WELCOME & OPENING REMARKS BY THE PRESIDENT
Fred F. Telischi, MD

7:32 INTRODUCTION OF ABSTRACTS - COCHLEAR IMPLANTS: INNOVATION AND SPECIAL CONSIDERATIONS
Peter C. Weber, MD, MBA, Moderator

7:33 Pre-Surgical MRI Radiomics Data Predicts Post-Implantation Electrocochleography Thresholds in Radiographically Normal Pediatric Cochleae
Nicholas A. George-Jones, MD
Christine Etler, AuD
Tanya Van Vorst, AuD
Camille C. Dunn, PhD
Bruce J. Gantz, MD
Marlan R. Hansen, MD

7:40 ANS TRAINEE AWARD
Machine Learning Approach for Screening Cochlear Implant Candidates: Comparing with the 60/60 Guideline
Ankita Patro, MD, MS
Elizabeth L. Perkins, MD
Carlos Ortega, BS
Nathan R. Lindquist, MD
René H. Gifford, PhD
David S. Haynes, MD
Naweed Chowdhury, MD, MPH

7:47 The Impact of Musical Rehabilitation on Complex Sound Perception in Cochlear Implant Users: A Systematic Review
Hasan Abdulbaki, BA
Jonathan Mo, BS, BM
Charles J. Limb, MD
Nicole T. Jiam, MD

7:54 Vestibular Weakness in Cochlear Implant Candidates
Allison Reeder, MD
Rema Shah, BS
John F. Kveton, MD
Eugenia Vining, MD
Hannah Dunn, AuD
Nofrat Schwartz, MD

8:01 Estimation of Cochlear Implant Insertion Depth Using 2D-3D Image Registration of Postoperative X-Ray and Preoperative CT Image
George S. Liu, MD
Shayna P. Cooperman, MD
Caio A. Neves, MD
Nikolas H. Blevins, MD

8:08 Comparison of Cochlear Implant Outcomes in Vestibular Schwannoma between Sporadic and Neurofibromatosis Type 2 Populations
James R. Dornhoffer, MD
Travis Haller, MD
Brian A. Neff, MD
Colin L.W. Driscoll, MD
Matthew L. Carlson, MD

8:15 DISCUSSION

8:20 INTRODUCTION OF ABSTRACTS - VESTIBULAR SCHWANNOMA
Courtney C.J. Voelker, MD, PhD, Moderator

8:21 Metformin Reduces Tumor Growth in a Murine Flank Schwannoma Model
Sudhir Manickavel, MD
Yolanda Hartman, BS
Andrew Burns, BS
Manuel A. Lora Gonzalez, MD
Jason Warram, PhD
Erika M. Walsh, MD
Daniel E. Killeen, MD

8:28 ANS TRAINEE AWARD
Identifying Tumor Microenvironment Biomarkers in Adherent and Cystic Vestibular Schwannomas
Lisa Zhang, MD
Hsuan-Chih Kuo
Jose Otero, MD, PhD
Yin Ren, MD, PhD

8:35 A Mouse Model of Neurofibromatosis Type 2 Demonstrates Glial Cell Proliferation and Neuronal Loss
Judith S. Kempfle, MD
Andrea Zhang, BS
Richard Kuang, BS
Sina Schwinn, BS
Konstantina Stankovic, MD, PhD
D. Bradley Welling, MD, PhD
David H. Jung, MD, PhD

8:42 Automated Radiomic Analysis of Vestibular Schwannomas and Inner Ears using Contrast-enhanced T1-weighted and T2-weighted MRI Sequences and Artificial Intelligence
Caio A. Neves, MD
George S. Liu, MD
Trishia El Chemaly, MS
Isaac A. Bernstein, BS
Nikolas H. Blevins, MD

8:49 Stratifying Risk of Future Growth Among Growing Sporadic Vestibular Schwannomas
John P. Marinelli, MD
Zane Schnurman, MD, MBA
Daniel E. Killeen, MD
Jacob B. Hunter, MD

Douglas Kondziolka, MD
J. Thomas Roland Jr., MD
Matthew L. Carlson, MD

8:56 Limitations of Linear Tumor Measurement in Vestibular Schwannoma
Michael H. Freeman, MD
Nathan R. Lindquist, MD
Robert J. Dambrino IV, MD
Nathan D. Cass, MD
Peter J. Morone, MD
Kareem O. Tawfik, MD

9:03 DISCUSSION

9:08 INTRODUCTION OF WILLIAM E. HITSELBERGER LECTURE
Fred F. Telischi, MD

9:10 WILLIAM E. HITSELBERGER MEMORIAL LECTURE
"Chemotherapy for Vestibular Schwannoma: Finding the Right Niche"
Scott R. Plotkin, MD, PhD
Executive Director, Stephen E. & Catherine Pappas Center for Neuro-Oncology
Massachusetts General Hospital
Armenise Family-Harvard Professor of Neurology, Harvard Medical School
Boston, MA

9:40 BREAK WITH EXHIBITORS

10:10 INTRODUCTION OF ABSTRACTS - VESTIBULAR AND OTHER TOPICS
Ronna Hertzano, MD, PhD, Moderator

10:11 Contribution of Endoplasmic Reticulum Stress to Noise-induced Hearing Loss in the Mouse Cochlea
Tracy Cheng, MD, MHSc
Julia D. Lewis, BS
Alicia M. Frank, MPPM
Abigail Sanders BS
Christopher L. Cunningham, PhD

10:18 Use of Observational Camera in Rotary Chair Test for Young Children: Clinical Experience and Outcomes
Guangwei Zhou, ScD
Stephanie Walsh, BA
Jacob Brodsky, MD

10:25 Nortriptyline vs. Migraine Lifestyle Modifications on Vestibular Migraine
Karen Tawk, MD
Joshua K. Kim, BS
Abdula Al-Seraji, BS
Khodayar Goshtasbi, MD
Mehdi Abouzari, MD, PhD
Hamid R. Djalilian, MD

10:32 The Natural History of Observed Sdhx-Related Head and Neck Paragangliomas Using 3D Volumetric Tumor Analysis
Evan L. Tooker, MS

Richard H. Wiggins, III, MD
Mana Espahbodi, MD
Anne Naumer, MS
Luke O. Buchmann, MD
Samantha E. Greenberg, MS
Neil S. Patel, MD

10:39 The Role of Lumbar Drains in the Perioperative Management of Primary Spontaneous Temporal Lobe Encephaloceles and Cerebrospinal Fluid Leaks
Zachary G. Schwam, MD
Maria Mavrommatis, MD
Sunder Gidumal, MD
Enrique R. Perez, MD, MBA
Maura K. Cosetti, MD
George B. Wanna, MD

10:46 NICHOLAS TOROK VESTIBULAR AWARD
Mindfulness-Based Stress Reduction for the Treatment of Vestibular Migraine: A Prospective Trial
Eric J. Formeister, MD, MS
James Mitchell, PhD
Roseanne Krauter, FN-P
Ricky Chae, BS
Adam Gardi, BS
Maxwell Hum, BS
Jeffrey D. Sharon, MD

10:53 DISCUSSION

10:58 INTRODUCTION OF PANEL
Fred F. Telischi, MD

10:59 PANEL
Treatment of the Facial Nerve: from Inside Out
Daniel Zeitler, MD (Co-Moderator)
Emily Stucken, MD (Co-Moderator)
Jacques Morcos, MD
Seilesh Babu, MD
Myriam Loyo Li, MD, MCR

12:00 CLOSING REMARKS
Fred F. Telischi, MD

INTRODUCTION OF INCOMING PRESIDENT
Elizabeth H. Toh, MD, MBA

12:05 ADJOURNMENT

SELECTED ABSTRACTS

ORAL PRESENTATIONS

IN ORDER OF PRESENTATION

58th Annual Spring Meeting
AMERICAN NEUROTOLOGY SOCIETY

May 5-6, 2023
Sheraton Boston / Hynes CC
Boston, MA

Add-on Flexible Sensor Arrays for Real-time Monitoring of Cochlear Implant Electrode Insertion

Jay W. Reddy, PhD; Mohsen Tabrizi, PhD; Douglas A. Chen, MD
Abraham Jacob, MD; Maysam Chamanzar, PhD

Hypothesis: We hypothesize compact sensors integrated with cochlear implant (CI) electrodes can provide real-time force and position monitoring and feedback without contributing significantly to the implant stiffness.

Background: CI electrode mechanics and surgical techniques have been tuned to minimize insertion trauma. However, CI electrode insertion still results in undesired outcomes such as scalar translocation and tip-foldover, as well as structural damage and loss of residual hearing. We propose that integrated sensors can be used to measure clinically relevant features (i.e. wrapping factor, insertion force) and surgical events (i.e. tip-foldover, scalar translocation) to predict and potentially reduce these surgical risks.

Methods: We designed and fabricated novel stretchable, biocompatible, and ultrathin (< 20 μm) capacitive strain micro-sensor arrays using simulation and advanced lithographic microfabrication techniques. The sensors map the deformation and force at 16 points along the length of the CI electrode. The stiffness was characterized by a custom-made three-point bending setup comparing silicone electrode blanks (control) and sensor-attached samples.

Results: Computer simulations demonstrate sensitivity to CI electrode bending < 0.1 mm within the bend radius range of 0 to 4 mm, sufficient to clearly detect deformations associated with tip-foldover or scalar translocation. Experimental datasets show reliable attachment of the sensor to the CI electrode, with a small (<10%) contribution to the stiffness of the implant.

Conclusions: The strain sensors can be attached to CI electrodes to provide add-on force and position sensing capabilities without compromising the electrode flexibility, potentially enabling new fundamental understanding of electrode insertion dynamics and providing a novel intra-operative monitoring tool.

Professional Practice Gap & Educational Need: We lack knowledge of the dynamics of CI electrode insertion which leads to structural damage and residual hearing loss. This is tied to the lack of tools to enable high-resolution real-time monitoring of intracochlear electrode placement and forces. Polymer microfabrication provides the opportunity to integrate sensing modalities onto the electrode array itself, but a method for doing so without negatively impacting the highly-refined electrode array flexibility has yet to be demonstrated.

Learning Objective: To understand sensing modalities (i.e. capacitive, optical spectroscopy) that can be implemented in a flexible polymer substrate and how these may be used to advance fundamental scientific and clinical understanding of cochlear implantation outcomes, as well as to appreciate recent state-of-the-art experimental results showing sensor integration with CIs.

Desired Result: The audience will better understand the capabilities and feasibility of microfabricated sensors for integration with CI electrodes for real-time monitoring within the cochlea. We also aim for the audience to appreciate how such data can be used to refine clinical and fundamental science understanding of cochlear implantation.

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

Indicate IRB or IACUC : Exempt

NEUROTOLOGY FELLOW AWARD

Application of Spectral Domain Optical Coherence Tomography to Visualize Cochlear Microanatomy

Pawina Jiramongkolchai, MD; Marcello M. Amaral, PhD; Yilin Li
Timothy Holden, BSE; Chao Zhou, PhD
Craig A. Buchman, MD

Hypothesis: Our custom spectral domain optical coherence tomography (SD-OCT) platform can provide high resolution imaging of cochlear microanatomy.

Background: Current clinical imaging modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI), provide limited visualization of the human cochlea. Optical coherence tomography (OCT) is a non-invasive imaging modality that provides real-time three-dimensional (3D) visualization of tissue microstructure at higher spatial resolutions than that of clinical CT or MRI.

Methods: A customized SD-OCT system, operating at 1300 nm wavelength and providing 7 μm of transverse and 5 μm of axial resolution, was used to obtain 3D images of cochlear microanatomy before and after cochleostomy in cadaveric human temporal bones. The acquired OCT images were then directly compared with micro-CT library images of the human cochlea.

Results: High-resolution OCT images of the cochlea were obtained through both an intact and opened round-window membrane (RWM). Through an intact RWM, the scala tympani (ST) and basilar membrane (BM) were identified. Following cochleostomy, the scala vestibuli (SV), ST, and BM were visualized. OCT images were also obtained of a dummy cochlear implant electrode through the RWM. Importantly, our SD-OCT platform captured highly detailed and accurate 3D images of cochlear microanatomy and orientation that correlated with anatomical landmarks from a micro-CT human cochlea library.

Conclusion: Our custom SD-OCT platform can generate high-resolution real-time 3D visualization and orientation of cochlear microanatomy. This technology has the potential to further understanding of cochlear pathophysiology and to serve as a real-time surgical 3D image guidance tool for accessing the inner ear.

Professional Practice Gap & Educational Need: Intraoperative real-time visualization of cochlear orientation and anatomy remains limited. SD-OCT offers the potential to serve as a real-time surgical image guidance tool.

Learning Objective: To obtain high-resolution images of cochlear microanatomy using a custom SD-OCT system.

Desired Result: A custom SD-OCT platform can be used to generate real-time 3D images of the cochlear microanatomy and potentially serve as an intraoperative surgical guidance tool.

Level of Evidence: V

Indicate IRB or IACUC: Exempt

The Local Relationship between Acute Insertion Trauma and Chronic Intracochlear Ossification and Fibrosis after Cochlear Implantation: A Human Temporal Bone Study

Alexander R. Geerardyn, MD; MengYu Zhu, MS; Joseph B. Nadol Jr., MD
Nicolas Verhaert, MD, PhD; Alicia M. Quesnel, MD

Hypothesis: Trauma to the osseous spiral lamina (OSL) or spiral ligament (SL) during cochlear implant (CI) insertion induces localized intracochlear ossification and fibrosis.

Background: The goal of atraumatic insertion of the CI electrode is to preserve intracochlear structures in order to limit reactive intracochlear tissue formation and preserve residual hearing. Previous studies on individual 2D histological sections or the total cochlear volume reported conflicting results on the relationship between acute insertional trauma and chronic intracochlear ossification or fibrosis. This study evaluates the localized effect of insertional trauma on intracochlear tissue formation by virtually re-sectioning 3D reconstructions.

Methods: 3D reconstructions were generated based on digitized histological sections of a representative selection of twenty-one post-mortem human temporal bones with a CI. The reconstructions were virtually re-sectioned perpendicular to the cochlear spiral at high resolution. The percentage of the cochlear volume occupied by ossification or fibrosis was determined at the center, 30° proximal, and 30° distal to the trauma.

Results: Seven cases showed an OSL fracture. Significantly more intracochlear ossification was observed at the center of the OSL fracture, compared to 30° proximal or distal (paired t-test; $p=0.04$ and $p=0.02$, respectively). No such pattern was observed for fibrous tissue (paired t-test; $p>0.05$). In the twelve cases with a perforation of the SL no localized pattern of ossification, nor fibrosis was observed around these perforations.

Conclusions: A fracture of the OSL during CI insertion may serve as a nidus for localized intracochlear neo-ossification while perforation of the SL does not seem to have such a localized effect.

Professional Practice Gap & Educational Need: There is incomplete knowledge about the relationship between acute insertional trauma and chronic intracochlear tissue formation. This tissue formation may potentially cause a loss of residual hearing and limit the hearing performance with the cochlear implant.

Learning Objective: To understand the localized relationship between trauma to the osseous spiral lamina or spiral ligament and intracochlear tissue formation.

Desired Result: The participants become aware of the potential local consequences of an OSL fracture during cochlear implantation and further increase their effort to limit acute insertional trauma.

Level of Evidence – Level IV

Indicate IRB or IACUC : IRB 2021P001593, Mass General Brigham

Incidence Of Electrode Contacts in The Functional Acoustic Region for Cochlear Implant Recipients with Hearing Preservation

Evan P. Nix, MD, MBA; Nicholas J. Thompson, MD
Margaret T. Dillon, AuD, PhD; Matthew M. Dedmon, MD, PhD
A. Morgan Selleck, MD; Kevin D. Brown, MD, PhD

Objective: To investigate the incidence of electrode contacts within the functional acoustic hearing region in adults with post-operative hearing preservation following cochlear implantation.

Study Design: Retrospective review

Setting: Tertiary referral center

Patients: 142 cochlear implant recipients with functional acoustic hearing preservation as defined by an unaided hearing threshold of 80 dB or better at 250 Hz at their initial post-operative evaluation.

Interventions: Subjects underwent cochlear implantation with a 24-, 28-, or 31.5-mm lateral wall electrode array. The angular insertion depth (AID) of individual electrode contacts was calculated from post-operative imaging. Unaided acoustic thresholds and AID values were used to determine whether electrode contacts were within the subject's functional acoustic hearing region.

Main Outcome Measures: The presence and number of electrode contacts within the functional acoustic hearing region.

Results: Preliminary data demonstrate that 64% of subjects had one or more electrode contacts within the functional acoustic hearing region. For those with electrode contacts within the functional acoustic hearing region, 66% had one contact, 19% had two contacts, 9% had three contacts, and 6% had four or more contacts.

Conclusion: There is a high incidence of electrode contacts within the functional acoustic hearing region for adults with preserved acoustic hearing following cochlear implantation, which is not accounted for with default mapping procedures. Presenting electric stimulation within the functional acoustic hearing region could cause electric-on-acoustic masking, which could negatively impact speech recognition when listening with electric and acoustic stimulation in the same ear.

Professional Practice Gap & Educational Need: Hearing preservation following cochlear implantation with electrode contact placement within the functional acoustic hearing region was previously thought to be a rarity. Retrospective data quantifying the number of electrode contacts within the functional acoustic hearing region has yet to be reported.

Desired Result: Attendees will have a better understanding of the relationship between electrode angular insertion depth and post-operative hearing preservation outcomes.

Level of Evidence - Level V

Indicate IRB or IACUC: Approved

Factors Affecting Performance in Adults with Cochlear Implants: A Role for Cognition and Residual Cochlear Function

Amit Walia, MD; Matthew A. Shew, MD; Amanda Ortmann, PhD
Jordan Varghese, MD; Shannon Lefler, AuD
Jacques A. Herzog, MD; Craig A. Buchman, MD

Objective: To evaluate the impact of pre- and peri-operative factors on postlinguistic adult cochlear implant (CI) performance and design a multivariate prediction model.

Study Design: Prospective cohort study

Setting: Tertiary referral center

Patients: 192 postlinguistic adult CI recipients

Main Outcome Measures: Speech-perception testing (CNC, AzBio in noise +10-dB SNR) at 3-months postoperatively; Electrocochleography-total response (ECochG-TR), a measure of residual cochlear function, at the round window before electrode insertion

Results: There was a strong linear correlation between ECochG-TR and CNC word score at 3-months (r=0.66, p<0.0001). A multivariable linear regression model including age, pure tone average, Montreal Cognitive Assessment Score (MoCA), duration of hearing loss, angular insertion depth, and ECochG-TR did not perform significantly better than ECochG-TR alone in explaining the variability in CNC. There were also moderate linear correlations for AzBio in noise with MoCA (r=0.52, p<0.0001) and ECochG-TR (r=0.60, p<0.0001). Multivariate modeling using ECochG-TR and MoCA and the interaction between ECochG-TR*MoCA explained 59.8% of the variability in AzBio in noise scores.

Conclusions: This study uses the most comprehensive dataset to date to validate ECochG-TR as a measure of cochlear health as it relates to suitability for CI stimulation, and it further underlies the importance of the cochlear neural substrate as the main driver in speech perception performance. Performance in noise is more complex and requires both good residual cochlear function (ECochG-TR) and cognition (MoCA). Other demographic and audiologic variables are poorly correlated with CI performance suggesting that these are poor surrogates for the integrity of the auditory substrate.

Professional Practice Gap & Educational Need: Recognizing factors that affect CI performance has critical implications on counseling, post-CI aural rehabilitation, surgical technique, device choice and design and fitting. Prior studies consistently have shown that demographic, surgical, and audiologic variables account for less than 25% of the variability in speech-perception scores in quiet, making them poor indicators of performance. Recent work has highlighted the importance of residual cochlear function (as measured by ECochG-TR) and cognition in understanding the variability in CI performance. However, these studies have been underpowered to assess a comprehensive set of variables in addition to ECochG-TR.

Learning Objective: To understand the impact of demographic, audiologic, surgical, cognitive, and ECochG-TR measures on CI speech perception performance in adults.

Desired Result: Practitioners and researchers will further realize the value of using a peripheral measure of cochlear health (ECochG-TR) and a cognitive measures to understand much of the observed variability in performance among CI patients.

Level of Evidence - IV

Indicate IRB or IACUC : Washington University in St. Louis IRB #202007087.

Early Datalogging Predicts Cochlear Implant Performance:
Building a Recommendation for Daily Device Usage

Nathan R. Lindquist, MD; Mary S. Dietrich, PhD, MS
Ankita Patro, MD, MS; René H. Gifford, PhD; David S. Haynes, MD
Elizabeth L. Perkins, MD; Jourdan T. Holder, AuD, PhD

Objective: We aim to elucidate the relationship between early device datalogging and speech recognition outcomes for cochlear implant (CI) recipients to better inform patient and clinician counseling regarding recommended daily wear time.

Study Design: Retrospective cohort.

Setting: Tertiary referral center.

Patients: 337 adult patients with datalogging and speech outcomes data were implanted between August 2015 and August 2020.

Main Outcome Measures: Processor datalogging, speech recognition, achievement of 'benchmark speech recognition performance' defined as 80% of the median score for one year speech recognition outcomes at our institution.

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

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

Professional Practice Gap & Educational Need: Our understanding of the role between daily device usage and speech recognition outcomes are in the early stages. Further investigations into this potential counseling point and intervention are necessary.

Learning Objective:

1. Quantify and characterize the relationship between early daily device usage and speech recognition outcomes.
2. Understand the rationale for the 'benchmark speech recognition performance' metric in data analysis.
3. Recognize early data logging as an inexpensive, easily accessible, and post-implantation intervention that requires minimal clinician bandwidth besides counseling and follow-up.

Desired Result: Viewers will be able to quantify and characterize the relationship between early daily device usage and speech recognition outcomes. In addition, we hope that exposure to this information solidifies data logging as an inexpensive, easily accessible, and post-implantation intervention that requires minimal clinician bandwidth.

Level of Evidence - Level III

Indicate IRB or IACUC : Vanderbilt University Medical Center IRB# 220255

Responsible Imputation of Missing Speech Perception Testing Data

Cole Pavelchek, BS; David S. Lee, MD; Amit Walia, MD
Amanda Ortmann, PhD; Jacques A. Herzog, MD
Craig A. Buchman, MD; Matthew A. Shew, MD

Objective: To address outcome heterogeneity in cochlear implant (CI) research, we built imputation models using multiple imputation by chained equations (MICE) and K-nearest neighbors (KNN) to convert between four common open-set testing scenarios: Consonant-Nucleus-Consonant word (CNCw), Arizona Biomedical (AzBio) in quiet, AzBio +5dB SNR, and AzBio +10dB SNR. We then analyzed raw and imputed datasets to evaluate factors affecting CI outcome variability.

Study Design: Retrospective cohort study of a national CI database (HERMES) and a non-overlapping single-institution CI database.

Setting: Multi-institutional (32 CI centers)

Patients: Adult CI recipients (n=4,046 patients).

Main Outcome Measure: Mean absolute error (MAE) between imputed and observed speech perception scores

Results: Imputation models of preoperative speech perception measures demonstrate an MAE of less than 10% for feature triplets of CNCw/AzBio in quiet/AzBio +10dB SNR (MICE: MAE=9.52%, 95%CI=9.40–9.64; KNN: MAE=8.93%, 95%CI=8.83–9.03) and AzBio in quiet/AzBio +5dB SNR/AzBio +10dB SNR (MICE: MAE=8.85%, 95%CI=8.68–9.02; KNN: MAE=8.95%, 95%CI=8.74–9.16) with one feature missing. Postoperative imputation can be safely performed with up to 4 of 6 features missing in a set of CNCw and AzBio in quiet at 3, 6, and 12 months post-cochlear implantation using MICE (MAE=9.69%, 95%CI=9.63–9.76). For multivariable analysis of CI performance prediction, imputation increased sample size by 72%, from 2,756 to 4,739, with marginal change in adjusted R^2 (0.13 raw, 0.14 imputed).

Conclusions: Missing data across certain sets of common speech perception tests may be safely imputed, enabling multivariate analysis of one of the largest CI outcomes datasets to date.

***Professional Practice Gap & Educational Need:** A major challenge to studying CI outcomes is that there are multiple heterogeneous speech perception measures with no clear standard across practices. This prevents meaningful aggregation of data within and between institutions, limiting CI outcome research to predominantly single-institution studies and small sample sizes. Developing methods for converting one speech performance measure to another would facilitate analyses of multi-institutional databases for CI research with greater power, generalizability, and impact.

***Learning Objective:** To develop imputation models for converting between commonly used speech perception tests using a large multi-institutional database. To perform a proof-of-concept analysis on preoperative factors associated with postoperative hearing outcomes before and after imputation.

***Desired Result:** Empower attendees to use the proposed imputation models on their own CI outcome databases to increase sample size and generalizability of their studies.

***Level of Evidence -** III

***Indicate IRB or IACUC:** Washington University in St. Louis IRB #201911036

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

Ashley M. Nassiri, MD, MBA; John P. Marinelli, MD
Christine M. Lohse, MS; Matthew L. Carlson, MD

Objectives: The current study evaluates changes in the number of cochlear implant (CI) surgeries performed and the age of implantation among the pediatric population with congenital sensorineural hearing loss (SNHL) in the U.S.

Study Design: Deidentified CI data were acquired from prospectively collected patient registries from two CI manufacturers (Cochlear Americas and Advanced Bionics), which supply an estimated 85% of CIs in the U.S. Children ≤36 months old were assumed to have bilateral congenital SNHL.

Setting: U.S. CI centers.

Patients: Children ≤36 months old who received CIs.

Interventions: Cochlear implantation.

Main Outcome Measures: Annual implantation rates, age at implantation.

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

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

Professional Practice Gap & Educational Need: While FDA labeling and indications for cochlear implantation have expanded in recent years, the level of success in clinical implementation within the pediatric CI candidate population has not been measured. Detailed metrics evaluating rates of CI, age at implantation, and rates of simultaneous implantation are critical in understanding current practices, which may lag behind recommendations.

Learning Objectives: Describe the rates of cochlear implantation and changes over time within the pediatric population with congenital sensorineural hearing loss. Understand factors associated with age of implantation within the pediatric population with congenital sensorineural hearing loss. Understand current practices and shortcomings of implementation of expanded cochlear implant criteria.

Desired Result: Physicians, audiologists, and researchers would better understand current cochlear implantation practices within the pediatric population with congenital sensorineural hearing loss and identify areas for improvement.

Level of Evidence: III

Indicate IRB or IACUC: Exempt

Pre-Surgical MRI Radiomics Data Predicts Post-Implantation Electrocochleography Thresholds in Radiographically Normal Pediatric Cochleae

Nicholas A. George-Jones, MD; Christine Etler, AuD
Tanya Van Vorst, AuD; Camille C. Dunn, PhD
Bruce J. Gantz, MD; Marlan R. Hansen, MD

Objective: Radiomics involves extracting higher-order relationships of voxel intensity and position from an image that that cannot be appreciated by the human eye. These features correlate with differences in underlying tissue composition and can provide predictive models of disease outcomes. Here, we investigated whether radiomics data from pre-implantation imaging can predict electrically evoked compound action potential (eCAP) thresholds in pediatric cochlear implant (CI) recipients.

Study Design: Retrospective study.

Setting: Tertiary care center

Patients: Children that had normal cochleae on pre-operative MRI and eCAP measures available for a slim perimodiolar array.

Interventions: Radiomics data were extracted from segmented T2 SPACE images and a predictive model of eCAP thresholds was constructed using a support vector machine regressor. Leave-one-out cross validation was used, in which a prediction was generated for each patient using a model trained on the other patients' radiomics features. A logarithmic transformation was used to scale model output.

Main Outcome Measures: Model performance was assessed using the regression coefficient p-value, least squares (R^2), and root mean square error (RMSE) of the predicted eCAP versus actual eCAP.

Results: 26 patients were included of which 14 had bilateral CI's for a total of 40 ears. Model performance on the apical ($p < 0.001$, R^2=0.665, RMSE = 9.438) , middle ($p < 0.001$, $R^2 = 0.6805$, RMSE = 15.47), and basal ($p < 0.001$, R^2=0.5864, RMSE = 14.85) portions of the electrode array each demonstrated strong correlation.

Conclusions: Pre-operative cochlear radiomics data may predict post-implantation eCAPs and provide information about individual cochlear physiologic characteristics.

Professional Practice Gap & Educational Need: Methods in machine learning and artificial intelligence are increasingly being applied to medical data and have important implications for individualizing care and patient expectations. It is important for providers to be aware of the growing importance of these methods, and their utility for use in studying other lateral skull base pathologies.

Learning Objective: To understand that new techniques and data analysis may be useful in offering previously unknown information about the state of health of the cochlea that may be important to better predict patient outcomes.

Desired Result: Providers will have a new understanding that certain types of radiomics data may offer a new way to characterize the physiology of the cochlea using established, routine medical imaging. This understanding may provide a new avenue for investigations in predicting outcomes for patients receiving surgery.

Level of Evidence - IV

Indicate IRB or IACUC : University of Iowa IRB #201110703

ANS TRAINEE AWARD

Machine Learning Approach for Screening Cochlear Implant Candidates: Comparing with the 60/60 Guideline

Ankita Patro, MD, MS; Elizabeth L. Perkins, MD
Carlos Ortega, BS; Nathan R. Lindquist, MD; René H. Gifford, PhD
David S. Haynes, MD; Naweed Chowdhury, MD, MPH

Objective: To develop a machine learning-based referral guideline for patients undergoing cochlear implant candidacy evaluation (CICE) and to compare with the widely used 60/60 guideline.

Study Design: Retrospective cohort.

Setting: Tertiary referral center.

Patients: 772 adults undergoing CICE from 2015—2020.

Interventions: Variables included demographics, unaided thresholds, and word recognition score (WRS). A random forest classification model was trained on patients undergoing CICE, and bootstrap cross-validation was used to assess the modeling approach's performance.

Main Outcome Measures: The machine learning-based referral tool was evaluated against the 60/60 guideline based on ability to identify CI candidates under traditional and expanded criteria.

Results: Of 587 patients with complete data, 563 (96%) met candidacy at our center, and the 60/60 guideline identified 512 (87%) patients. In the random forest model, WRS; thresholds at 3000, 2000, and 125; and age at CICE had the largest impact on candidacy (mean decrease in Gini coefficient: 2.8, 1.6, 1.2, 1.2, and 1.2, respectively). The 60/60 guideline had sensitivity of 0.91, specificity of 0.42, and accuracy of 0.89 (95% CI: 0.86—0.91). The random forest model obtained higher sensitivity (0.96), specificity (1.00), and accuracy (0.96; 95% CI: 0.95—0.98). Across 1000 bootstrapped iterations, the model yielded a median sensitivity of 0.92 (IQR 0.85—0.98), specificity of 1.00 (IQR 0.88—1.00), accuracy of 0.93 (IQR 0.85—0.97), and area under the curve of 0.96 (IQR 0.93—0.98).

Conclusions: A novel machine learning-based screening model predicts CI candidacy with notably higher sensitivity, specificity, and accuracy than the 60/60 guideline. Bootstrapping confirmed that this approach is likely generalizable with consistent results.

Professional Practice Gap & Educational Need: With less than 10% of adult candidates receiving CIs, several screening tools, including the 60/60 guideline, have been developed to help streamline referrals. Recent literature, however, highlights that these screening tools are only modestly successful at identifying potential CI candidates. Novel methods to improve referrals and access to implantation are needed.

Learning Objective: To identify how machine learning methods can aid in the development of superior screening tools for CICE.

Desired Result: Providers will have additional knowledge about this machine learning-based algorithm, which can more accurately refer patients for CICE than currently practiced guidelines. These results can be utilized to support increased awareness of CI candidacy and timely referrals, in turn, decreasing the burden associated with hearing loss.

Level of Evidence: Level IV – Historical cohort or case-controlled studies.

Indicate IRB or IACUC: IRB Exempt (221833, Vanderbilt University).

The Impact of Musical Rehabilitation on Complex Sound Perception in Cochlear Implant Users: A Systematic Review

Hasan Abdulbaki, BA; Jonathan Mo, BS, BM; Charles J. Limb, MD; Nicole T. Jiam, MD

Objective: To evaluate the efficacy of music rehabilitation in controlled experimental studies on cochlear implant (CI) user speech and music perception.

Data sources: PubMed, Embase, Web of Science, PsycARTICLES, and PsycINFO databases were queried using the search terms "cochlear implant," "music rehabilitation," and "music therapy" for English-language articles through July 2022.

Study selection: Randomized controlled trials and prospective studies were included if they compared pretest and posttest data and excluded hearing aid-only users.

Data extraction: PRISMA guidelines were used to extract data from 11 included studies with a total of 206 pediatric and adult participants. Interventions included group music therapy, melodic contour identification (MCI) training, auditory-motor instruction, or structured digital music training. Risk of bias was assessed regarding confounding, timeframe, and rate of follow up among other parameters using the NIH Quality Assessment Tool.

Data synthesis: A total of 735 studies were screened and 11 met inclusion criteria. Studies employed heterogeneous outcome measures evaluating speech and music perception. Six trials reported both speech and music outcomes while 5 reported only music outcomes following intervention relative to control. For music perception outcomes, significant findings included improvements in MCI (5 studies, $p<0.05$), timbre recognition (3 studies, $p<0.05$), and song appraisal (3 studies, $p<0.05$) in their respective trials. For speech prosody outcomes, only vocal emotion identification demonstrated significant improvements (3 studies, $p<0.05$).

Conclusions: Music rehabilitation improves performance on multiple measures of music perception, as well as tone-based characteristics of speech (i.e., emotional prosody). This suggests that rehabilitation may facilitate improvements in the discrimination of spectrally complex signals.

Professional Practice Gap & Educational Need: While music training has been studied as a potential mode of aural rehabilitation for CI users, no standardized music intervention protocol has been developed for routine clinical application. As a result, providers rarely employ music as a rehabilitative strategy due to uncertainty in clinical outcomes. The lack of literature synthesizing music rehabilitation's impact on CI user complex sound processing represents a barrier to practice standardization and thus further contributes to uncertainty in clinical applicability despite existing evidence of efficacy.

Learning Objective: To review the various modes of music-based aural rehabilitation and improve current understanding regarding their impact on music and speech perception in cochlear implant users.

Desired Result: Encourage providers to adopt music-based interventions for CI user auditory rehabilitation by consolidating the wide base of evidence on their clinical efficacy for complex sound hearing improvement.

Level of Evidence - II

Indicate IRB or IACUC: Exempt.

Vestibular Weakness in Cochlear Implant Candidates

Allison Reeder, MD; Rema Shah, BS; John F. Kveton, MD
Eugenia Vining, MD; Hannah Dunn, AuD
Nofrat Schwartz, MD

Background: Cochlear implantation (CI) has been associated with postoperative vestibular dysfunction in the implanted ear, however, baseline vestibular function in this population is not well known

Objective: Describe preoperative prevalence of vestibular weakness/ identify correlated audiologic findings in the profoundly deaf

Study Design: Retrospective cohort study (2012-2022) of the CI candidate population. All patients evaluated for CI underwent routine preoperative vestibular evaluation, irrespective of symptoms.

Results: Of 180 CI patients, 39.4% had preoperative vestibular weakness as determined on caloric testing. Of these, 26.8% had bilateral weakness, 60.5% had unilateral weakness ipsilateral to planned implant ear and 12.7% had contralateral weakness. There was no difference in age between patients with vestibular weakness (65.4±14.8 years) and those without (65.6±15.9 years) or gender (%female 52.1% vs. 60.6%, p=0.263). Patients with vestibular weakness were more likely to have poorer low-tone hearing than those with normal vestibular function (250 Hz: 79.7dB±23.5 vs. 64.4dB±24.0, p<0.001 and 500 Hz: 86.1dB±23.3 vs. 73.8dB±23.8, p <0.001) as well as lower pure tone average (88.8dB±18.7 vs. 83.1dB±18.1, p=0.046). WRS were also lower in weak patients but did not reach significance (17.8%±20.9% vs. 20.6±20.1%, p=0.185).

Conclusions: CI candidates have a high prevalence of preoperative vestibular weakness both unilateral and bilateral. Previous studies have suggested increased postoperative dizziness in patients with abnormal VNG. This raises concerns prior to CI, especially in patients with bilateral/ contralateral vestibular weakness. Our data suggests that decreased low-tone hearing may be a predictor for abnormal vestibular function and further investigation with VNG may be useful in guiding decision making/ counseling prior to CI.

Professional Practice Gap & Educational Need: Preoperative VNG testing in CI candidates is not routinely done, however we suggest there are certain audiologic findings that may be indicative of preoperative vestibular dysfunction in this population.

Learning Objective: Understand prevalence of vestibular weakness in CI candidates and correlate this with audiogram findings that may be predictive of vestibular system dysfunction

Desired Result: Educate about preoperative prevalence of vestibular weakness in CI candidates and consider VNG testing in patients with poor low tone hearing on audiogram.

Level of Evidence - IV

Indicate IRB or IACUC: Yale School of Medicine, IRB ID: 2000031399

Estimation of Cochlear Implant Insertion Depth Using 2D-3D Image Registration of Postoperative X-Ray and Preoperative CT Images

George S. Liu, MD; Shayna P. Cooperman, MD
Caio A. Neves, MD; Nikolas H. Blevins, MD

Objective: To evaluate cochlear implant (CI) insertion depth using fused 2D and 3D spatial information from postoperative x-rays and preoperative CTs.

Study Design: Retrospective cohort.

Patients: 10 adult cochlear implant recipients with pre- and postoperative temporal bone CT and postoperative skull x-ray imaging.

Interventions: Postoperative x-rays and digitally reconstructed radiographs (DRR) from preoperative CTs were registered using 3D Slicer and MATLAB to enhance localization of the round window and modiolus. Angular insertion depth (AID) was estimated in original and registration-enhanced x-rays and DRRs in the cochlear view. Linear insertion depth (LID) was estimated in registered images by two methods that localized the proximal CI electrode or segmented the cochlea. Ground truth assessments were made in postoperative CTs.

Main Outcome Measure(s): Errors of insertion depth estimates were calculated relative to ground truth measurements and compared with paired t-tests. Pearson correlation coefficient was used to assess inter-rater reliability of two reviewer's measurements of AID in original x-rays.

Results: In postoperative x-rays, AID estimation errors were similar with and without registration enhancement (-1.3 ± 20.7° and -4.8 ± 24.9°, respectively; mean ± SD; $p=0.6$). AID estimation in original x-rays demonstrated strong inter-rater agreement ($\rho=0.79$, $p<0.05$) and inter-rater differences (-15.0 ± 35.3°) comparable to estimate errors. In the cochlear view, AID estimation errors were 14.6 ± 30.6°. Estimation errors of LID were similar between proximal electrode localization and cochlear segmentation methods (-0.9 ± 2.2 mm and -2.1 ± 2.7 mm, respectively; $p=0.3$).

Conclusions: 2D-3D image registration is a promising approach to measure angular and linear insertion depths of CIs without postoperative CT imaging.

Professional Practice Gap & Educational Need: Final cochlear implant position is an important determinant of audiologic outcomes but is not readily assessed in 3-dimensional space from a single postoperative skull radiograph. With advances in digital image technology, developing systems to enhance the assessment of cochlear implant positioning in radiographs using patient-specific anatomical image data from preoperative CT imaging is important.

Learning Objective: Review existing and new potential applications of image analysis technology to quantitatively assess cochlear implant insertion depth.

Desired Result: Discuss the opportunities and limitations of applying digital image analysis technology to aid in the assessment of postoperative CI positioning and outcomes.

Level of Evidence: IV

Indicate IRB or IACUC: Stanford University IRB #48036 approved 11/9/2018

Comparison of Cochlear Implant Outcomes in Vestibular Schwannoma between Sporadic and Neurofibromatosis Type 2 Populations

James R. Dornhoffer, MD; Travis Haller, MD; Brian A. Neff, MD
Colin L.W. Driscoll, MD; Matthew L. Carlson, MD

Objective: To compare cochlear implant outcomes between patients with sporadic vs neurofibromatosis type 2 (NF2)-related vestibular schwannoma.

Study Design: Retrospective review

Setting: Tertiary academic center

Patients: 60 patients (64 ears) undergoing cochlear implantation for moderate-to-profound hearing loss in the setting of vestibular schwannoma. Of these, 27 presented with sporadic disease, and 33 with NF2.

Interventions: Cochlear implantation ipsilateral to vestibular schwannoma

Main Outcome Measures: Consonant-Nucleus-Consonant phoneme (CNCp), CNC word (CNCw), and AzBio sentences in quiet.

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

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

REQUIRED:
Professional Practice Gap & Educational Need: Cochlear implantation is an appropriate modality of salvage and/ or preservation of functional hearing in patients with vestibular schwannoma. However, most data on implantation with vestibular schwannoma comes from the NF2 population, despite the fact that the majority of all schwannomas are sporadic. As such, we must understand differences in cochlear implant outcomes between these two populations to most appropriately counsel patients and further research on such care.

Learning Objective: To explore differences in cochlear implant outcomes between vestibular schwannoma patients with and without a history of NF2.

Desired Result: Practitioners and researchers will recognize important differences in cochlear implant outcomes between patients with sporadic and NF2-associated vestibular schwannoma, and use this to inform research goals and counselling of patients considering cochlear implantation in the setting of vestibular schwannoma.

Level of Evidence – Level IV: Historical cohort or case-controlled studies.

Indicate IRB or IACUC : 22-000183

Metformin Reduces Tumor Growth in a Murine Flank Schwannoma Model

Sudhir Manickavel, MD; Yolanda Hartman, BS; Andrew Burns, BS
Manuel A. Lora Gonzalez, MD; Jason Warram, PhD
Erika M. Walsh, MD; Daniel E. Killeen, MD

Hypothesis: Metformin reduces schwannoma growth.

Background: Patients with vestibular schwannomas prescribed metformin had decreased tumor volumetric growth compared to non-users in retrospective studies. Aspirin has also been found to reduce schwannoma growth in animal studies**.**

Methods: Rat schwannoma cell lines were grown and implanted into 50 athymic nude mice. Tumors were allowed to grow to 5mm and then injected with either low or high dose metformin, aspirin, or saline daily. Tumors were measured until mice demonstrated symptoms or 14 days had elapsed.

Results: There were no significant differences in day 0 tumor sizes between the control and treatment groups ($p = 0.7271$). In the low dose but not high dose groups, day 7 volumes were significantly different for both metformin ($p = 0.0437$) and aspirin ($p = 0.02$) compared to placebo. Mean tumor growth rates were 126.6 +/- 65.57 mm^3 for saline compared to 73.67 +/- 29.51 mm^3 for low dose metformin ($p=0.0315$) and 68.66 +/- 34.76 mm^3 for low dose aspirin ($p=0.0164$). There were no significant differences in tumor sizes ($p = 0.5913$) or growth rates ($p = 0.7459$) between low dose metformin and aspirin groups. Low dose groups had treatment stopped at 14 days and continued monitoring demonstrated significant increases in tumor growth off treatment for both aspirin ($p=0.0057$) and metformin ($p=0.0483$).

Conclusions: In the first study, to our knowledge, to investigate the effect of metformin on schwannomas in an animal model, metformin treatment significantly reduced schwannoma growth to a similar level as aspirin. Furthermore, when removing metformin treatment, tumor growth significantly increased.

***Professional Practice Gap & Educational Need:** Patients with vestibular schwannomas are currently offered observation, radiosurgery, or microsurgical approaches for management. Data regarding the treatment of vestibular schwannomas with aspirin and metformin can help provide additional treatment options for patients in the future.

***Learning Objective:** Attendees will understand the effect of metformin and aspirin on vestibular schwannomas tumor growth in a murine model

***Desired Result:** Attendees will note that there are decreased tumor size and growth rates in mice treated with metformin in this preliminary study, though further animal studies and eventually prospective clinical trials are needed with regard to dosing and efficacy to determine if metformin would be an effective treatment for vestibular schwannoma.

***Level of Evidence –** N/A (basic science lab research)

***Indicate IRB or IACUC :** University of Alabama Medical Center, IACUC #22466

ANS TRAINEE AWARD

Identifying Tumor Microenvironment Biomarkers in Adherent and Cystic Vestibular Schwannomas

Lisa Zhang, MD; Hsuan-Chih Kuo; Jose Otero, MD, PhD
Yin Ren, MD, PhD

Objective: A subset of vestibular schwannomas (VS) exhibit cystic degeneration resulting in adherence of the tumor capsule to the brainstem and facial nerve. We aim to identify tumor microenvironment (TME) biomarkers to better classify these tumors.

Study Design: Retrospective case series

Setting: Tertiary academic skull base referral center

Methods: Adult patients with sporadic cystic VS and patients with solid VS matched in tumor size who underwent microsurgical resection between February 2010 and August 2021 were included. TME biomarkers including matrix metalloproteinases (MMP-2, MMP-9, MMP-14), pan-leukocyte (CD45), tumor-associated macrophages (CD80, CD163) and endothelial cells (CD31) were quantified via immunohistochemical staining. The distribution of CD45+ cells was evaluated in both intratumoral and perivascular regions. Degree of tumor adherence was categorized as none, adherent to facial nerve, or adherent to both facial nerve and brainstem.

Results: Twenty-eight patients were included (50% female, mean age 56 +/- 15 years). Cystic VS were significantly more adherent to the facial nerve and brainstem than solid VS ($p=0.02$). Linear discriminant analyses demonstrate MMP-14, CD80, CD163, and perivascular CD45 to be individually predictive of the degree of tumor adherence (all $p<0.04$), with perivascular CD45 being the best performing independent predictor ($p=0.005$). A linear discriminant model including these biomarkers demonstrated 100% accurate discrimination of all three levels of tumor capsule adherence ($p=0.003$).

Conclusions: Cystic VS tend to be more adherent to critical neurovasculature structures and negatively affecting surgical outcomes. Adherent tumors have a distinct TME characterized by elevated MMP-14 expression, enrichment of tumor-associated macrophages, and perivascular immune cell infiltration.

Professional Practice Gap & Educational Need: A subset of sporadic VS exhibit uniquely aggressive cystic degeneration and increased tumor adherence to the facial nerve and brainstem, making tumor resection extremely challenging and could lead to significant postoperative morbidity. Currently, there are no well-established biomarkers to classify these tumors or provide mechanistic insight into how cystic VS develop.

Learning Objective: We provide initial insights into the role of the VS tumor microenvironment in highly adherent tumors. We identify several novel biomarkers that classify adherent tumors, including a matrix metalloproteinase, tumor-associated macrophages, and the degree of perivascular immune cell infiltration.

Desired Result: To describe the unique tumor microenvironment of cystic VS that are adherent to the facial nerve and brainstem.

Level of Evidence – Level IV

IRB: The Ohio State University, IRB #1994H0241, Approved 6/2/2022

A Mouse Model of Neurofibromatosis Type 2 Demonstrates Glial Cell Proliferation and Neuronal Loss

Judith S. Kempfle, MD; Andrea Zhang, BS; Richard Kuang, BS
Sina Schwinn, BS; Konstantina Stankovic, MD, PhD
D. Bradley Welling, MD, PhD; David H. Jung, MD, PhD

Objective: Neurofibromatosis type 2 (NF2) is associated with loss of *NF2*/Merlin, which leads to schwannomas of the vestibular nerve and varying degrees of sensorineural hearing loss (SNHL). The etiology of the hearing loss remains to be elucidated, although leading current theories implicate the secretion of pro-inflammatory and potentially neurotoxic factors. In this study, we examined the auditory and vestibular nerves in a mouse model for NF2 to further investigate the underlying cochlear NF2 phenotype.

Study Design: Basic Science study

Setting: Animal model

Patients: N/A

Interventions: NF2 mice or controls were aged up to 11 months. Animals underwent serial measurements of auditory brainstem responses (ABR) and 5-Ethynyl-2′-deoxyuridine (EdU) injections.

Main Outcome Measures: Inner ear histology was performed for glial and neuronal markers at 11 months. Proliferation was assessed after EdU labeling. Schwann cells and neurons were quantified on serial sections. Cochlear whole mounts were stained and quantified for synaptic markers. Glial cells at early and late time points were isolated using fluorescence-activated cell sorting (FACS), and microRNA and mRNA were isolated for quantitative PCR.

Results: At 10-11 months of age, and compared to controls, ABR demonstrated significant hearing loss in all NF2 animals. EdU increased proliferation of glial cells within the cochlea that was associated with increased loss of ribbon synapses, followed by neuronal loss.

Conclusions: NF2 mice display a cochlear phenotype that associated with dysregulation of glial cell proliferation after loss of *NF2*/Merlin. This proliferation is further associated with a loss of auditory synapses and neurons. These findings may in part explain the sensorineural hearing loss in patients with vestibular schwannomas.

Professional Practice Gap & Educational Need: To date, there is no conclusive explanation for the SNHL developed by patients with NF2. In order to treat NF2 related hearing loss, we need to understand the underlying pathophysiology of the disease.

Learning Objective: Animal models for NF2, pathophysiology of NF2

Desired Result: Become familiar with theories regarding SNHL in NF2

Level of Evidence – N/A

Indicate IRB or IACUC : IACUC 2021N000080

Automated Radiomic Analysis of Vestibular Schwannomas and Inner Ears using Contrast-enhanced T1-weighted and T2-weighted MRI Sequences and Artificial Intelligence

Caio A. Neves, MD; George S. Liu, MD; Trishia El Chemaly, MS
Isaac A. Bernstein, BS; Nikolas H. Blevins, MD

Objective: To objectively evaluate vestibular schwannomas (VS) and their spatial relationships with the ipsilateral inner ear (IE) in MRI scans using deep learning.

Study Design: Cross-sectional study.

Patients: 490 adults with VS, high resolution MRI scans, and no prior neurotologic surgery.

Interventions: The VS patient cohort was split into training (390 patients) and test (100 patients) sets. A 3-dimensional convolutional neural network model was trained to segment VS and IE structures using contrast-enhanced T1-weighted and T2-weighted MRI sequences, respectively. Manual segmentations were used as ground truths. Model performance was evaluated on the test set and on an external set of 100 VS patients in a public dataset (Vestibular-Schwannoma-SEG).

Main Outcome Measure(s): Dice score, relative volume error (RVE), average symmetric surface distance (ASSD), 95th-percentile Hausdorff distance (HD95), and centroid locations.

Results: Dice scores for VS and IE volume segmentations in the test set were 0.91 and 0.90, respectively. On the public dataset, the model segmented VS tumors with a Dice score of 0.89 ± 0.06 (mean ± SD), VRE of 9.8 ± 9.6%, ASSD of 0.31 ± 0.22 mm, and HD95 of 1.26 ± 0.76 mm. Predicted VS segmentations overlapped with ground truth segmentations in all test subjects. Mean errors of predicted VS volume, VS centroid location, and IE centroid location were 0.05 cm^3, 0.52 mm, and 0.85 mm, respectively.

Conclusions: A deep learning system can segment VS and IE structures in high resolution MRI scans with excellent accuracy. This technology offers promise to improve the clinical workflow for assessing VS radiomics and enhance the management of VS patients.

Professional Practice Gap & Educational Need: Volumetric measurement is the gold standard for detecting subtle growth of VS tumors but is cumbersome to implement in clinical practice. With advances in artificial intelligence technology, developing systems to improve the workflow for measuring VS volumes is potentially both important and achievable.

Learning Objective: Review technological advances in artificial intelligence and their application to quantitatively assessing radiomic features of VS tumors.

Desired Result: Discuss the opportunities and limitations of applying deep learning technology to aid in the volumetric assessment of VS tumors and neighboring inner ear anatomy.

Level of Evidence: IV

Indicate IRB or IACUC: Stanford University IRB #61070

Stratifying Risk of Future Growth Among Growing Sporadic Vestibular Schwannomas

John P. Marinelli, MD; Zane Schnurman, MD, MBA; Daniel E. Killeen, MD
Jacob B. Hunter, MD; Douglas Kondziolka, MD
J. Thomas Roland Jr., MD; Matthew L. Carlson, MD

Objective: Whether considering upfront treatment or toleration of growth during observation management, stratification of patients at increased risk for future growth is critical. The aim of the current work was to determine if patients with growing sporadic vestibular schwannomas could be stratified by likelihood of subsequent growth based on prior growth behavior.

Study Design: Slice-by-slice volumetric tumor measurements from 3,505 serial MRI studies were analyzed from 952 consecutively treated patients.

Setting: Three tertiary-referral centers.

Patients: Adults with sporadic vestibular schwannoma.

Interventions: Wait-and-scan.

Main Outcome Measures: Composite endpoint of subsequent growth- or treatment-free survival rates (where growth is defined as ≥20% increase in tumor volume from size at time of initial growth).

Results: Among 405 patients who elected continued observation despite documented growth, stratification by volumetric growth rate into <25% (reference), 25 to <50% (HR 1.39, p=0.06), 50 to <100% (HR 1.71, p=0.002), and ≥100% (HR 2.01, p<0.001) change per year predicted likelihood of future growth. Subsequent growth or treatment-free survival rates (95% CI) at 1 and 5 years following detection of initial growth were 80% (73-88) and 31% (21-44); 65% (56-76) and 18% (10-32); 57% (49-68) and 15% (9-26); and 51% (41-62) and 6% (2-16), respectively, for the four stratification groups.

Conclusions: At time of diagnosis, clinical features cannot predict which tumors will ultimately display aggressive behavior. Stratification by volumetric growth rate at time of initial growth results in a stepwise progression of increasing likelihood of subsequent growth. When considering toleration of growth during observation management, almost 95% of patients with ≥100% change in tumor volume between diagnosis and first detection of growth demonstrate further tumor growth or undergo treatment within 5 years.

Professional Practice Gap & Educational Need: When considering tolerating some growth during observation management, stratifying which patients are at highest risk for future growth or requiring treatment is paramount. However, due to the historical paradigm where growing tumors undergo treatment, little data currently characterizes future growth behavior of growing sporadic vestibular schwannomas.

Learning Objective: Describe the survival rates and associated risk for future growth or treatment by the volumetric growth rate stratification grouping for patients with sporadic vestibular schwannoma.

Desired Result: In patients undergoing a Threshold Observation approach where some growth during observation is tolerated, practitioners would be able to stratify those patients with greatest risk of future growth or requiring definitive management with either radiosurgery or microsurgery.

Level of Evidence – IV

Indicate IRB or IACUC: IRB approval was obtained from each participating center before data collection (IRB numbers 15-008224, 112016-040, and S13-00063, respectively).

Limitations of Linear Tumor Measurement in Vestibular Schwannoma

Michael H. Freeman, MD; Nathan R. Lindquist, MD
Robert J. Dambrino IV, MD; Nathan D. Cass, MD
Peter J. Morone, MD; Kareem O. Tawfik, MD

Objective: Characterize the relationship between tumor length and tumor volume in vestibular schwannomas (VS) to better understand the role of volumetric analysis.

Study Design: Retrospective review

Setting: Single tertiary care center from 2000-2020

Patients: 382 patients with diagnosis of VS undergoing a total of 652 MRIs

Interventions: Imaging analysis including volumetric segmentation

Main Outcome Measures: VS length, VS volume

Results: Mean tumor length was 2.3cm with a mean volume of 4.3cm^3. The variability of tumor volumes as a function of length increased exponentially as tumor size increased. For tumors greater than or equal to 2 centimeters in maximal linear dimension, the variance in volume was as much as 300% for equivalently long tumors. Tumor volumes increased at about half the rate expected for a spheroid object based on tumor maximal length (slope ratio 0.44, $p<0.01$).

Conclusions: Although VS are spheroid, their most obvious linear dimension, maximal length, is a poor surrogate for tumor volume. This is especially true in larger tumors – as tumor length increases, variability in actual tumor size as measured by volume increases accordingly. In larger tumors, volumetric analysis should be employed to ensure accurate analysis of tumor growth.

Professional Practice Gap & Educational Need: A number of measuring schemes have been utilized in an attempt to standardize the measurement of VS. These typically rely on linear dimensions. Accurate measurements of tumor size are important, as management paradigms often center around observation of nongrowing tumors. Volumetric analysis has been popularized in the evaluation of other tumors, and the role for volumetric analysis in monitoring VS is developing.

Learning Objective: To understand that tumor length is a relatively poor predictor of tumor volume, especially in larger tumors.

Desired Result: Attendees will: (1) Understand the relationship between VS length and volume; and (2) Appreciate the limitations of linear measurement and role for volumetric analysis in surveillance of VS.

Level of Evidence – Level V

Indicate IRB or IACUC : VUMC IRB #220712

Contribution of Endoplasmic Reticulum Stress to Noise-induced Hearing Loss in the Mouse Cochlea

Tracy Cheng, MD, MHSc; Julia D. Lewis, BS**
Alicia M. Frank, MPPM; Abigail Sanders BS
Christopher L. Cunningham, PhD
**These authors contributed equally*

Hypothesis: Endoplasmic reticulum stress (ERS) and the unfolded protein response (UPR) contribute to noise-induced cochlear pathology.

Background: Noise exposure is the most common cause of acquired hearing loss and can lead to temporary and permanent hearing threshold shifts termed noise-induced hearing loss (NIHL). Recent work has implicated ERS/UPR in NIHL, but little is known about cochlear ERS/UPR. Furthermore, the molecular details of cochlear ERS/UPR in NIHL are unclear. This project examined the dynamics of cochlear ERS/UPR-linked RNA and protein expression after pathologic noise exposure.

Methods: Awake 8-week-old C57BL/6 mice were exposed to 105dB noise (8-16 kHZ) for 2 hours. Auditory brainstem responses (ABRs) were obtained 1 day prior and 1, 7, and 14 days post treatment. At each time point, cochleae from noise-exposed and sham mice were extracted and processed to examine cell-type-specific ERS/UPR protein dynamics with immunohistochemistry and cochlea-wide and cell-type-specific ERS/UPR RNA dynamics with quantitative PCR and fluorescent in situ hybridization respectively.

Results: Noise exposures at 105 dB led to temporary and permanent shifts in ABR thresholds. RNA expression of multiple canonical ERS/UPR genes were dynamically altered cochlea-wide, while others were unchanged. Major cochlear cell types expressed distinct subsets of ERS/UPR genes and unique responses to noise exposure.

Conclusions: We characterized cochlear ERS/UPR-associated RNA and protein expression dynamics associated with NIHL. We identified subsets of ERS/UPR-associated genes that exhibit altered expression after noise exposure, supporting the hypothesis that ERS/UPR contribute to the cochlear response in NIHL. Future experiments will examine whether genetic or pharmacological manipulation of key cochlear ERS/UPR molecules has potential to mitigate NIHL.

Professional Practice Gap & Educational Need: Noise exposure commonly encountered in occupational and recreational settings can lead to temporary and permanent hearing threshold shifts due to myriad cellular effects in the cochlea, called noise-induced hearing loss (NIHL). There are no biological treatments to prevent or mitigate NIHL.

Learning Objective: Understanding the contribution of ERS/UPR to noise-induced cochlear pathology

Desired Result: Uncovering molecular ERS/UPR cochlear targets to prevent or mitigate NIHL

Level of Evidence – Level III

Indicate IRB or IACUC : University of Pittsburgh IACUC Protocol# 21049152

Use of Observational Camera in Rotary Chair Test for Young Children: Clinical Experience and Outcomes

Guangwei Zhou, ScD; Stephanie Walsh, BA; Jacob Brodsky, MD

Objective: To explore the usefulness of observational camera during rotary chair testing for young children when video-goggles can't be used.

Study Design: Retrospective cohort study.

Setting: Tertiary referral center.

Patients: Young pediatric patients (≤3 years) with suspected vestibular impairment.

Interventions: Rotary chair test was conducted using observational camera vs binaural video goggles to determine the functional status of vestibulo-ocular reflex (VOR).

Main Outcome Measures: Normal vs abnormal results of rotary chair test

Results: A total of 221 young children, averaged age = 1.8 years (SD = 0.8) underwent rotary chair test. Overall, 129 patients (58%) had abnormal VOR outcome. Observational camera was used in 196 patients and 105 of them (54%) had abnormal VOR findings. In comparison, 24 of 28 patients (86%) who were able to wear video goggles for rotary chair test had abnormal VOR findings. Probable causes of abnormal VOR included inner ear malformations, infection diseases and genetic mutations, etc. There were 33 patients who returned for follow-up testing and 28 of them had no change in their VOR responses, including 5 patients who underwent the second rotary chair test using video goggles.

Conclusions: Observational camera is useful for young children who needs assessment of VOR function when video-goggles is not an option. The outcomes of VOR obtained by this method seem reliable and consistent. Although clinical protocol may be needed to establish initially, experienced clinicians can interpret the VOR responses accurately base on recorded video clips, which can be replayed off-line for analysis and training.

Professional Practice Gap & Educational Need: Due to practical reasons, rotary chair test for young children ≤ 3 years is unavailable in most of vestibular specialty clinics. Lack of published study on this subject should be addressed. Providers of vestibular services should recognize the importance of early diagnosis of VOR loss in young children.

Learning Objective: To demonstrate the value of observational camera as an alternative method during rotary chair testing for young children.

Desired Result: Recognition of observational camera in rotary chair test being effective in identification of VOR loss among young children.

Level of Evidence - Level IV

Indicate IRB or IACUC : IRB of Boston Children's Hospital (#P00005505 and #P00014654).

Nortriptyline *vs.* Migraine Lifestyle Modifications on Vestibular Migraine

Karen Tawk, MD; Joshua K. Kim, BS; Abdula Al-Seraji, BS
Khodayar Goshtasbi, MD; Mehdi Abouzari, MD, PhD; Hamid R. Djalilian, MD

Objective: To compare the effectiveness of nortriptyline regimen *vs.* migraine dietary/lifestyle modifications on symptoms of dizziness and stress level in patients diagnosed with vestibular migraine.

Methods: Thirty-five patients diagnosed with definite vestibular migraine based on the International Classification of Headache Disorders (ICHD-3) were enrolled. The patients received either a nortriptyline regimen alone without instruction on lifestyle/dietary changes (escalating dosage starting at 10 mg to 40 mg daily) (Group A, n=17) or migraine dietary/lifestyle modifications (Group B, n=18). Group B patients were instructed to avoid starvation and certain food triggers, stay hydrated, get regular sleep, and were asked to take vitamin B2 and magnesium supplements. The primary outcomes were the severity of dizziness and the stress level measured by the visual analog scale (VAS).

Results: The mean age was 54.7±8.7 and 62.3±17.6 (p=0.11) and 58% and 72% were women (p=0.42) in groups A and B, respectively. At 4-week point post treatment, the VAS score for dizziness decreased from 6.0±2.5 to 4.2±3.4 (p=0.069) and from 8.7±1.5 to 3.6±3.0 (p<0.001) and the VAS score for stress decreased from 5.5±1.3 to 5.4±2.9 (p=0.93) and from 6.9±3.2 to 5.0±2.7 (p=0.025) in groups A and B, respectively. The δ value (i.e., pre-treatment minus post-treatment) of the VAS score for dizziness was 1.8±3.7 and 5.1±3.1 (p=0.008) and the δ value of the VAS score for stress was 0.06±2.9 and 1.9±3.3 (p=0.09) in groups A and B, respectively. Quality of life improved in 15 (88%) patients in group A and 17 (94%) patients in group B (p=0.53).

Conclusions: This study suggests that nortriptyline alone, while helpful in alleviating the patients' symptoms is less effective than migraine diet and lifestyle modifications in treating vertiginous symptoms and reducing the stress level in vestibular migraine patients. However, both interventions are equally effective in ameliorating the quality of life of patients.

REQUIRED:
Define Professional Practice Gap & Educational Need: The pathophysiology and management of vestibular migraine have remained subject of debate. Further investigation into discovering new and improved management solutions for better treating vestibular migraine has been called. For this reason, a need to educate otolaryngologists on appropriate pharmacological and non-pharmacological treatments for vestibular migraine is warranted.

Learning Objective: To propose a treatment option in vestibular migraine patients to ANS members which can relate this entity with other complex disorders such as migraine. This can help in creating an improved treatment algorithm using our results, as well as results from other clinical trials of high quality.

Desired Result: Informing neurotologists of a possible effective treatment option in patients with vestibular migraine.

Level of Evidence - III

Indicate IRB or IACUC: The study has IRB approval from UC Irvine under the PI name of Hamid R. Djalilian.

The Natural History of Observed *Sdhx*-Related Head and Neck Paragangliomas Using 3D Volumetric Tumor Analysis

Evan L. Tooker, MS; Richard H. Wiggins, III, MD; Mana Espahbodi, MD
Anne Naumer, MS; Luke O. Buchmann, MD
Samantha E. Greenberg, MS; Neil S. Patel, MD

Objective: Characterize the natural history and clinical behavior of head and neck paragangliomas (HNPGL) in patients with *SDHx* pathogenic variants (PV) using volumetric tumor measurements.

Study Design: Using a prospectively maintained database of individuals with *SDHx* PV HNPGL, a retrospective review of all patients with serial (≥2) imaging (MRI or CT) between 2004 and 2022 was performed. Age at diagnosis, sex, laterality, type of tumor, *SDHx* PV, clinical symptoms at time of diagnosis, clinical symptoms that developed during period of observation, type of treatment, and cranial nerve (CN) outcome data were obtained. Serial tumor MRI and CT volumes were generated using a slice-by-slice, non-interpolative method and reviewed by a senior neuroradiologist.

Setting: Tertiary referral academic medical center.

Patients: Individuals aged 13-75 years with confirmed *SDHx* PV HNPGL tumors and serial (≥2) imaging (MRI or CT) between 2004 and 2022 were included.

Interventions: Diagnostic interventions included next generation sequencing (NGS), MRI, and CT imaging. Tumors were treated using microsurgical resection, stereotactic radiosurgery (SRS), or multimodality therapy.

Main Outcome Measures: Radiographic progression and rapid radiographic progression were defined as a ≥15% and ≥50% increase in volume, respectively. Cranial nerve functional outcomes were assessed using clinical documentation of facial, laryngeal, tongue, and shoulder function.

Results: Thirty-two HNPGL comprising carotid body tumor (CBT) (n=17), vagal paraganglioma (VP) (n=10), and jugular paraganglioma (JP) (n=5) were radiographically observed for a median duration of 2.08 years, 2.58 years, and 0.75 years, respectively. The median volumetric increase per year was 15% for CBT, 21% for VP, and 44% for JP. Kaplan-Meier estimated rates of survival free of radiographic progression (n= number still at risk) at 1, 2, and 3 years were as follows: CBT (93%, n=14; 62%, n=7; 31%, n=5), VP (89%, n=8; 78%, n=7; 33%, n=3), and JP (60%, n=2; 60%, n=2; 30%, n=1). Survival free of rapid (≥50%) radiographic progression at 1, 2, and 3 years were as follows: CBT (100%, n=14; 83%, n=9; 50%, n=5), VP (100%, n=8; 100%, n=7; 57%, n=3), and JP (100%, n=2; 100%, n=2; 50%, n=1). Among HNPGLs, 12% (n=2) of CBT, 30% (n=3) VP, and 80% (n=4) of JP presented with tumor related symptoms at the time of diagnosis. No tumors developed new CN palsies during the period of observation. No CBT or VP became symptomatic during observation while 40% (n=2) of JP developed new symptoms, prompting intervention. No CBT or JP developed iatrogenic CN deficits while 40% (n=4) of VP developed vagal neuropathy, of which 3 were permanent.

Conclusions: This is the first study to characterize the natural history of observed *SDHx*-related HNPGLs. Over short to intermediate term follow up, observation did not result in new cranial neuropathy, even when including tumors that grew rapidly during the interval. Expectedly, VP had the highest rates of iatrogenic lower cranial nerve palsy, suggesting that the decision to intervene should be primarily based on CN status and not necessarily growth rate. Patients with observed JP that underwent intentional subtotal resection did not suffer a new lower CN palsy. Given the rate of multicentricity of *SDHx*-related HNPGLs, these data may aid in determining the optimal treatment strategy for cranial nerve functional preservation.

Professional Practice Gap & Educational Need: At present, the natural history of head and neck paragangliomas as it relates to cranial nerve involvement, development of new symptoms, and tumor growth remains unknown.

Learning Objective: Understand the natural history of observed *SDHx*-related head and neck paragangliomas

Desired Result: Characterize the natural history of observed *SDHx*-related head and neck paragangliomas

Level of Evidence – Level V **Indicate IRB or IACUC:** Approved

The Role of Lumbar Drains in the Perioperative Management of Primary Spontaneous Temporal Lobe Encephaloceles and Cerebrospinal Fluid Leaks

Zachary G. Schwam, MD; Maria Mavrommatis, MD
Sunder Gidumal, MD; Enrique R. Perez, MD, MBA
Maura K. Cosetti, MD; George B. Wanna, MD

Objective: To determine the role of postoperative lumbar drains (LDs) in managing spontaneous temporal bone cerebrospinal fluid (CSF) leaks.

Study Design: Retrospective cohort study.

Setting: Tertiary neurotology practice.

Patients: Those with primary spontaneous temporal encephaloceles and CSF leaks undergoing surgical correction.

Interventions: Transmastoid (TM), middle fossa craniotomy (MFC), or combined approach with or without perioperative LD.

Main Outcome Measures: Complication rate, ICU stay, length of stay (LOS), readmission, treatment failure.

Results: 62 patients were identified between 2017-2022, with mean age 58.7 years and mean BMI 33.4. Bony defect width was a mean 6.29mm on coronal CT. Mean follow-up was 10.5 months. TM/MFC approach was used in 79.0%, TM alone in 19.4%, and isolated MFC in 1.6%. The most common reconstructive grafts were fat (77.4%), temporalis fascia (93.5%), split calvarial bone (21.0%), and cartilage (45.2%). Overall complication rate was 14.5%, and the treatment failure rate was 4.8%. A lumbar drain was placed in 71.0% and when present, was kept for a median of 2.0 days. Length of stay (LOS) was significantly longer for those with a LD (mean 3.4 versus 1.6 days, p=.005). Presence of a LD was associated with higher ICU admission rates amongst TM/MCF and MCF patients (p=.020) but not physical therapy needs or rates of readmission, overall complications, or treatment failures (p=.470). There was no correlation between bony defect size, age, graft type, or BMI and placement of LD.

Conclusions: LD placement is associated with higher LOS without lower treatment failure rates.

Professional Practice Gap & Educational Need: To recognize the role of lumbar drains in the perioperative management of patients with temporal encephaloceles and spontaneous CSF leaks.

Learning Objective: To critically examine the factors that go into LD placement and whether perioperative LD affect patient outcomes for this indication.

Desired Result: To show a significant or non-significant difference in the rates of treatment failure, complications, or admission-level variables as they relate to LD placement.

Level of Evidence - IV

Indicate IRB or IACUC : Icahn School of Medicine at Mount Sinai, #21-01768

NICHOLAS TOROK VESTIBULAR AWARD

Mindfulness-Based Stress Reduction for the Treatment of Vestibular Migraine: A Prospective Trial

Eric J. Formeister, MD, MS; James Mitchell, PhD
Roseanne Krauter, FN-P; Ricky Chae, BS; Adam Gardi, BS
Maxwell Hum, BS; Jeffrey D. Sharon, MD

Objective: To describe the implementation and efficacy of mindfulness based stress reduction (MBSR) therapy for treating dizziness symptoms in subjects with vestibular migraine (VM).

Study Design: Prospective cohort study.

Setting: Tertiary referral center; virtual platform for guided MBSR classes.

Patients: Twenty adult, English-speaking patients with a diagnosis of VM.

Interventions: Subjects participated in an eight-week long virtual MBSR course with required reading materials and weekly, 2.5 hour guided meditation and instructional sessions.

Main Outcome Measures: Pre- and post-MBSR scores on the Dizziness Handicap Index (DHI), Cognitive Failures Questionnaire (CFQ), Patient Health Questionnaire-9 (PHQ-9), General Anxiety Disorder-7 (GAD-7), VM Patient Assessment Tool and Handicap Inventory (VM-PATHI), Patient Reported Outcome Measure Information System (PROMIS) Global Physical and Mental Health Forms, and daily vertigo severity scores.

Results: Twenty participants (100.0% female, 70.0% White; avg. age, 46.7 years) completed the study. The DHI, CFQ, PHQ-9, GAD-7, VM-PATHI, and PROMIS scores all improved significantly after MBSR treatment compared to prior to treatment (all questionnaires, $p<0.01$ except for CFQ ($p=0.02$)). Mean daily vertigo scores did not change significantly over time in the 24 day lead-in period (adjusted $r^2 = 0.03$; $p=0.54$) but decreased significantly over the 8 week MBSR treatment period (adjusted $r^2 = 0.32$, $p<0.001$).

Conclusions: In this prospective pilot study, MBSR was highly effective for decreasing dizziness burden and improving measures of quality of life in subjects with VM. Future randomized controlled trials are warranted and forthcoming.

Professional Practice Gap & Educational Need:

Despite being the second most common cause of dizziness in the U.S., the data surrounding treatment for vestibular migraine (VM) is lacking. In particular, treatments are borrowed by analogy from treating migraine headaches, and all carry substantial side effects that lead to a high rate of medication non-adherence. Those with VM might have symptoms attributable to catastrophization, a concept that can be broken through time-honored mindfulness based stress reduction and medication techniques. More research is needed to investigate non-pharmacologic treatment option for vestibular migraineurs.

Learning Objective:

To discuss the efficacy of non-pharmacologic, mindfulness based stress reduction and meditation techniques for treating dizziness symptoms in patients with VM.

Desired Result:

At the end of this presentation, the participant will learn 1) about the techniques of mindfulness-based stress reduction, and 2) how application can effectively reduce dizziness burden and improve quality of life metrics for patients with VM.

Level of Evidence: Level III.

Indicate IRB or IACUC : This study was approved by the University of California – San Francisco's Institutional Review Board (IRB #18-25365).

SELECTED ABSTRACTS

POSTER PRESENTATIONS

IN ORDER OF PRESENTATION

58th Annual Spring Meeting
AMERICAN NEUROTOLOGY SOCIETY

May 5-6, 2023
Sheraton Boston / Hynes CC
Boston, MA

Improved Postoperative Speech Recognition and Processor Use with Early Cochlear Implant Activation

Ankita Patro, MD, MS; Nathan R. Lindquist, MD; Jourdan T. Holder, AuD, PhD
René Gifford, PhD; David S. Haynes, MD; Elizabeth L. Perkins, MD

Objective: To report speech recognition outcomes and processor use based on timing of cochlear implant (CI) activation.

Study Design: Retrospective cohort.

Setting: Tertiary referral center.

Patients: 604 adult CI recipients from 2011-2022, stratified by timing of CI activation (group 1: ≤10 days, n=47; group 2: >10 days, n=557).

Main Outcome Measures: Average daily processor use; CNC and AzBio in quiet at 1, 3, 6, and 12-month visits; time to peak performance.

Results: Both groups did not differ in gender (p=0.887), age at CI (p=0.109), preop CNC (p=0.073), or preop AzBio in quiet (p=0.114). Group 1 had higher average daily processor use than group 2 at the 1-month (11.5 vs. 9.9 hours/day, p=0.014) and 3-month (12.2 vs. 10.9 hours/day, p=0.042) visits, with no significant differences at 6 and 12 months. The early activation group had superior CNC performance at 3 months (54% vs. 43%, p=0.007) and 12 months (58% vs. 50%, p=0.044). Similarly, the early activation group had superior AzBio in quiet performance at 3 months (69% vs. 56%, p=0.008) and 12 months (72% vs. 63%, p=0.049). Both groups were equivalent in time to peak performance for CNC and AzBio. A very weak but significant negative correlation was found between timing of activation and AzBio scores (r_s = -0.10, p=0.021).

Conclusions: CI activation within 10 days of surgery is associated with increased device usage and superior speech recognition at both early and late follow-up visits. Using a large cohort, this study is the first to report outcomes related to timing of CI activation.

Professional Practice Gap & Educational Need: The impact of the timing of CI activation on postoperative outcomes such as processor use and speech recognition has not been reported. These findings are important for optimizing performance after implantation and counseling patients.

Learning Objective: To understand the impact of CI activation timing on speech and datalogging outcomes.

Desired Result: Providers will have knowledge about better postoperative speech perception and higher processor use with early CI activation. Coupled with other studies showing the safety of early activation, these results can be utilized to streamline activation within 10 days of implantation.

Level of Evidence: Level IV – Historical cohort or case-controlled studies.

Indicate IRB or IACUC: IRB Exempt (221833, Vanderbilt University).

The Younger, the Better: The Effect of Age on Facial Nerve Recovery after Vestibular Schwannoma Resection

Robert J. Macielak, MD; Christine M. Lohse, MS
Katherine P. Wallerius, MD; Skye K. Lawlor, MD
Brian A. Neff, MD; Colin L.W. Driscoll, MD; Matthew L. Carlson, MD

Objective: To assess the influence of age on facial nerve recovery after vestibular schwannoma (VS) microsurgical resection

Study Design: Historical cohort study

Setting: Tertiary referral center

Patients: Patients with a House-Brackmann (HB) grade ≥III in the immediate postoperative period after microsurgical resection of sporadic VS

Interventions: Microsurgical resection

Main Outcome Measures: Complete recovery of facial nerve function to HB grade I at least 12 months postoperatively

Results: There were 6 patients with intracanalicular tumors and 100 with cerebellopontine angle (CPA) tumors eligible for study. Given the few patients with intracanalicular tumors, no further analysis was pursued in this subset. Median age for patients with CPA tumors was 49 years (IQR 40-60). There were 44 HB grade III, 19 grade IV, 15 grade V, and 22 grade VI assessments in the immediate postoperative period, and 35 HB grade I, 27 grade II, 26 grade III, 9 grade IV, 2 grade V, and 1 grade VI assessments at most recent evaluation. Univariable analysis of patient and tumor characteristics noted age (OR for 10-year increase of 0.69; 95% CI 0.50-0.93; p=0.02) and immediate postoperative HB grade (OR for 1-grade increase of 0.27; 95% CI 0.15-0.49; p<0.001) to be significantly associated with complete recovery. After multivariable adjustment for immediate postoperative HB grade, age remained significantly associated with complete recovery (OR 0.68; 95% CI 0.47-0.98; p=0.04).

Conclusions: After considering immediate postoperative HB grade, older age at surgery was found to significantly decrease the odds of complete facial nerve recovery, which can assist in intraoperative decision-making regarding extent of resection and postoperative counseling.

Professional Practice Gap & Educational Need: Knowledge of the effect of age on facial nerve recovery after vestibular schwannoma resection

Learning Objective: The learner should be able to identify patient and tumor characteristics that affect facial nerve recovery after microsurgical resection.

Desired Result: The desired result is that the provider will be able to counsel the patient on potential facial nerve recovery if paresis or paralysis is experienced in the postoperative period.

Level of Evidence: IV

Indicate IRB or IACUC: Mayo Clinic IRB Protocol #16-007363

ANS POSTER G003

Immunofluorescence Intensity Analysis in Human Temporal Bones in Patients with Meniere's Disease

J. Dixon Johns, MD; Rafal Olszewski, PhD; Ivan Lopez, PhD
Akira Ishiyama, MD; Michael Hoa, MD

Hypothesis: Analysis of human temporal bone specimens of patients with Meniere's Disease (MD) may demonstrate altered expression of gene products related to barrier formation and ionic homeostasis within cochlear structures compared to control specimens.

Background: MD represents a challenging otologic disorder for investigation. Prior studies have highlighted a number of phenotypic findings within the inner ear, including endolymphatic hydrops and atrophy of many cochlear structures. Despite attempts to define the pathogenesis of MD, there remain many gaps in our understanding, including differences in critical cell type-specific protein expression within the inner ear. Understanding these changes may facilitate the identification of more targeted therapies for MD.

Methods: Human temporal bones from patients with MD (n = 8) and age-matched control patients (n = 8) were obtained and processed with immunohistochemistry stains to detect known cell type-specific protein expression related to ionic homeostasis and barrier function in the cochlea. Immunofluorescence intensity analysis was performed to quantify protein expression in the stria vascularis (SV), organ of Corti (OoC), and spiral ganglion (SGN).

Results: Analyses of protein expression in the different regions of the cochlea (SV, OoC, SGN) suggest the possibility of differential expression of proteins related to ionic homeostasis and barrier function in the stria vascularis.

Conclusions: The results of this study support that there may be differences in the expression of proteins related to ionic homeostasis and barrier function within the cochlea, potentially supporting the role of targeted therapies to treat MD.

Professional Practice Gap & Educational Need: There continues to be a lack of knowledge regarding the expression of gene products within the inner ear structures and how they relate to the pathogenesis of MD. Immunohistochemistry analysis has provided many insights into the pathophysiology of many other disease processes within the inner ear and may similarly be utilized to gain better understanding in patients with MD.

Learning Objective: To 1) highlight differential degrees of expression of genes of interest within human temporal bone specimens in patients with MD compared to control, and 2) determine specific anatomic locations within the cochlea for these differentially expressed gene products.

Desired Result: This study will contribute to our understanding of differential expression of gene targets within the cochlea for patients with MD, allowing for a discussion on how these differences may contribute to disease progression and providing rational support for future studies aimed at identifying potentially druggable gene targets for Meniere's disease.

Level of Evidence: Level III – cohort and case-control studies

Indicate IRB or IACUC : The studies involving human participants were reviewed and approved by the University of California at Los Angeles Institutional Review Board (IRB protocol #10-001449). Appropriate informed consent for inclusion in the study was obtained from each temporal bone donor.

Design and Methods of the Early Age-Related Hearing Loss Investigation (EARHLI) Randomized Controlled Trial

Michael W. Denham, MPhil; Michelle L. Arnold, AuD, PhD
Victoria A. Sanchez, AuD, PhD; Frank R. Lin, MD, PhD
Jose A. Luchsinger, MD, MPH; Justin S. Golub, MD, MS

Objective: To describe the design and methods of the upcoming NIH-funded Early Age-Related Hearing Loss Investigation (EARHLI) randomized controlled trial, which will assess whether a hearing intervention versus a health education comparator affects cognition, social engagement, and brain connectivity

Study Design: Randomized controlled trial (RCT)

Setting: Single academic medical center

Subjects: 150 community-dwelling adults aged 55-75 years with borderline-to-moderate hearing loss (20-55 dB pure-tone average) and amnestic mild cognitive impairment

Interventions: Subjects will be randomized to a best-practices hearing rehabilitation program including hearing aids versus a standardized health education program comparator.

Main Outcome Measures: Subjects will be followed for one year to evaluate pre- vs. post- intervention change on: (1) Global and domain-specific cognitive performance on the Alzheimer Disease Cooperative Study Preclinical Alzheimer Cognitive Composite (ADCS-PACC) standardized assessment, Trail Making Test Part B, and the ADCS-Activities of Daily Living-Prevention Instrument; (2) Social engagement (social activity frequency, Community Integration Measure, Cohen's Social Network Index, and the UCLA Loneliness Scale); and (3) Brain cross-modal organization and functional/structural connectivity on fMRI.

Conclusions: When completed in 2027, the EARHLI trial will provide substantive evidence on the effects of hearing intervention on cognitive performance, social engagement, and brain organization/connectivity in middle-aged to older community-dwelling adults with hearing loss. In this presentation, we describe the design and methods of this first-in-kind trial that will help clarify whether there is a causal relationship between hearing loss and cognitive decline.

Professional Practice Gap & Educational Need: While many studies have demonstrated an association between hearing loss and cognitive decline, there remains a lack of evidence supporting a hypothesized causal relationship between the two.

Learning Objective: Attendees will understand the design and methods of an upcoming NIH-funded RCT that will help elucidate whether there is a causal relationship between hearing loss and cognitive decline.

Desired Result: Attendees will leave with an understanding of an ongoing RCT with implications to change clinical management of patients at risk of or experiencing cognitive decline.

Level of Evidence – Level I

IRB: Pending, Columbia University

ANS POSTER G005

Quality of Life with Cochlear Implantation Using the CI QOL-35 at a Tertiary Urban Medical Center: Our Experience

Kaitlyn A. Brooks, MD; Esther X. Vivas, MD

Objective: Assessment of quality of life (QOL) outcomes after cochlear implantation (CI) using the Cochlear Implant Quality of Life-35 questionnaire (CI QOL-35) at a tertiary medical center

Study Design: Retrospective cohort

Setting: Single institution tertiary care center

Patients: Patients 18 years and older who have undergone CI and completed a CI QOL-35

Interventions: Implementing CI QOL-35 from 2019 to 2022 to measure change in QOL after CI. Statistical analysis included two-tailed t-test and ANOVA. Significance was set at .05.

Main Outcome Measures: Differences in QOL among CI patients in each of the CI QOL-35 domains

Results: Inclusion criteria yielded 95 patients (44 female, 51 male) aged 20 to 93 years of age (mean 64.1 years) with 131 QOL surveys (64 pre-activation, 67 post-activation). QOL was significantly improved in post-activation scores when compared to pre-activation scores for all domains ($p<.001$). Number of months after implant activation did not affect post-activation QOL scores ($p>.05$). Most post-activation surveys (73%) were obtained within the first 12 months after CI. There was no statistical significance in pre-activation scores when adjusted for gender and age; post-activation QOL scores in the environmental domain, however, were statistically different between male and female patients ($p<.001$). Post-activation scores were not statistically significant when categorized by patient age. Mean follow-up was 19 months post-implantation (range 4 – 57 months).

Conclusions: Cochlear implantation patients experienced improved quality of life post-activation regardless of age and gender. There may be an early plateau for QOL improvement once the implant is activated.

Professional Practice Gap & Educational Need: CI QOL-35 is a relatively young quality of life measurement tool for CI patients and currently has little published data from its implementation. This data will both characterize QOL using the CI QOL-35 and determine if certain patient groups experience different QOL outcomes after CI.

Learning Objective: To understand timing of QOL improvement and change in QOL after cochlear implantation for patients from varied demographic backgrounds in a diverse, urban academic center

Desired Result: Providers will gain knowledge regarding improvement in QOL for patients after cochlear implantation, especially in regards to time after implant activation and patient demographics.

Level of Evidence: Level IV – Retrospective cohort

Indicate IRB: Emory University IRB #00107266

ANS POSTER G006

Hearing Loss, Cisplatin Use, and The Role of Sodium Thiosulfate and Audiological Evaluations – A National Database Study

Amiti Jain, BS; Dev Amin, MD; Anna Bixler, AuD; Irina Middleton, AuD
Zachary D. Urdang, MD, PhD; Thomas O. Willcox, MD; Rebecca C. Chiffer, MD

Objective: Leverage a national electronic health records database to investigate trends in incident cisplatin-related hearing loss (HL), audiological evaluations prior to cisplatin dosing, and use of peri-cisplatin-dosed sodium thiosulfate (STS) for oto-protection.

Study Design: Retrospective cohort study with propensity-score matching.

Setting: TriNetX US-collaborative database.

Patients: Patients experiencing HL, cisplatin, and STS treatment.

Main Outcome Measures: Incidence of cisplatin use (VA: AN2555), sensorineural/ototoxic HL (ICD-10: H91.0, H90.3), sodium thiosulfate (STS) use post-cisplatin (VA: M36726), and audiological evaluation pre-cisplatin (CPT: P1012897, P92557). Population proportion instances were normalized by number of visits recorded annually.

Results: 956,537 patients were reported with HL, a 102% increase in incidence from 2016-2021. Within 2016-2022, 41,249 patients received cisplatin. 6.5% developed cisplatin-related HL, an average increase of 0.5% annually. 43% of ototoxic HL incidents occurred within 60 days of the first cisplatin dose. 6.0% received audiological evaluations within 2 months prior to cisplatin. Excluding patients diagnosed with hepatoblastoma, due to dosing differences, and cyanide poisoning, 246 received STS post-cisplatin therapy, an average annual increase of 45%. Audiological evaluations pre-cisplatin use decreased annually by 2% and were weakly associated with cisplatin use ($R^2 = 0.62$). A balanced risk analysis trends towards oto-protection with STS use but lacks sufficient statistical power to conclusively measure an odds ratio.

Conclusions: Incident HL and cisplatin-related HL is rising. Yet, audiologic testing prior to cisplatin administration is scarce. STS use for oto-protection is increasing; however, there is inadequate data for statistically significant conclusions. This study highlights the need for ototoxicity monitoring practices for platin chemotherapy and the inconclusive efficacy for STS as an oto-protectant.

Professional Practice Gap & Educational Need: Trends for hearing loss cisplatin use, cisplatin-related HL, ototoxicity monitoring programs, and STS for oto-protection in the United States has yet to be described on the national level. This study illustrates these trends and highlights the need for more robust oto-toxicity monitoring, and more clinical trial data for STS as an oto-protectant.

Learning Objectives: 1) Recognize the increasing incidence of sensineural/ototoxic HL and the role of cisplatin 2) Appreciate the need for audiological evaluations prior to cisplatin use and STS as a potential oto-protectant.

Desired Result: Evidence informed action plans for enhancing ototoxicity monitoring programs and new clinical trials for systemic and intratympanic STS treatment for cisplatin-related HL.

Level of Evidence – Level III

Indicate IRB or IACUC: Exempt

ANS POSTER G007

Impact of Comorbidities on Cochlear Implant Outcome

Sabina Dang, MD; James W. Bao, MSCI; David Lee, MD
Jordan Varghese, MD; Amit Walia, MD
Jay F. Picirillo, MD; Matthew Shew, MD

Objective: To examine the association between pre-operative comorbidities and cochlear implant (CI) speech perception outcomes.

Study Design: Retrospective cohort

Setting: Tertiary referral center

Patients: Adult patients (>18) who underwent CI at a tertiary referral center between Jan 2015 – Dec 2021

Exposure: Adult Comorbidity Evaluation 27 (ACE-27), a validated comorbidity index

Main Outcome Measures: Postoperative change in Consonant-Nucleus-Consonant (CNC) scores of the implanted ear at three, six, and twelve months.

Results: A total of 983 patients underwent CI and 625 had comorbidity data available. 32 patients were excluded due to age <18 years, leaving a total of 593 patients for analysis. 29.2% of patients had comorbidity scores of zero; 31.4% had comorbidity scores of one; 27.5% had comorbidity scores of two; 12.0% had comorbidity scores of three. ACE-27 scores were negatively associated with change in CNC at three months ($p=0.044$, $R^2 = 0.0081$, $\beta = -2.6$, 95% CI = -5.1 to -0.072) and twelve months ($p=0.043$, $R^2= 0.010$, $\beta = -3.1$, 95% CI = -6.1 to -0.10). This effect persisted in a multivariate analysis controlling for duration of hearing loss, hearing aid use, and sequential CI at three months ($p=0.017$, $\beta = -3.4$, 95% CI = -6.1 to -0.62) and twelve months ($p=0.011$, $\beta = -4.20$, 95% CI = -7.4 to -1.0). However, comorbidities were no longer significantly associated with worse outcome when age was added to this model. Instead, age was a significant factor in this multivariate analysis (three months [$p<0.001$, $\beta = -0.47$, 95% CI = -0.65 to -0.30], twelve months [$p<0.001$, $\beta = -0.42$, 95% CI = -0.64 to -0.24]).

Conclusions: We present the largest cohort evaluating medical comorbidities in the CI population to date. Our findings suggest that medical comorbidities as assessed by ACE-27 and age may impact postoperative word recognition scores.

Professional Practice Gap & Educational Need: There continues to be significant variability in CI postoperative word recognition scores. This variability results in challenges for preoperative counseling. Current models using duration of hearing loss, age of onset, etiology, hearing aid use, etc. only account for about 20% of variability in outcome. The role of medical comorbidities in CI outcome is poorly studied and may have implications for preoperative counseling.

Learning Objective: To determine whether medical comorbidities as assessed by the ACE-27 index are associated with postoperative word recognition scores in CI patients.

Desired Result: Practitioners will have an increased understanding of the impact of medical comorbidities and age on CI outcome allowing for improved perioperative counseling.

Level of Evidence - IV

Indicate IRB or IACUC: Washington University in St. Louis IRB# 201911036

Volumetric Tumor Growth Rate in Intracanalicular Vestibular Schwannoma Predict Audiometric Decline

Hyun Seo Jung, MD, MS; Daniel Morrison, MD
Garrett G.A. Casale, MD; Sergio Ferrante, MD
Terence Imbery, MD; Bradley W. Kesser, MD

Objective: To evaluate the relationship between growth rate of untreated vestibular schwannomas and the rate of change in audiometric parameters

Study Design: Retrospective case series

Setting: Single tertiary medical center

Patients: 48 vestibular schwannoma patients with complete imaging and audiometric data, evaluated between the years 2004-2019

Interventions: Tumor observation

Main Outcome Measures: Volumetric tumor growth rate (VTGR), pure tone average (PTA), speech reception threshold (SRT), and word recognition score (WRS)

Results: We identified 48 vestibular schwannoma (VS) patients with sequential surveillance data. Audiograms were used to calculate the rate of change for PTA, SRT and WRS for each patient. Similarly, serial surveillance MRI data were used to calculate the VTGR (average +8.8mm^3/month, range -35.2 to +131.2mm^3/month). Average follow up duration was 899 days (range 148 – 3493 days). Multivariate linear regression analyses were performed to evaluate correlations. For intracanalicular (Koos I) tumors, there was a statistically significant ($p = 0.002$) and highly linear (*Pearson correlation coefficient = 0.786*) relationship between VTGR and PTA decline. For larger tumors with CPA extension, there was no correlation observed. There was no statistical correlation between VTGR and change in SRT or WRS for any size of tumor.

Conclusions: Volumetric tumor growth rate and the rate of change in patient PTA exhibit a highly linear relationship for intracanalicular (Koos I) tumors, while this relationship is lost once the tumor extends into the CPA. These data support our prediction that the effects of tumor compression on the acoustic nerve may play an important role in the pathophysiology of audiometric decline in VS patients.

Professional Practice Gap & Educational Need: There remains a lack of consensual understanding of the nature of relationship between tumor growth and audiometric decline in the setting of vestibular schwannoma. Clarification of this relationship will help guide surgeons in counseling VS patients being observed with serial imaging.

Learning Objective: 1) Attendees will understand the potential relationship between volumetric tumor growth rate and decline in audiometric performance. 2) Attendees will discuss the compressive effects of vestibular schwannoma within the internal auditory canal leading to audiometric to decline in audiometric performance.

Desired Result: Further investigation into the relationship between tumor growth and audiometric performance will help guide shared decision making between the surgeon and patient when considering intervention for vestibular schwannoma.

Level of Evidence – Level IV

Indicate IRB or IACUC : University of Virginia Health System IRB #20669

Cochlear Implantation Decreases the Odds of Developing Dementia, Neuropsychiatric, and Incident Adverse Life Event Outcomes – A Multi-National Database Study

Zachary D. Urdang, MD, PhD: Amiti Jain, BS: Natalie M. Perlov, BS
Thomas L. Haupt, BS; Thomas O. Wilcox, MD
Rebecca C. Chiffer, MD; Richard K. Gurgel, MD

Objective: Determine whether cochlear implantation (CI) affects the odds of developing dementia, neuropsychiatric conditions such as depressive disorder, and incident adverse life events (ALEs) which are a subset of social determinants of health with negative implications.

Study Design: Retrospective cohort database study with propensity-score matching.

Setting: TriNetX is a live HIPPA-compliant federated cloud electronic health record research network representing pooled data from about 110-million patients from 70 healthcare organizations in the United States, Brazil, and India.

Patients: Subjects with bilateral sensorineural hearing loss (SNHL) (ICD10 H91.0), with and without CI (CPT 69930).

Main Outcome Measures: Odds-ratios with 95% confidence intervals (OR, 95% confidence interval) for incident dementia (ICD-10 F01, F03, G30), neuropsychiatric (ICD-10 F20.xx-F45.xx), and ALEs (ICD-10 Z55.xx-Z65.xx) after SNHL diagnosis, stratified by CI.

Results:
There were 13,861 cochlear implant recipients in this study. The average age was 55.4 years old, with 49% female patients. 809,315 control patients with SNHL were identified. After 1:1 propensity-score matching for SNHL- and dementia-related risk factors, the risk of developing dementia among CI recipients was 1.37% compared to 2.46% in controls (OR: 0.55, 0.46-0.66), 8.07% compared to 12.79% for any new neuropsychiatric diagnosis (OR: 0.60, 0.55-0.65) with dissociative disorder having the strongest protective association, and 3.01% compared to 4.02% for any new ALE (OR: 0.74, 0.65-0.85) with food insecurity having the strongest protective association.

Conclusions: CI for SNHL decreases the odds of developing dementia, neuropsychiatric, and ALEs. This study represents the largest cohort-controlled study examining the protective association of CI.

Professional Practice Gap & Educational Need: There is a strong association between SNHL and dementia. It is unknown whether treating SNHL with CI decreases the risk of dementia. The current study demonstrates that CI decreases the odds of developing dementia. This is also true for neuropsychiatric and social (ALE) outcomes. Better delineation of these associations will improve patient consultation for CI.

Learning Objectives: 1) Demonstrate that CI decreases the odds of developing dementia. 2) Understand the growing number of neuropsychiatric and social determinants of health outcomes (such as ALEs) improved by CI.

Desired Result: Improved understanding of the benefits of CI in decreasing odds of dementia, neuropsychiatric diagnoses, and incident ALEs.

Level of Evidence – Level III

Indicate IRB or IACUC: Exempt

Chemical Chaperone 4-Phenylbutyric Acid Ameliorates Cdh23 Compound Heterozygous Non-Syndromic Sensorineural Hearing Loss

Jessica H. Pham, BA; Da Sun, PhD; Jing Yuan, PhD; Bo Li, PhD
James Xu, BS; Qing Yin Zheng, PhD; Wei-Jia Kong, PhD

WITHDRAWN BY AUTHOR

Socioeconomic Disparities in the Pursuit of Care at a High-Volume Institution for Surgical Resection of Vestibular Schwannomas

Eric Y. Du, BS; Omid Moshtaghi, MD MS; Sahar H. Assi, MD
Marc S. Schwartz, MD; Rick A. Friedman, MD, PhD
Peter R. Dixon, MD, MS

Objective: Increased surgical resection volume for vestibular schwannomas (VS) has been associated with improved patient outcomes, including reduced risk of prolonged hospital stay and readmission. Possible disparities in the pursuit of care at these high-volume institutions remain unknown.

Study Design: Retrospective cohort epidemiological study.

Setting: National Cancer Database (NCDB), a hospital-based registry of over 1,500 facilities in the United States.

Patients: Adult VS patients (age >18 years) treated surgically.

Interventions: High- vs. low-volume facilities, defined using a facility volume threshold of 25 cases per year. A risk-adjusted restricted cubic spline model was used to identify this risk threshold as an inflection where decrease in negative outcomes plateaued with increasing volume.

Main Outcome Measures: Sociodemographic factors, including race, ethnicity, income, insurance status, and rurality. Multivariable analyses were adjusted for patient and tumor characteristics including age, sex, Charlson-Deyo score, and tumor size.

Results: 10,048 patients were identified (median [IQR] age: 51 [41, 60] years, 54% female, 87% Caucasian). Patients with Spanish/Hispanic ethnicity (OR 0.71 [0.52, 0.96]), income below median (OR 0.63 [0.55, 0.73]), and Medicare, Medicaid, or other government insurance vs. private insurance (OR 0.63 [0.53, 0.74]) had reduced odds [95% CI] of treatment at a high-volume facility. Further sensitivity analyses in which facility volume was operationalized continuously reinforced direction and significance of these associations.

Conclusions: Socioeconomic disparities exist in the propensity for VS patients to be treated at a high-volume facility. Further work is needed to understand the nature of these associations and whether interventions can be designed to mitigate them.

***Define Professional Practice Gap & Educational Need:** Recent literature has demonstrated associations between increased hospital surgical volume and improved outcomes in vestibular schwannoma care, encouraging referral to surgical centers of excellence. There is a paucity of research in possible disparities in the pursuit of care at one of these institutions.

***Learning Objective:** Demonstrate the socioeconomic inequities in the pursuit of VS surgical care at a high-volume institution.

***Desired Result:** Given demonstrated benefits, there are trends towards regionalization of VS care to high volume centers of excellence. Improving knowledge about the disparities in pursuit of care at these institutions, which likely includes increased logistical complexity and travel, will encourage insurance providers and programs to provide expanded coverage in the goal of improved equity.

***Level of Evidence -** Level IV

***Indicate IRB or IACUC:** Exempt

Analysis of Vestibular Testing Results Using Unsupervised Clustering Techniques

Connor L. Pratson, MD; Krystal M. Riska, PhD, AuD
Kayla W. Kilpatrick, PhD; Maragatha Kuchibhatla, PhD
David M. Kaylie, MD; Calhoun D. Cunningham III, MD
Steven J. Eliades, MD, PhD

WITHDRAWN BY AUTHOR

Elevated Body Mass Index Associated with Cerebrospinal Fluid Leak after Lateral Skull Base Surgery: A Systematic Review and Meta-Analysis

Frederick G. Durrant, BS; Brendon K. Warner, MD
Shaun A. Nguyen, MD; Joshua J. Sturm, MD, PhD
Ted A. Meyer, MD, PhD

Objective: To determine if body mass index (BMI) increases the risk of cerebrospinal fluid (CSF) leak following lateral skull base surgery.

Data sources: CINAHL, PubMed, and Scopus were searched from January 2010 to September 2022 for articles published in English.

Study selection: Articles that reported BMI or obesity with and without CSF leaks following lateral skull base surgery were included.

Data extraction: Two reviewers (FGD, BKW) independently performed study screening, data extraction, and risk of bias assessment. Risk of bias was assessed with ROBINS-I. Publication bias was assessed by funnel plot.

Data synthesis: A total of 11 studies and 9,112 patients met inclusion criteria. Meta-analysis of mean difference (MD), odds ratio (OR), proportions, and risk ratio (RR) were calculated using RevMan 5.4 and MedCalc 20.110. BMI for patients with CSF leak following lateral skull base surgery (28.37 kg/m^2) was significantly greater than BMI for patients without CSF leak following lateral skull base surgery (26.03 kg/m^2) with a MD of 2.26 kg/m^2 ([95% CI 0.91 to 3.62], p = 0.001). The proportion of patients with BMI > 30 kg/m^2 that had a CSF leak was 12.7%, and the proportion of patients with BMI < 30 kg/m^2 (control) that had a CSF leak was 7.9%. The OR for CSF leak following lateral skull base surgery in patients with BMI > 30 kg/m^2 was 1.94 ([1.40 to 2.68], $p < 0.0001$) and the RR was 1.85 ([1.39 to 2.47], $p < 0.0001$).

Conclusions: Elevated BMI increases the risk of cerebrospinal fluid leak after lateral skull base surgery.

Professional Practice Gap & Educational Need: There is disagreement amongst retrospective reviews on the impact of obesity on CSF leaks after lateral skull base surgery.

Learning Objective: To understand the effect of modifiable risk factors on post-operative complications, specifically CSF leaks following lateral skull base surgery.

Desired Result: Statistically significant difference in the mean BMI of patients with CSF leaks compared to those without CSF leaks, as well as increased risk of CSF leak in patients with elevated BMI.

Level of Evidence: Level IIa.

Indicate IRB or IACUC: Exempt.

Dural Venous Sinus Thrombosis in Postauricular Craniotomies for Vestibular Schwannoma Resection

Hunter L. Elms, MD; James C. Campbell, MD; David M. Straka, MD
Howard W. Francis, MD; David M. Kaylie, MD
Calhoun D. Cunningham, III, MD

Objective: Characterize the incidence, risk factors, and patient outcomes of dural venous sinus thrombosis identified on postoperative imaging after retrosigmoid or translabyrinthine craniotomy for vestibular schwannoma resection.

Study Design: Retrospective case-control

Setting: Single tertiary academic referral center

Patients: 81 patients with vestibular schwannomas aged 19-82 years, 58% female.

Interventions: Retrosigmoid or translabyrinthine craniotomy with postoperative MRI/MRV.

Main Outcome Measures: Association between rate of thrombus and operative approach, patient age, sex, BMI, tumor size, dominant sinus, operative time, laterality, and perioperative CSF leaks was analyzed. Postoperative complications including hydrocephalus, deep vein thrombosis (DVT), intraventricular hemorrhage (IVH), and chronic headache were compared.

Results: Translabyrinthine craniotomy was associated with the highest relative risk of thrombosis (OR = 11.1944 [1.3847 - 90.4984], p = 0.007), followed by male sex (OR = 2.6518 [1.0580 - 6.6466], p = 0.035). Patient age, BMI, tumor size, dominant sinus, operative time, laterality, and perioperative CSF leak were not associated with increased rates of dural venous thrombosis. Complications were rare with no hydrocephalus, 1 chronic headache patient in each group, 1 DVT in the thrombus group, and 1 IVH in the non-thrombotic group.

Conclusions: Translabyrinthine approach and male sex most strongly predicted postoperative dural venous thrombosis after postauricular craniotomy for vestibular schwannoma resection. Complication rates did not differ significantly between patients without and without thrombi.

Professional Practice Gap & Educational Need: understanding of risk factors and management of dural venous thrombosis after vestibular schwannoma surgery

Learning Objective: characterize clinically significant risk factors for dural venous thrombosis in vestibular schwannoma surgery

Desired Result: identification of risk factors for and complications of dural venous thrombosis after vestibular schwannoma surgery

Level of Evidence - III

Indicate IRB or IACUC : Exempt

Differences in Subjective Music Appreciation between Bilateral and Single-Sided Deafness Cochlear Implant Recipients

Alex W. Yang, MD; Elicia Pillion, AuD
Charles A. Riley, MD; Anthony M. Tolisano, MD

Objective: To compare changes in music appreciation after cochlear implant (CI) surgery for patients with bilateral and single-sided deafness (SSD).

Study Design: Retrospective cohort.

Setting: Tertiary-care military medical center.

Patients: Adult CI recipients from November 2019 to September 2022.

Interventions: Unilateral or bilateral CI surgery.

Main Outcome Measures: Musical questionnaire subset from Cochlear Implant Quality of Life (CIQOL) – 35 Profile Instrument Score (maximum raw score of 15). Functional CI assessment was measured with CI-alone speech-in-quiet (SIQ) scores (AzBio and CNC).

Results: 29 adults underwent CI surgery for SSD and 20 adults for bilateral deafness (7 sequentially implanted). Every patient group had clinically significant improvements ($p<0.001$) in mean SIQ scores in the most recently implanted ear (Azbio SSD: 12% to 62%, bilateral: 19% to 71%, sequential: 14% to 71%). SSD adults on average had higher music QOL scores at baseline (SSD: 11.21; bilateral: 7.31; sequential: 9.00, $p<0.001$). No group had significant increases in raw score at the first post-operative visit (SSD: 11.45, $p=0.67$; bilateral: 8.15, $p=0.36$; sequential: 10.57, $p=0.46$). By the most recent post-implantation evaluation (median 10.1 months for SSD, 10.3 months for bilateral, 10.0 months for sequential), SSD adults had a significant increase in raw score from baseline (11.21 to 12.48, $p=0.03$), whereas bilaterally deafened (7.31 to 8.85, $p=0.18$) and sequentially implanted (9.00 to 10.14, $p=0.59$) adults had nonsignificant increases.

Conclusions: SSD patients demonstrate higher baseline music appreciation than bilaterally deafened individuals regardless of unilateral or bilateral implantation, and are more likely to demonstrate continued improvement in subjective music appreciation at last follow-up even when speech perception outcomes are similar.

Professional Practice Gap & Educational Need: This data adds to the emerging literature related to music and its improvements on the quality of life of CI patients. SSD is also a more recent indication for CI and this study highlights how SSD patients differ from traditional bilaterally deafened patients in regards to subjective music appreciation.

Learning Objective: To provide evidence that SSD CI patients are expected to have greater improvements in subjective music appreciation than bilaterally deafened CI patients.

Desired Result: These results can be utilized by practitioners to inform SSD patients about the benefits of cochlear implantation in regards to complex auditory stimuli as well as drive future research utilizing SSD CI patients given their simultaneous experience with both a natural and electrical hearing ear.

Level of Evidence: Level III

Indicate IRB or IACUC: Institutional Review Board approval from the Department of Research Programs at the Walter Reed National Military Medical Center was obtained (WRNMMC-2020-0290)

Community Health Worker Assessment of Central Auditory Processing in Children using a Novel Tablet-based Platform in Rural Nicaragua

Torri E. Lee, BA; Catherine C. Rieke, AuD; Jay C. Buckey, MD
Christopher Niemczak, AuD, PhD; Marvin A. Quiroz, MD
Karen M. Mojica; James E. Saunders, MD

Objective: Evaluate the administration of a portable, tablet-based central auditory processing (CAP) test battery to Spanish-speaking children by minimally trained community health workers (CHW) in Nicaragua

Study Design: Cross-sectional study.

Setting: Community-based settings in Chontales, Nicaragua.

Patients: Spanish-speaking children and adolescents (n=210, average age 12, range 8-18 years old)

Main Outcome Measures: Completed tests with valid responses (Tablet-based pure tone average (PTA), Gap Detection Threshold, Fixed Level Frequency Threshold (FLFT), Masking Level Difference (MLD), Hearing and Noise Test (HINT), Dichotic Digits Test (DDT), and Frequency Pattern Recognition Test (FPR).

Results: All CAP tests were successfully completed except for the FPR, which exhibited high variability. Of the remaining 2,310 administered tests, there was an overall successful completion rate of 92.9% with missing data in 96 tests and 59 invalid results in GDT (21, 5.0%) and MLD (38, 9.0%). Invalid GDT and MLD tests were significantly associated with increased PTA ($p<0.001$) and shorter completion time ($p=0.001$), respectively. Test validity was not associated with age. In the valid responses, CAP tests (GDT, MLD, HINT) results were independent of PTA ($p=0.203$-0.891). Only DDT results were correlated with age and PTA ($p<0.001$).

Conclusions: Pediatric CAP testing can be successfully completed by minimally trained CHWs in rural low-resource settings using a tablet-based platform. Hearing acuity (PTA) was associated with performance on DDT. Inadequate training was felt to be responsible for high variability of FPR.

Professional Practice Gap & Educational Need: CAP testing that can be administered without an audiologist is not currently accessible for communities at high risk for central auditory processing deficits in areas where healthcare resources are lacking.

Learning Objective: To understand the impact of administering a portable CAP test in underserved communities using self-administered, tablet-based training.

Desired Result: To provide the attendee with the knowledge of a new mobile-based platform for CAP testing that could be used for future clinical investigations where a trained audiologist is not readily accessible.

Level of Evidence - Level V

Indicate IRB or IACUC: Dartmouth Health Institutional Review Board STUDY02000479 – approved 7/14/2020

Which Vestibular Test is Best for Diagnosing a Peripheral Vestibular Disorder?

Cameron Fattahi; Janice Chung; Divya A. Chari, MD

Objective: The utility of individual vestibular tests in the diagnosis of vestibular disorders is unclear and debate remains over which test is optimal. Herein, we seek to characterize the predictive power of widely used vestibular tests in the differentiation of peripheral and central vestibulopathy.

Study Design: Retrospective chart review.

Setting: Tertiary academic medical center.

Patients: 90 adult patients in a multidisciplinary vestibular clinic between 01/2016 and 01/2022.

Interventions: Calorics, rotary chair, and video head impulse test (vHIT)

Main Outcome Measures: (1) Receiver operating characteristic (ROC) analysis of individual test parameters for area under the curve (AUC) as an indication of predictive value and (2) Logistic regression analysis of test combinations for identification of optimal test battery for differentiation of peripheral and central vestibulopathy.

Results: The best overall predictive parameter of peripheral vestibulopathy was rotary chair time constant (AUC-ROC, 0.78; 95% confidence interval, 0.69-0.88). Rotary chair time constant also demonstrated the highest sensitivity (79%) and specificity (73%) based on clinical parameters. However, the combination of vHIT and calorics improved prediction to above that of either individual test (AUC-ROC, 0.75).

Conclusions: In our data set, rotary chair time constant most consistently differentiated peripheral and central vestibular disorders. However, the combination of vHIT and caloric testing improved the predictive capabilities for identifying peripheral vestibular dysfunction compared to either test alone.

Professional Practice Gap & Educational Need: Differentiating peripheral and central vestibular disorders can be challenging. In some cases, various vestibular tests can give discordant results. Improved understanding of the relative predictive power of vestibular tests may help clinicians in the diagnostic workup of patients with dizziness and imbalance.

Learning Objective: To better understand the utility of vestibular testing in the diagnostic workup of peripheral and central causes of dizziness.

Desired Result: Rotary chair testing offers clinical benefit over vHIT and calorics in the diagnosis of peripheral causes of dizziness

Level of Evidence – Level IV

IRB: 2019P000438, Massachusetts Eye and Ear

Modesty Concerning the Therapeutic Effect of Radiosurgery for Vestibular Schwannoma: A Systematic Review and Comparative Analysis of Long-term Data

Kevin M. Guy, MS, Matvey V. Karpov, Peter G. Volsky, MD

Objective: Reconcile the high rates of tumor stability observed among sporadic vestibular schwannomas (VS) that are untreated and those treated with stereotactic radiosurgery (SRS).

Data Sources: PubMed, Google Scholar, and Web of Science.

Study Selection: Terms 'vestibular schwannoma,' 'radiosurgery,' or well-known variations, without language restrictions, were applied to articles published before September 6, 2022 reporting 10-year tumor control of VS treated with SRS, and excluding studies with greater than 10 percent of subjects with neurofibromatosis 2 (NF2).

Data Extraction: Two-reviewer extraction and tabulation.

Data Synthesis: Twenty-one studies, 4513 VS treated with SRS, with a mean 10-year progression free survival rate of 91.5% (85%-100% SD 4.3%) comprised the study population. As a control group we selected published data from a national cohort of 1543 observed VS (more than 10 years). In comparison, SRS reduced the absolute risk of tumor growth by 8.5% compared to no treatment [mean ARR was 0.085 (SD 0.040)]. The mean NNT for one patient to benefit from SRS was 16(SD 11). In relative comparisons, the mean RR and RRR were 0.493 (SD 0.246) and 0.507 (SD 0.246), respectively. Lack of data reporting standards nullified attempts at meta-analysis.

Conclusions: For VS that are not neurosurgically critical, two facts refine the therapeutic benefit of SRS: (1) for all tumors (regardless of prior growth behavior), SRS reduces the absolute risk of tumor growth by 8.5% compared to no treatment; and, (2) that the proportion of "uncontrolled" tumors under observation is reduced by 50.7% after SRS.

Professional Practice Gap & Educational Need: The therapeutic benefit of SRS relative to the natural history of vestibular schwannoma is unknown. Without this knowledge, providers are limited in the ability to counsel patients about the relative benefits and risks.

Learning Objective: For the management of vestibular schwannomas that are not neurosurgically critical, two facts are important to better appreciate the therapeutic benefit of SRS: (1) for all tumors (without consideration of prior growth behavior), SRS reduces the absolute risk of tumor growth by 7.8% compared to no treatment; and, (2) that the proportion of "uncontrolled" tumors under observation is reduced by 50.7% after SRS.

Desired Result: Surgeons and radiation oncologists will quantitatively appreciate limitations of therapeutic benefit of SRS in cases of observable vestibular schwannomas.

Level of Evidence – Level II

Indicate IRB or IACUC: 22-06-NH-0122, Eastern Virginia Medical School Institutional Review Board.

Closing the Gender Gap: Progress of Neurotology Compared to Other Skull Base Specialties

Shrey Patel, MS; Emily Gall, MD; Jacob Kosarchuk, MD
Christian Soneru, MD; Kathryn Noonan, MD

Objective: There has been recent increased attention to gender make-up within neurotology and related subspecialties. This study seeks to evaluate changes within neurotology compared to other skull base specialties.

Study Design: Information regarding fellows training in the past ten years, current fellowship directors, and current faculty were extracted from the American Neurotology Society (ANS) website and related sources, tabulated, and summarized. Chi-square analysis was done to compare the proportional make-up of female fellows within related fields.

Setting: Demographic data from all skull base fellowship programs from 2012 to 2022.

Main Outcome Measures: Proportional gender make-up of neurotology fellows compared to other skull base specialties and over the past decade.

Results: In the past decade in neurotology, males constituted 89 of 128 (69.53%) fellows, 25 of 29 (86.2%) fellowship directors, and 132 of 170 (77.64%) faculty. Within rhinology, males constituted 211 of 279 (75.63%) fellows, 32 of 35 (91.4%) fellowship directors, and 113 of 141 (80.14%) faculty. In neurosurgical programs, males constituted 94 of 105 (90%) fellows, 43 of 44 (97.73%) fellowship directors and 120 of 133 (90%) faculty members. In neurotology, the proportion of female fellows increased (12%, p=0.06) from 2012-2017 to 2018-2022. Neurosurgery and rhinology had statistically insignificant increases of 4% and 9%. The increase in neurotology was not significantly higher than increases within rhinology (p=0.87) and neurosurgery (p=0.86).

Conclusions: The proportion of female fellows within neurotology has not increased significantly, similar to other skull base specialties. Limitations include use of publicly available data and changes in faculty make-up over the past ten years.

Professional Practice Gap & Educational Need: There is a clear gender gap within neurotology and other related specialties.

Learning Objective: Evaluate the current gender make-up neurotology fellowship and compare it to other skull base specialties.

Desired Result: Further understand the relationship between same gender mentorship and recruitment within skull-base specialties.

Level of Evidence – Level IV

Indicate IRB or IACUC: Exempt

VM-PATHI Correlates with Cognitive Function Improvement after Successful Treatment in Patients with Vestibular Migraine

Evan J. Patel, MD; Maxwell Hum, BA; Adam Z. Gardi, BA
Kristen K. Steenerson, MD; Habib G. Rizk, MD
Jeffrey D. Sharon, MD

Objective: To assess changes in cognitive function in vestibular migraine patients undergoing treatment.

Study Design: Prospective cohort

Setting: Single-institution tertiary care center

Patients: Thirty-four patients with vestibular migraine were included in the study. Average age at diagnosis was 47.9 years-old. The majority of patients were female (91.2%).

Intervention: Vestibular therapies included mindfulness-based stress reduction (58.8%), pharmacologic (32.4%), and others (8.8%).

Main outcome measures: Pre- and post-treatment questionnaires were collected including the Cognitive Failures Questionnaire (CFQ), Vestibular Migraine Patient Assessment Tool and Handicap Inventory (VM-PATHI) and Dizziness Handicap Inventory (DHI).

Results: Median time between pre- and post-treatment questionnaire was 4.4 months (range 2.8-15.6. months). CFQ scores decreased only in subjects who responded to treatment, as defined by those with a positive change in VM-PATHI score (average decrease 6.5, $p = 0.03$). CFQ scores did not improve in subjects who had no improvement in their vestibular condition, as defined by no change or a negative change in VM-PATHI score ($p = 0.53$). Univariate linear regression showed that VM-PATHI score change was highly predictive of CFQ change ($p < 0.01$, r-squared = 0.36). Multivariate regression demonstrated that VM-PATHI ($p = 0.03$) and not DHI ($p = 0.10$) predicted changes in CFQ score.

Conclusions: Self-reported cognitive dysfunction improves with successful treatment of vestibular migraine.

Professional Practice Gap & Education: Given the association of cognitive impairment and vestibular symptoms, cognitive function tests are being incorporated into evaluations of patients with vestibular migraine. There is limited data to support the correlation of self-reported surveys which assess dizziness compared to those which analyze cognitive function.

Learning Objective: To demonstrate the correlation of vestibular symptoms with cognitive function after treatment in patients with vestibular migraine.

Desired Result: Attendees will understand that VM-PATHI is a reliable predictor of cognitive improvement after treatment in patients with vestibular migraine.

Level of Evidence - Level III

IRB: University of California San Francisco IRB #18-25365 (approved 2/26/19)

Diagnosis and Management of the Dizzy Patient- Survey of the American Neurotological Society

Pawina Jiramongkolchai MD, Nedim Durakovic MD, Joel Goebel MD

Objective: To study the attitudes, preferences, and practice patterns of members of the American Neurotological Society (ANS) in the diagnosis and management of the dizzy patient.

Study Design: A 17-item survey was emailed to members of the ANS.

Main Outcome Measure: Comfort level in managing the complex dizzy patient.

Results: Of the 123 members of the ANS that completed the survey, the majority were male (81%), over the age of 40 (83%), in academic practice (70%) with over 11 years in practice (70%). Despite dizziness being one of the most common conditions seen in clinic, the majority of respondents (59%) felt least comfortable treating vestibular pathology, especially vestibular migraines (24%) and central vertigo (13%), when compared to other neurotologic disorders. A multidisciplinary approach to managing vestibular patients was frequently employed with close collaboration with neurology (95%) and physical therapy (96%). Despite lower comfort level and higher utilization of other subspecialities, an overwhelming majority of ANS members (90%) surveyed felt that neurotologists were best suited to managing vestibular patients. Furthermore, there was a trend towards significance of increased exposure to vestibular pathology during residency and fellowship and comfort level in treating vestibular disorders in practice.

Conclusion: Compared to other neurotologic disorders, ANS members were least comfortable in treating the complex dizzy patient. Given the trend towards increased comfort in evaluating dizziness with more exposure during training in residency and fellowship, future residency and fellowship curriculums may benefit from a more formal instruction on vestibular disorders.

***Professional Practice Gap & Educational Need:** Dizziness is common condition that affects up to 35% of individuals during their lifetime. Neurotologists are often involved in the care of dizzy patients. However, because of the subtleties of presentation, management can be complex.

***Learning Objective:** To understand the attitudes, preferences, and practice patterns of neurotologists in managing the complex dizzy patient.

***Desired Result:** Formal curriculum on vestibular disorders during residency and fellowship may improve comfort level in the management of the complex dizzy patient.

***Level of Evidence**: V

***Indicate IRB or IACUC**: Exempt

ANS POSTER G022

Histopathological Comparison of Sporadic Vestibular Schwannoma and NF2

Susan Ellsperman, MD; Ivan Lopez, PhD
Gail Ishiyama, MD; Akira Ishiyama, MD

Objective: To describe the location and characteristics of vestibular schwannomas (VS) in patients with sporadic VS and with neurofibromatosis type 2 (NF2)

Study Design: Retrospective chart and histopathological review

Setting: Tertiary academic institution

Patients: Subjects with known sporadic VS and NF2 with temporal bones previously donated to a histopathology lab

Interventions: Surgical resection or observation with serial imaging

Main Outcome Measures: The anatomic location of schwannoma, previous treatment, and destruction of sensory structures within the temporal bone was determined.

Results: Sixteen temporal bones were included in analysis; six from patients with NF2 and 10 from patients with sporadic VS. Patients in the NF2 group(67 years; range 41-89) were younger at the age of death than patients in the sporadic group(84.6 years, range 58-101; $p = 0.054$). Prior surgical resection was performed in two of the NF2 temporal bones(2/6, 33.3%) and five of the sporadic VS temporal bones(5/10, 50%). Translabyrinthine approaches were used most often(6/7, 85.7%). In patients with NF2 without surgical resection, the cochlea morphology, organ of corti (OC) hair cells, and spiral ganglion neurons (SGN) were preserved in all temporal bones(4/4, 100%). In the two post-surgical temporal bones, there was abnormal cochlear morphology and loss of OC and SGN cells in both specimens and fibrosis in one of the two specimens. In patients with sporadic VS, cochlear morphology, OC, and SGN structures were preserved in only 60%(3/5) of unoperated temporal bones. There was ossification in one unoperated specimen(1/5, 20%). In sporadic VS cases that underwent resection, the cochlear morphology and OC were damaged in all specimens(5/5, 100%). One specimen(1/5, 20%) had preserved SGNs and no cochlear fibrosis. The other four postoperative temporal bones(4/5, 80%) had degenerated SGNs and fibrosis.

Conclusions: Cochlear morphology, OC hair cells, and SGNs are well preserved in patient with NF2 who did not undergo surgical resection. Results in patients with sporadic VS are variable.

Professional Practice Gap & Educational Need: cochlear implantation is a rehabilitation option for patients with sporadic VS and NF2. Patient outcomes are variable, and predicting performance is challenging. Preservation of the OC HCa, SGNs, and lack of cochlear morphology changes may explain why patients with large tumor burden have better than expected CI performance outcomes.

Learning Objective: Sensory epithelia is well preserved in unoperated temporal bones in patients with NF2.

Desired Result: Contribute to understanding of NF2 disease process and potential rehabilitation options.

Level of Evidence – Level IV

Indicate IRB or IACUC : IRB # 10-001449

Long-Term Results of Hybrid Cochlear Implantation

Mandy Salmon, BS; Alexandra E. Quimby, MD, MPH
Hannah S. Kaufman, AuD; Jason A. Brant, MD
Douglas C. Bigelow, MD; Michael J. Ruckenstein, MD, MSc

Objective: Characterize long-term hearing outcomes in patients implanted with Hybrid L24 devices.

Study Design: Retrospective case series.

Setting: Tertiary academic center.

Patients: Adult patients implanted with Hybrid L24 cochlear implants between 2014-2021.

Interventions: Pure tone audiometric testing.

Main Outcome Measures: Changes in low-frequency pure tone average, LFPTA (125, 250, 500 Hz) over time; proportion of patients with preserved LFPTA ($\leq$ 80 dB) at last follow-up; incidence of residual hearing loss (LFPTA >80 dB).

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

Conclusions: Cochlear implantation with the L24 device appears to offer good rates of hearing preservation both immediately and long-term post-implantation.

Professional Practice Gap & Educational Need: A number of options for hearing preservation cochlear implantation are available but few have been studied in the long-term post-implantation. The present study offers a cohort of individuals implanted with the hybrid L24 cochlear implant on whom data was collected in the long-term ($\geq$ 48 months post-implantation) in order to demonstrate changes in preserved low-frequency hearing over time post-implantation. Our findings will aid physicians in counselling patients and providing evidence-based recommendations regarding options for hearing preservation cochlear implantation.

Learning Objective: Appreciate the distribution of hearing changes over time post-hybrid L24 cochlear implantation.

Desired Result: Audience members will learn the long-term outcomes of Hybrid L24 cochlear implantation.

Level of Evidence – IV

Indicate IRB or IACUC : University of Pennsylvania, protocol no. 850966

Malignant Otitis Externa: What is the Role of Surgery?

Lisa Zhang, MD; Joseph Bonanno; Woo Yul Byun; Yin Ren, MD, PhD

Objective: Malignant otitis externa (MOE) is typically managed with long-term broad-spectrum antibiotics. The role of surgical management on clinical outcomes is currently not well understood. This study compares long-term functional outcomes of MOE patients managed with or without surgery.

Study Design/Setting: Retrospective cohort, tertiary academic center

Methods: Patients diagnosed with MOE between January 2010 to September 2022 were included. Univariate analyses compared symptoms at initial presentation and long-term (≥1 year) outcomes between surgical and non-surgical patients.

Results: A total of 23 patients were included (78% male, mean age 69 +/- 13 years, median follow-up 305 days). Twenty-two (96%) were diabetic. Seventeen (74%) underwent surgery (76% mastoidectomy, 24% external ear canal biopsy). Poor FN function (House-Brackmann [HB] ≥3) at initial presentation significantly predicted surgical intervention (p=0.02). Following surgery, there were no differences in HB scores between surgical versus nonsurgical patients at either immediate or long-term follow-up (p>0.05). There were no differences in the degree of hearing loss, degree of diabetes control, rate of insulin dependence, incidence of immunosuppression, or Charlston Comorbidity Index (p>0.05). No significant differences in the length of stay (9 vs. 6 days, p=0.2), rate of readmission (31% vs. 17%, p=0.5) or 5-year overall survival (78% vs. 67%, p=0.6) were observed.

Conclusions: Long-term outcomes for patients with MOE remains poor. Patients with poor FN function at presentation were more likely to undergo surgery. Patient comorbidities, including severity of diabetes, were not predictive of undergoing surgery. However, surgery did not impact the length of stay, rate of readmission, or mortality.

Professional Practice Gap & Educational Need: To provide data regarding predictors of patients requiring surgical debridement following diagnosis of MOE as well as long-term outcomes associated with surgical vs. medical management.

Learning Objective: Patients with poor facial nerve function were most predictive of requiring surgical management. Patient comorbidities, including severity of diabetes, were not significantly predictive of who ultimately proceeded to surgery. Surgery did not appear to impact length of stay, readmission, or overall survival.

Desired Result: Providers will be able to better identify surgical candidates when diagnosing patients with MOE and describe long-term outcomes in these patients.

Level of Evidence – Level IV

IRB: The Ohio State University, IRB #2022H0178 06/23/2022

The First Year Impact of the COVID-19 Pandemic on Otologic and Neurotologic Surgical Volumes: Disproportionate Changes in Military Practice

Nicholas J. Novak, DO; Jason K. Adams, MD
John P. Marinelli, MD; Samuel A. Spear, MD
Isaac D. Erbele, MD

Objective: The COVID-19 pandemic appears to have reduced surgical volume in otolaryngology surgeries during its first year. The objective of this study was to determine the impact on otologic and neurotologic surgical volumes in military and civilian facilities.

Study Design: Database review

Setting: Military and civilian practices

Patients: Tricare beneficiaries with Current Procedural Terminology (CPT) codes related to otologic or neurotologic surgery

Interventions: Changes in care delivered in response to the COVID-19 pandemic

Main Outcome Measures: Change in surgical volume between 2020 and averages of 2017-2019

Results: Over the study period, there were an average of 9.5 million beneficiaries covered per year. During the first calendar year of the COVID-19 pandemic, there were 4,570 otology- and neurotology-related cases performed, a reduction of 13% ($p<0.0001$, Incidence Rate Ratio = 0.87, 95% CI 0.83-0.90) compared to the three years prior (5,233 cases/yr). This reduction was principally in the cases performed in military facilities (39% reduction), rather than care delivered in civilian institutions (5% reduction, $p<0.0001$). Bone-anchored hearing aid surgeries had the greatest reduction (30%), followed by stapedectomies (27%), and vestibular surgeries (25%). Cochlear implantation was relatively stable (4% reduction), while schwannoma excision cases slightly increased (+8%).

Conclusions: There was a reduction in the number of otology and neurotology cases in 2020, and this reduction in surgical volume disproportionally affected military facilities. Lower acuity cases were affected to a greater degree, however, cochlear implantation and schwannoma excision rates appeared largely unchanged.

Professional Practice Gap & Educational Need: Lack of understanding of the impact of the COVID-19 pandemic on the volume of otology and neurotology-related cases.

Learning Objective: Describe the impact of COVID-19 related policies on otologic and neurotologic surgical volumes in military and civilian facilities, and what type of cases were impacted.

Desired Result: Recognize the types of cases affected by policies related to the COVID-19 pandemic and appreciate the disproportionate reduction in volume of cases within the military.

Level of Evidence - IV

Indicate IRB or IACUC: Exempt

Immediate Continuous Positive Airway Pressure use following Middle Cranial Fossa Repair of Spontaneous Cerebrospinal Fluid Leaks with Hydroxyapatite Bone Cement

Evan C. Cumpston, MD; Douglas J. Totten, MD
Rick F. Nelson, MD, PhD

Objective: As continuous positive airway pressure (CPAP) after skull base surgery can lead to pneumocephalus, timing for resuming CPAP postoperatively is controversial. We determined the safety of immediate CPAP use after middle cranial fossa (MCF) spontaneous cerebrospinal fluid (sCSF) leak repair with bone cement.

Study Design: Prospective cohort study.

Setting: Tertiary referral center.

Patients: 13 consecutive patients with temporal bone sCSF leaks and OSA using CPAP between July 2021 and October 2022. Postoperative high-resolution temporal bone CT was obtained to assess skull base reconstruction followed by immediate CPAP use.

Interventions: Patients were instructed to resume CPAP use immediately following repair of sCSF leaks with bone cement.

Main Outcome Measures: Postoperative skull base defects on CT, pneumocephalus or intracranial complications.

Results: There were no residual skull base defects on postoperative imaging. Average age was 55.5 [standard deviation] [±8.8] years. 30.8% (4) subjects were male, 69.2% (9) female. The average BMI was 45.39 [±15.1]. 53.8% (7) of repairs were right and 46.2% (6) were left. 53.9% of patients had multiple defects identified intraoperatively. The average number of defects was 1.85 [±0.99]. The average defect size determined by preoperative imaging was 6.57mm [±3.45]. All patients had encephalocele identified intraoperatively. All skull base repairs were primary. No postoperative complications occurred. One patient developed a contralateral sCSF leak 2 months following repair. There were no recurrent sCSF leaks.

Conclusions: Immediate postoperative CPAP use is safe in patients undergoing MCF sCSF leak repair with bone cement due to the robust skull base repair.

Professional Practice Gap & Educational Need: As use of CPAP after skull base surgery can lead to pneumocephalus, timing for resuming CPAP postoperative is controversial.

Learning Objective: To determine the safety of immediate CPAP use after middle cranial fossa spontaneous cerebrospinal fluid leak repair with bone cement.

Desired Result: Determine the safety of immediate CPAP use after MCF repair of sCSF leaks with bone cement.

Level of Evidence - III

Indicate IRB or IACUC : Exempt

Evaluation of Hydroxyapatite Use in CSF Leak Repair during Skull-Base Surgery

Rema Shah, BS; Sen Ninan, MD; Hemali Shah, BS
Nofrat Schwartz, MD

Objective: To evaluate the efficacy and outcomes of using a transmastoid approach with hydroxyapatite to repair lateral skull-base CSF leak

Study Design: Retrospective cohort study

Setting: Tertiary-level-care hospital

Patients: Patients aged 18+ who underwent surgery between 2013-2022 for spontaneous CSF leak

Interventions: trans-mastoid approach for skull-base repair using Hydroxyapatite cement

Main Outcome Measures: failure rate of repair; location, size and patient demographic factors of all repairs

Results: Of the 55 patients (60 total repairs, 5 bilateral repairs) that underwent CSF leak repair using hydroxyapatite cement, 50 patients had successful repairs (91.9%) and 5 patients had failed repairs (9.1%). The average defect size in failed repairs was 1.12cm, compared to 0.81cm for successful repairs. Additionally, 4 out of 5 (80%) of the failed repairs were in the tegmen tympani region. Average time to recurrent symptoms was 1.75 years in the failed repair cohort. 4 out of the 5 (80%) patients with failed repairs were given Diamox prior to their second procedure. 3 out of those 5 (60%) were in women and 4 out of 5 (80%) were former smokers. 3 patients (5.4%) received shunts to relieve cranial pressure. 2 patients (3.6%) had complications of either infection or hearing loss.

Conclusions: Transmastoid approach utilizing Hydroxyapatite is successful for CSF leak repair, with a low complication and failure rate. Women, prior smoking history and patients with larger defects in the tegmen tympani region may opt for alternative materials or approach for repair. Longer follow-up is warranted as recurrence of symptoms might be delayed. In cases of BIH, shunt placement may prevent failures.

Professional Practice Gap & Educational Need: Hydroxyapatite is not a traditionally utilized material for CSF leak repair and this study helps to elucidate its growing value in skull base surgery.

Learning Objective: Investigate and understand the patient population best served with hydroxyapatite

Desired Result: Raise awareness about the operative success of transmastoid approach with hydroxyapatite as a repair material

Level of Evidence - Level IV

Indicate IRB or IACUC: EXEMPT

Yale School of Medicine, IRB ID: 2000032898; Board determined study EXEMPT on 5/16/2022

Quantification of Fat Graft Retention in the Translabyrinthine Approach Using MRI Volumetric Analysis

Adam S. Vesole, MD; Scott B. Shapiro, MD; Ravi N. Samy, MD
Myles L. Pensak, MD; Joseph T. Breen, MD

Objective: To better characterize the viability of autologous free fat grafts over time, determine clinical/patient factors that may affect free fat graft survival and assess the clinical impact of free fat graft survival on patient outcomes in the translabyrinthine approach for lateral skull base tumor resection.

Study Design: Retrospective chart review.

Setting: Tertiary neurotologic referral center.

Patients: Forty-two patients (≥18 years old) who underwent translabyrinthine approach for tumor resection with mastoid defect filled by autologous abdominal fat graft, and subsequently underwent > 1 post-operative brain MRI scans.

Intervention(s): Microsurgical resection of tumor, post-operative MRIs

Main Outcome Measure(s): Rate of fat graft volume loss; Fraction retention of original fat graft volume; Initial fat graft volume; Time to steady state fat graft retention; Rate of post-operative CSF leak and/or pseudomeningocele formation.

Results: Patients were followed post-operatively with MRI for a mean of 31.6 months with a mean of 3.2 post-operative MRIs per patient. Initial graft size was a mean of 18.7 cm^3 with a steady state fat graft retention of 35.5%. Steady state graft retention (<5% loss per year) was achieved at mean of 24.96 months post-operatively. No significant association was found in multivariate regression analysis of clinical factors (BMI, age, sex, diabetes mellitus, smoking history, tumor size) impact on fat graft retention and CSF leak/pseudomeningocele formation. Additionally, initial fat graft size, rate of fat graft resorption and percent retention at steady state did not significantly impact the CSF leak/pseudomeningocele formation.

Conclusions: There is a statistically significant logarithmic decline in fat graft volume over time in mastoid defects, reaching steady state in 2 years with 35.5% retention. Rates of CSF leak and pseudomeningocele formation were not significantly affected by initial fat graft volume, rate of fat graft resorption or percent retention at steady state. Additionally, no analyzed clinical factors significantly influenced fat graft retention over time.

Professional Practice Gap & Educational Need: Autologous free fat grafts are routinely used for translabyrinthine mastoid defects, but the clinical implications of initial fat graft size and viability are not well understood.

Learning Objective: To characterize the viability of autologous free fat grafts in the mastoid cavity and any clinical/surgical factors that may influence graft resorption. To determine the impact of fat graft size and viability on the rate of CSF leak or pseudomeningocele formation.

Desired Result: Understanding that size and viability of the fat graft may not significantly increase the risk of CSF leak or pseudomeningocele formation. Additionally, knowledge of a logarithmic pattern of fat graft resorption may be useful to other otolaryngology fat graft applications.

Level of Evidence – IV

Indicate IRB or IACUC: IRB #2020-0472, Approved 6/24/2020, University of Cincinnati

Severe and Profound Hearing Loss in Patients with Multiple Sensory Impairments: Increased Incidence of Cognitive Impairment

Jacob C. Lucas, MD; Alexandra M. Arambula, MD; Katherine Yu, MD
Jason Lee, MD, PhD; Linda D'Silva, PT; Jennifer A. Villwock, MD
Hinrich Staecker, MD, PhD

Objective: Determine odds of incident cognitive impairment among patients with severe to profound hearing loss and co-existing multisensory impairment.

Study Design: Prospectively recruited cross-sectional case-control study

Setting: Tertiary care neurotologic/audiologic outpatient clinic

Patients: 14 prospectively recruited aging (age 50+) patients with severe and profound hearing loss were pooled for analysis with 180 previously enrolled patients with demonstrated multisensory impairment.

Interventions: Patients with severe and profound hearing loss were identified and underwent point-of-care multisensory testing and cognitive testing.

Main Outcome Measures: Multisensory testing using the Affordable, Rapid Olfactory Measurement Array (AROMA) for olfaction, pure tone audiometric evaluations, and the Timed 'Up and Go' test for gait and balance. Cognitive impairment was assessed via the Montreal Cognitive Assessment for the hearing impaired (HI-MoCA).

Results: A total of 194 patients were included. 34% (n=66) screened positive for cognitive impairment. Olfactory dysfunction, gait impairment, and sensorineural hearing loss were all significantly ($p<0.05$) associated with higher odds of cognitive impairment (ORs 3.17, 3.71, and 3.23, respectively in a multivariate model). Subjects with dysfunction in all domains were at highest risk for cognitive impairment (OR 15.2, $p < .001$) compared to impairment in 2 domains (OR 5.09, $p < .001$). Severe and profound hearing loss had higher odds (OR 8.32) compared to mild-moderately severe hearing loss (OR 2.81) of having incident cognitive impairment.

Conclusions: Dysfunction of the olfactory, auditory, and balance systems is associated with significantly increased odds of cognitive impairment. Patients with severe and profound hearing loss were more likely to have cognitive impairment.

Professional Practice Gap & Educational Need: There is emerging evidence that hearing loss increases the risk for development of dementia later in life. Other sensory domain deficits are similarly associated with dementia. Earlier intervention and rehabilitation of sensory losses such as hearing may theoretically decrease this risk. More prospective and long-term cohort studies are needed to further characterize this link.

Learning Objective: To demonstrate the link between hearing loss and incident cognitive impairment in aging adults, and to further characterize the role of multiple sensory impairments as additive in their effect on cognition.

Desired Result: Participants will have an improved understanding of multisensory impairment and the risk of cognitive impairment.

Level of Evidence – Level III

Indicate IRB or IACUC : University of Kansas Medical Center IRB #145682).

Disparities in Sporadic Vestibular Schwannoma Initial Presentation Between a Public Safety Net Hospital and Private Hospital at the Same Zip Code 2010-2020

Raffaello M. Cutri; Dorothy W. Pan, MD, PhD
Joshua Lin; Joni K. Doherty, MD, PhD

Objective: Evaluate initial vestibular schwannoma presentation disparities in patient populations presenting to a public safety net hospital (PSNH) versus tertiary academic medical center (TAMC) in the same zip code.

Study Design: Retrospective chart review.

Setting: TAMC and affiliated PSNH

Patients: All patients (n=545) >18 years presenting for initial evaluation of vestibular schwannoma between 2010-2020 at TAMC (n=475) and affiliated PSNH (n=70).

Main Outcome Measures: Ethnicity, insurance, maximum cerebellopontine angle (CPA) and internal auditory canal (IAC) tumor size, hearing status, and initial treatment recommendation.

Results: Average age at diagnosis was not significantly different at 51.5±13.8 (TAMC) vs. 52.3±12.3 (PSNH) years old. 57% (TAMC, n=272) and 51% (PSNH, n=36) patients were female. As anticipated, significant differences in patients ' insurance existed with majority (73.1%) privately insured at TAMC while majority (77.1%) Medicaid at PSNH. The racial and ethnic profile of patients were also significantly different with TAMC having 63.2% White and 8.2% Hispanic/Latinx patients, while PSNH having only 4.3% White but 58.6% Hispanic/Latinx patients. Average maximum CPA or IAC+CPA tumor size was larger at PSNH (24±13mm) than TAMC (21±9mm) but not significantly different; however, hearing status was significantly more impaired at PSNH than TAMC with mean pure tone average 53dB vs 43dB, respectively, and word recognition score 53% vs 68%, respectively. Initial treatment recommendations may have included more than one option, with TAMC patients offered 66.5% surgery, 31.4% observation, and 5.1% radiation, while PSNH patients offered 51.4% observation, 48.6% surgery, and 8.6% radiation.

Conclusions: Hearing status was worse in patients presenting to PSNH than TAMC, and tumor size was larger on presentation to PSNH though not statistically significant. Despite worse hearing status and larger tumor size, the majority of PSNH patients were initially offered observation compared to TAMC where most patients were initially offered surgery.

Professional Practice Gap & Educational Need: There exists a significant gap in the literature demonstrating how racial and socioeconomic status influence vestibular schwannoma presentation and outcome. The way these factors affect initial vestibular schwannoma presentation and evaluation in a public safety net hospital versus tertiary academic medical center in the same zip code has not been established.

Learning Objective: To increase understanding and awareness of how demographic and socioeconomic factors influence vestibular schwannoma presentation and outcomes.

Desired Result: Given that racial and socioeconomic factors contribute to healthcare outcomes, we hope to further elucidate these disparities when comparing initial vestibular schwannoma presentation and treatment recommendation in tertiary academic medical center and public safety net hospital patient populations.

Level of Evidence – Level IV – Historical cohort or case-control studies

Indicate IRB or IACUC : IRB Exempt (University of Southern California HS-21-00412, 8/4/2021)

Cytokine Profiling of Cerebrospinal Fluid and Cyst Fluid in Cystic Vestibular Schwannoma

Vivek V. Kanumuri, MD; Eric Nisenbaum, MD
Olena Bracho, BS; Tricia Scaglione, AuD
Rita Bhatia, MD; Fred F. Telischi, MD
Christine T. Dinh, MD

Hypothesis: Profiling of cyst fluid from cystic vestibular schwannoma (VS) will reveal increased levels of inflammatory cytokines

Background: There is evidence that cystic VS have increased peritumoral adhesion to surrounding structures such as the facial nerve. This may be secondary to factors within the tumor microenvironment (TME) that promote inflammation, increased vascularity, and tumor progression. Cytokines can take on several of these functions in the TME such as (1) polarization of macrophages, (2) induction of angiogenesis. Here, we analyze the cytokine profile of cyst fluid from patients with cystic VS and describe macrophage phenotypes within tumor

Methods: Tumor, CSF, and cyst fluid were collected from cystic VS patients from 2018 to 2022. Eighty cytokines were measured using a human cytokine array. Immunofluorescence was performed for CD80 and CD16 to detect macrophage subtypes within the tumor. Descriptive statistics and paired t-tests were used to compare cyst fluid features to surrounding CSF and to CSF from normal controls.

Results: Although CSF and cyst fluid demonstrate similar cytokine profiles overall, cyst fluid had greater protein expression levels ($p<0.0001$). Specifically, cytokines implicated in angiogenesis (angiogenin, TIMP) and macrophage polarization (IL-8, MCP-1, IGFBP-2, NAP-2, OPN) were noted to be present at high levels. In addition, immunofluorescence of tumor specimens demonstrated the presence of pro-tumorigenic macrophages.

Conclusion: CSF and cyst fluid from cystic VS patients expressed cytokines that have been linked to tumor progression and pro-tumor macrophage polarization. CSF and cyst fluid demonstrated similar cytokine profiles, suggesting analyzing CSF can provide information about the VS TME.

Professional Practice Gap & Educational Need: Knowledge of cystic vestibular schwannoma characteristics

Learning Objective: The audience will understand factors that may promote tumor adherence in cystic vestibular schwannoma

Desired Result: Increased practitioner understanding of vestibular schwannoma tumor biology

Level of Evidence – N/A

Indicate IRB or IACUC : University of Miami Institutional Review Board approved protocol (#20150637).

An Update on the Epidemiology and Clinicodemographic Features of Meniere's Disease

Emma De Ravin, BS; Alexandra E. Quimby, MD, MPH; Michael Bartellas, MD
Sydnie Swanson, BS; Douglas C. Bigelow, MD; Jason A. Brant, MD
Michael J. Ruckenstein, MD

Objective: To characterize clinicodemographic features of Ménière's disease (MD) using current diagnostic criteria.

Study Design: Retrospective case-control.

Setting: Tertiary academic center.

Patients: Cases were patients seen in otorhinolaryngology clinic with MD diagnoses meeting AAO-HNS diagnostic criteria. Controls were patients without MD seen at any outpatient clinic, matched by year of encounter, from 1/1/2012–7/31/2022.

Results: Of 806 patients screened using ICD-10 codes for MD, we identified 480 cases—168 definite and 312 probable. We identified 499 matched controls. The mean age at initial presentation for cases and controls was 49 and 51 years, respectively. Forty-seven percent of cases and 37% of controls were male (p=0.002). MD cases had a significantly higher proportion of white patients (79% versus 68%, p<0.0001) and significantly lower proportion of black patients (5% versus 19%, p<0.0001). The mean time since MD symptom onset was 6.7 years, with a mean attack duration of 4.6 hours; 25% reported a positive family history, and 7% had bilateral disease. Fluctuating symptoms reported during attacks were tinnitus (87%), aural fullness (66%), and hearing (83%). The proportion of patients with a history of headaches, including migraines, was similar between cases (44%) and controls (43%). MD patients were significantly less likely to have renal and autoimmune conditions (p=0.006; p=0.002) but similarly likely to have cardiac comorbidities (p=0.223).

Conclusions: There is a low prevalence of true MD, and even lower prevalence of definite MD, among patients with recorded MD diagnoses. We present an updated review of the epidemiology of MD, and have identified distinguishing clinicodemographic features of this population.

Professional Practice Gap & Educational Need: Most past descriptive studies of MD were performed prior to the implementation of current diagnostic criteria, and thus likely include and are confounded by patients with vestibular migraine and those that would not meet today's diagnostic criteria. The true epidemiology of MD is not yet understood.

Learning Objective: To describe the clinicodemographic presentation of a true MD cohort when compared with a control population of patients without MD seen at any outpatient clinic at our institution over the same time period.

Desired Result: To provide an updated understanding of the epidemiology of MD, including demographics, comorbid conditions, and prevalence of definite MD, probable MD, and misdiagnoses using updated AAO-HNS 2015 diagnostic criteria.

Level of Evidence: Level IV

Indicate IRB or IACUC: Approved by the University of Pennsylvania Institutional Review Board. Approval #831279.

Audiologic Outcomes for Cochlear Implant Recipients Following CT Modeling of Electrode Array Position Intervention

C. Cooper Munhall, MD; Christian M. Shannon, MS
Benoit M. Dawant, PhD; Jack H. Noble, PhD; Theodore R. McRackan, MD
Kara Leyzac, AuD, PhD; Robert F. Labadie, MD, PhD

Objective: Determine differences in audiologic outcomes between two cohorts of cochlear implant (CI) recipients before and after implementation of image-guided cochlear implant programming (IGCIP) which uses post-op CT scans to map electrode position for patient-specific CI programming.

Study Design: Retrospective review of audiologic outcomes for CI recipients before (2018-2019) and after (2019-2020) implementation of IGCIP.

Setting: Tertiary-care academic medical center.

Patients: 101 adult CI recipients.

Intervention(s): CI programming without knowledge of post-op electrode location (2018-2019 group) and with knowledge of post-op electrode location (2019-2020 group).

Main Outcome Measure(s): Pre- and post-operative CNC and AzBio in quiet scores. Cohen's d used to express effect size (ES).

Results: Improvements from baseline in CNC and AzBio in quiet scores at 3-, 6-, 12-, and 24-month follow-ups were observed in the 2019-2020 cohort compared with the 2018-2019 cohort yet were statistically insignificant. The largest difference between cohorts was at 24-months for both CNC (+11.4%, d=0.46, 95% CI -0.21, 1.15) and AzBio in quiet (+19.2%, d=0.57, 95% CI -0.05, 1.21).

Conclusions: While improvements were statistically insignificant in our relatively small cohorts, the medium ES for difference in 24-month AzBio in quiet scores and approaching medium ES for difference in 24-month CNC scores may yield significant results with larger sample sizes. Prior work evaluating individuals undergoing IGCIP after standard programming demonstrated that many individuals show substantial improvement with very few not improving. These most recent findings support that IGCIP may be, at a minimum, substantially equivalent to standard CI programming. Further investigation into how IGCIP is used by audiologists and larger prospective studies of implementation are warranted.

***Professional Practice Gap & Educational Need:** CI outcomes vary widely among recipients. Patient-specific electrode mapping and programming might decrease cross-channel interactions and improve hearing outcomes.

***Learning Objective:** Appreciate the potential utility of patient-specific CI electrode mapping for individualized audiologic programming.

***Desired Result:** Increase awareness of image-guided electrode mapping for individualized CI programming.

***Level of Evidence –** Level

***Indicate IRB or IACUC:** Medical University of South Carolina IRB #00049700

Positive Correlation between Quality of Life and Speech Recognition Outcomes following Cochlear Implantation

Christina Dorismond, MD, MPH; Ankita Patro, MD, MS
Jourdan T. Holder AuD, PhD; Elizabeth L. Perkins, MD

Objective: To investigate the relationship between Cochlear Implant Quality of Life-10 Global (CIQOL-10) and speech recognition scores 6 and 12 months after cochlear implantation (CI).

Study Design: Retrospective cohort.

Setting: Tertiary referral center.

Patients: 124 patients undergoing CI between 2018-2020 who completed CIQOL-10 questionnaire at 6 and/or 12 months.

Main Outcome Measures: CIQOL-10, CNC and AzBio in quiet and noise scores. Institution benchmark scores for CNC were 38% and 48% at 6 and 12 months, respectively. Institution benchmark scores for AzBio in quiet were 40% and 52% at 6 and 12 months, respectively.

Results: Median CIQOL-10 scores were 31.5 (IQR: 28.8-37.3) at 6 months and 34.0 (IQR: 29.0-37.5) at 12 months with a median improvement of 8.0 (IQR 6.0-12.3) at 6 and/or 12 months (n=34). Six months following implantation, there was a positive correlation between quality-of-life and CNC (r=0.248, p=0.029) and AzBio in quiet (r=0.300, p=0.011), and at 12 months, there was a positive correlation between quality-of-life and CNC (r = 0.343, p<0.001), AzBio in quiet (r=0.291, p=0.006), and AzBio in noise (r=0.290, p=0.046) scores. Patients who met benchmark CNC scores scored significantly greater on CIQOL-10 than those who did not at 6 months (33.7 vs 29.6, p=0.009) and 12 months (34.2 vs 29.5, p=0.001). Those who met benchmark AzBio scores demonstrated a similar relationship with CIQOL-10 at both 6 (33.8 vs 29.0, p=0.007) and 12 months (33.8 vs 29.8, p=0.010).

Conclusions: CIQOL-10 and speech recognition outcomes are positively correlated 6 and 12 months after CI. Patients who met benchmark speech recognition scores had significantly greater quality-of-life scores.

Professional Practice Gap & Educational Need: The relationship between the validated CIQOL-10 and speech recognition outcomes has yet to be established. There is also a lack of knowledge regarding the quality of life for those who meet benchmark score on speech recognition measures versus those who do not meet benchmark scores.

Learning Objective: Attendees will understand the relationship between quality of life and speech recognition scores and be able to compare quality of life scores for those who meet benchmark speech recognition measures scores and those who do not.

Desired Result: Attendees will recognize that there is a positive correlation between CIQOL-10 and speech recognition outcomes post-cochlear implantation. They will also understand that those who are meet benchmark scores have higher quality of life than those who do not meet benchmark scores.

Level of Evidence – IV

Indicate IRB or IACUC : Vanderbilt University Medical Center #221833

National Trends in Cochlear Implantation Across the Department of the Defense: A Case for Inclusion as a General Otolaryngology Core Competency

Jason K. Adams MD; John P. Marinelli MD; Russell W. DeJong MD
Samuel A. Spear MD; Isaac D. Erbele MD

Objective: With ongoing national expansions in cochlear implantation (CI) candidacy criteria, more patients qualify for CI today than ever before. Among United States veterans and military servicemembers, the prevalence of qualifying degrees of hearing loss secondary to occupational noise exposure exceeds the general population. The primary aim of the current work was to evaluate CI trends across the military health system.

Study Design: Database review.

Setting: Military and civilian practices.

Patients: Department of Defense (DoD) beneficiaries who underwent CI.

Main Outcome Measures: CI rates between 2010-2019.

Results: A total of 3,573 cochlear implants were performed among DoD beneficiaries from 2010-2019. The majority of patients were ≥64 years of age (55%), with the next most commonly implanted age group being 0-4 (14%). From 2010-2019, annual CI increased at a rate of 7% per year (Pearson's correlation $r=0.97$, $p<0.0001$). CIs performed within military practices increased at a similar rate of 6% per year ($r=0.77$, $p=0.009$).

Conclusions: Although the number of devices implanted is rapidly increasing among DoD beneficiaries, current utilization rates forecast that it would take over 30 years before all of those who qualify actually receive cochlear implants. A similar projection likely exists across the general public, especially considering the aging demographic in the West and continual expansions in FDA labeling. These data suggest that widespread expansion of the procedure to general otolaryngology practices will be required to meet current and future demands for CI. For this reason, CI should be considered for "key indicator" designation among residency training programs.

Professional Practice Gap & Educational Need: Data surrounding cochlear implant utilization among the general United States population suggest widespread underutilization. However, there is little to date that characterizes current trends among DoD beneficiaries, or informs future projections surrounding the improvement of utilization rates.

Learning Objective: Describe rates of CI across the United States military health system between 2010-2019.

Desired Result: Practitioners and researchers would appreciate that current trends show year-over-year increase in CI, but it is likely insufficient to address underutilization. To improve utilization rates in the United States, consideration should be given to steps necessary for a significant revamp of practice patterns.

Level of Evidence: IV

Indicate IRB or IACUC: This research was deemed IRB exempt.

Risk Factors and Outcomes in Pediatric Patients Undergoing Stapedotomy

David S. Lehmann, MD; Madelyn Wang, BS; Ewen Chao, MD
Robert Saadi, MD; Huseyin Isildak, MD

Objective: To report our outcomes on the efficacy of stapes surgery in the pediatric population

Study Design: Retrospective study

Setting: Single-institution, academic tertiary care center

Patients: Patients aged <21 who underwent stapedotomy between September 2013 and July 2020.

Interventions: Stapedotomy with perichondrial graft and bucket handle prosthesis

Main Outcome Measures: Postoperative Air Bone Gap (ABG) at 3 months

Results: 20 patients (13 female and 7 male), age 6 to 20, were included. 50% had unilateral disease and 50% had bilateral disease. 2 patients had a family history of hearing loss, 13 had a history of a previous otologic procedure, with 1 having previously had a stapes surgery. Mean preoperative ABG was 34.5 dB (SD 11). 4 patients did not have postoperative audiograms available. At three months, the mean postoperative ABG was 20.6 dB (SD 10.2), with a mean improvement in ABG of 17.0 dB (SD 12.1). 64% of patients had a closure of their ABG to 20dB or less. Patients with previous otologic surgery had less improvement in ABG, although this did not meet statistical significance ($p = 0.139$). Other complications included 1 patient who had an intraoperative TM perforation, 1 patient had severe postoperative dizziness, and 1 patient required revision surgery for adhesions.

Conclusions: Pediatric stapedotomy can be effective and safe. Unlike our previously published results in adult patients, age within the pediatric population did not show correlation to improvement in ABG. Patients with previous otologic surgery may have had a worse outcome, although our small sample size was unable to show significance for this.

Professional Practice Gap & Educational Need: Performing stapes surgery in the pediatric population still remains controversial. Additional studies are needed to demonstrate safety and efficacy of pediatric stapedotomy and to elucidate appropriate patient populations for surgery.

Learning Objective: To understand the audiometric and demographic data of pediatric otosclerosis patients. Increase providers' familiarity with outcomes of pediatric stapedotomy.

Desired Result: Encourage practitioners to pursue stapedotomy in appropriate pediatric patients.

Level of Evidence: IV

Indicate IRB or IACUC : Penn State Hershey Medical Center IRB (STUDY00014969)

MRI Enhancement Patterns after Resection of Sporadic Vestibular Schwannoma

Olivia La Monte, BS; Joshua Lee, BS; Peter R. Dixon, MD MSc
Omid Moshtaghi, MD MS; Marc Schwartz, MD; Rick A. Friedman, MD, PhD

Objective: Compare MRI enhancement patterns following retrosigmoid and translabyrinthine vestibular schwannoma (VS) resection.

Study Design: Cohort study.

Setting: Tertiary center.

Patients: 185 patients who underwent resection (93 retrosigmoid, 92 translabyrinthine) of sporadic VS and ≥ 2 postoperative contrast-enhanced MRIs.

Interventions: VS resection.

Main Outcome Measures: Qualitative analyses of enhancement patterns. Adjustment for tumor size by multivariable logistic regression.

Results: After surgeon-reported gross total resection, linear enhancement was present in 24/141 (17.0%) and nodular enhancement in 2/141 (1.4%) cases. Both patterns showed high rate of spontaneous resolution, with 3/24 (12.5%) of linear enhancements persisting on ≥ 2 scans and no nodular enhancements (0/2) persisting. Among patients with less than gross total resection, when present, nodular enhancement was more likely to persist (3/5, 60.0%) than linear enhancement (3/8, 38.0%, $p<0.001$). Approach was not associated with odds of nodular enhancement (OR for retrosigmoid vs. translabyrinthine 0.36, 95%Cl 0.05-1.89, $p=0.2$). Gross total resection was associated with reduced odds of nodular enhancement for translabyrinthine (OR 0.07, 95%CI 0.00-0.63, $p=0.04$) but not retrosigmoid (OR 0.09, 95%CI 0.00-2.76, $p=0.13$).

Conclusions: Postoperative enhancement should be interpreted in the context of surgeon-reported resection extent. When gross total resection is reported, a high rate of spontaneous resolution is observed regardless of enhancement pattern. With less than gross total resection, nodular enhancement is more likely to persist. Retrosigmoid approach does not appear to be associated with increased risk of residual, but the surgeon may better predict resection completeness with the translabyrinthine approach.

Professional Practice Gap & Educational Need: In VS patients, MRI surveillance is the imaging of choice for monitoring tumor recurrence after resection, although the protocol remains unclear. Furthermore, little research has been done utilizing MRI to determine regrowth across tumor resection approaches. The retrosigmoid approach has the disadvantage of not being able to see tumor at the fundus, which means tumor might be left behind unknowingly. We evaluated the differences in enhancement of two approaches to better understand the relationship between resection approach and likelihood of tumor regrowth.

Learning Objective: The audience can utilize the findings of our study to assist in their evaluation risk of tumor regrowth in VS patients post resection via retrosigmoid or translabyrinthine approach using MRI with contrast.

Desired Result: The goal of our study is to present additional data surrounding the gold standard for tumor surveillance post operatively and better identify patterns of tumor regrowth for varying approaches.

Level of Evidence - III

Indicate IRB or IACUC: IRB: 180978; University of California, San Diego; Approved 10/3/2018

Audiometric Outcomes following the Middle Cranial Fossa Repair of Superior Semicircular Canal Dehiscence

Hong-Ho Yang, BS; Isaac Yang, MD; Quinton S. Gopen, MD

Objective: To evaluate the audiometric outcomes following the middle cranial fossa approach (MCF) for superior semicircular canal dehiscence (SCD) repair

Study Design: Retrospective review

Setting: Tertiary referral center

Patients: Cases from 2012 to 2022 with sufficient, properly calibrated preoperative and postoperative audiogram data

Interventions: The MCF repair of SCD

Main Outcome Measures: Air conduction threshold (AC), bone conduction threshold (BC), and air bone gap (ABG) at each frequency, pure tone average (PTA) (AC 500-3000Hz)

Results: Among 202 repairs, 57% were bilateral SCD disease and 9% had prior surgery on the affected ear. The approach significantly narrowed ABG at 250Hz, 500Hz, and 1000Hz. The narrowing of ABG was achieved by both decreased AC and increased BC at 250Hz, but mediated primarily by increased BC at 500Hz and 1000Hz. PTA remained in the normal range for cases without prior ear surgery (mean 21dB preop, 24dB postop). PTA remained in the mild hearing loss range for cases with prior ear surgery (mean 33dB preop, 35dB postop).

Conclusion: This is the largest study examining the audiometric outcomes following the MCF approach for SCD repair. Findings of this investigation support that the approach is effective and safe with long-term hearing preservation for most.

Professional Practice Gap & Educational Need: Low case numbers in prior series (n<50) with overall conflicting results.

Learning Objective: To understand the mechanism, magnitude, and direction of change in audiogram metrics following the procedure.

Desired Result: Evidence presented in this study can inform surgeons' perioperative considerations and counseling.

Level of Evidence: V

Indicate IRB or IACUC: UCLA #22-000259

Idiopathic Intracranial Hypertension in Patients with and without Pulsatile Tinnitus: Clinical Correlates

Jatin P. Vemuri, BS; Jonathan R. Widmeyer, BA; Jonathon Jacobs, BS
Aristides Sismanis, MD; Warren Felton, MD; Scott Haines, MD
Daniel H. Coelho, MD

Objective: Pulsatile tinnitus (PT) is very common in patients with idiopathic intracranial hypertension IIH. However, little is known about why some patients with IIH develop PT and others do not. The purpose of this study is to determine which clinical findings associated with IIH differ between patients with and without pulsatile tinnitus (PT), potentially elucidating a pathophysiologic mechanism.

Study Design: Retrospective, age-matched, cohort study

Setting: Tertiary referral center

Patients: Adults seen in an outpatient neuro-ophthalmologic IIH clinic diagnosed by modified Dandy criteria, with documented presence/absence of PT.

Main Outcome Measures: BMI; blood pressure; Humphrey's visual field mean deviation; visual acuity; retinal nerve fiber layer (RNFL) measured on OCT scan; pre-treatment CSF opening pressure; sleep apnea; snoring; migraines; headaches; transient visual obscurations (TVOs); dizziness; trigeminal neuralgia; facial paralysis

Results: Statistical analysis found no significant difference in CSF opening pressure, (33.6 vs. 33.5, p=.956). Differences were found in BMI (45.1 vs. 37.7, p =.003), pulse pressure (60.1 vs. 51.6, p =.020), snoring (65% vs. 42%, p =.044), sleep apnea (60% vs. 15%, p < .001) and migraines (70% vs. 37.5%, p =.003). Multivariate analysis showed that sleep apnea (adjusted odds ratio 13.9, 95%CI (2.3, 83.5)), migraines (4.1, 95%CI (1.2, 13.9)), and BMI(1.085, 95%CI (1.008, 1.168)) were all independently associated with PT.

Conclusions: Counterintuitively, Presence of pulsatile tinnitus does not correlate with severity of intracranial hypertension. However, PT is highly associated with obesity and its sequelae.

Professional Practice Gap & Educational Need: Currently the causative factors of pulsatile tinnitus within the context of IIH are poorly defined. These data are important for increasing understanding of the pathophysiologic process involved in this symptom.

Learning Objective: At the conclusion of this presentation, participants should be able to recognize the clinical correlates of IIH that are most associated with pulsatile tinnitus in this patient population.

Desired Result: Providers will have additional knowledge about clinical factors that may influence the presence or absence of pulsatile tinnitus in the IIH patients. These results may be able to guide additional symptomatic treatment that was not previously clear.

Level of Evidence - Level III

Indicate IRB or IACUC : VCU Health IRB: HM20020839 - Exempt

Superior Semicircular Canal Dehiscence Repair using Cement via a Transmastoid Approach

Hemali P. Shah, BS; Jacqueline Ihnat, BS; Sen Ninan, MD
Allison Reeder, MD; Nofrat Schwartz, MD

Objective: To assess the efficacy of superior semicircular canal dehiscence (SSCD) repair via a transmastoid approach using hydroxyapatite bone cement capping.

Study Design: Retrospective case series.

Setting: Tertiary referral center.

Patients: Patients ≥18-years-old diagnosed with SSCD between 2012-2022.

Interventions: Transmastoid approach with hydroxyapatite bone cement capping.

Main Outcome Measures: Failure rate (lack of symptom resolution or dehiscence on postoperative imaging) and/or need for revision surgery. Dehiscence location and size were assessed from preoperative CT temporal bone scans.

Results: Nineteen patients (22 ears) were included. Mean age was 52.2 years (SD=9.5 years) with 47.4% female patients (n=9). Predominant location of SSCD was apical (72.7%, n=16), followed by posterior limb (9.1%, n=2) and anterior limb (9.1%, n=2); dehiscence location was determined to be posterior-apical for two ears (9.1%). Mean dehiscence size was 2.9 mm (SD=1.4 mm). Median follow-up time was 12.5 months (IQR:3.8-37.0 months). Failure rate was 9.1% (n=2). Both cases demonstrated persistent SSCD on postoperative imaging; one case had an apical dehiscence of 1.6 mm persistent at 4 months, and one had a posterior-apical dehiscence of 2.3 mm persistent at 8 months after surgery. No patients experienced postoperative complications.

Conclusions: Transmastoid approach for SSCD repair with hydroxyapatite bone cement capping has a relatively low failure rate alleviating the need for middle fossa approach. No pattern was identified among failed cases of SSCD repair for this approach. To our knowledge, this case series represents the largest for this approach and material combination for SSCD repair, demonstrating that transmastoid repair with bone cement represents a promising approach for effective management of patients with SSCD.

Professional Practice Gap & Educational Need: Given that SSCD is a rare, relatively newly introduced condition, there is a need to accumulate knowledge and share experiences of different surgical treatment methods in order to identify the best options for patient care. There is a paucity of literature on the transmastoid approach with bone cement repair of SSCD.

Learning Objective: We aim to provide attendees with exposure to the technique of transmastoid repair of SSCD with hydroxyapatite bone cement and the impact of this outcome on symptom resolution and imaging confirmation of successful repair.

Desired Result: We aim to have attendees consider implementing the transmastoid approach and hydroxyapatite for SSCD repair in their future patient care.

Level of Evidence - Level V

Indicate IRB or IACUC : This study (IRB#2000032898) was deemed exempt on 5/16/2022.

Use of a Soft Cervical Collar Improves Surgeon Ergonomics during Otologic Surgery

Sunder Gidumal, MD; Mia Saade, BA; Zachary Schwam, MD
Kevin Wong, MD; Maria Mavrommatis, MD; Enrique Perez, MD
Maura K. Cosetti, MD

Objective: To determine whether surgeon use of a soft cervical collar during endoscopic and microscopic otologic surgery is feasible and impacts surgeon ergonomics as measured by inertial sensors

Study Design: Prospective, randomized, cross-over trial

Setting: US-based otolaryngology training program

Patients: Otolaryngology residents and fellows

Interventions: Use of a soft cervical collar during simulated otologic surgery

Main Outcome Measures: Time spent in high-risk angles of neck and back flexion and extension; average angle of neck flexion, extension, rotation, and lateral bending; validated assessment of neck pain; average daily phone use

Results: 15 subjects met criteria for inclusion. 10/15 (67%) were male. 7/15 (47%) were PGY1-2. 7/15 (47%) reported a history of neck pain. None reported prior spinal steroid injections or surgery. Across all subjects, use of the soft cervical collar significantly reduced time spent in high-risk angles of neck flexion/extension during both endoscopic (56% vs 35%, $p<0.05$) and microscopic (60% vs 32%, $p<0.05$) otologic surgery. There was no effect on back flexion or extension. There was no difference in time spent in high-risk neck or back angles between endoscopic and microscopic surgery. Average angles of neck or back flexion, extension, lateral bending, and rotation were not significantly different for subgroups with more operative experience, increased phone use, perception of good posture, or history of neck pain.

Conclusions: Use of a soft cervical collar during simulated otologic surgery significantly reduced time spent in high-risk neck positions. These data support feasibility of soft collar use during otologic surgery and hold promise for reduction in the high rates of neck pain reported by neurotologists.

Professional Practice Gap & Educational Need: Improving surgeon ergonomics for otologic surgery

Learning Objective: To identify a therapeutic intervention to mitigate neck pain in surgeons caused by assumption of high-risk cervical neck flexion and extension

Desired Result: To demonstrate that use of a readily-available soft cervical collar reduces risk of neck pain in otologic surgeons

Level of Evidence - II

Indicate IRB or IACUC : Exempt

Skull Thinning in Patients with Superior Semicircular Canal Dehiscence

Douglas J. Totten, MD, MBA; Leah Dauterman, BS; McKenzie Stewart
Evan Cumpston, MD; Rick F. Nelson, MD, PhD

Objective: To use skull thickness to determine if an isolated skull thinning process occurs in patients with superior semicircular canal dehiscence (SSCD).

Study Design: Retrospective cohort study.

Setting: Tertiary referral center.

Patients: A power analysis required 28 patients per cohort. 38 SSCD patients (with absent bone overlying superior canal on CT) and 44 control patients without SSCD for whom imaging was obtained for unrelated reasons.

Main Outcome Measures: Thickness of calvarium and ipsilateral extracranial zygoma in SSCD and control patients as measured using standardized 3D slicer measurements of high-resolution temporal bone computed tomography scans obtained at a single tertiary referral center.

Results: 37 SSCD patients (58 SSCD ears) and 44 control patients (88 ears) were assessed for thickness of ipsilateral calvarium and extracranial zygoma. SSCD patients were slightly older than control patients (55 [standard deviation:15] vs. 48 [18] years; p=0.02) while BMI was similar (32 [10] vs. 30 [8] kg/m^2); p=0.10). Females comprised 25 (65%) of SSCD patients and 28 (64%) of control patients while 35 (95%) of SSCD patients and 33 (79%) of control patients were white. SSCD patients had mean calvarium thickness of 2.13 (0.42) cm and mean zygoma thickness of 4.75 (0.47) cm compared with 2.42 (0.46) cm and 5.08 (0.82) cm for control patients (ratio: 0.45 vs. 0.48, respectively [p=0.06]). There was a significant association between zygomatic and calvarium thickness ($p<0.0001$).

Conclusions: Patients with SSCD have thinner intracranial and extracranial skull thicknesses. This suggests SSCD does not develop via an isolated intracranial skull base thinning process but rather from a systemic and/or developmental bone formation process.

Professional Practice Gap: Etiology of SSCD is poorly understood. This study attempts to elucidate whether SSCD occurs as a result of an isolated skull base defect or a more systemic process.

Learning Objective: Patients with SSCD may globalized skull base thinning due to systemic processes rather than isolated bone defects.

Desired Result: Clinicians will gain further understanding regarding the pathophysiology of SSCD prompting additional research into understanding this complex disease process

Level of Evidence: IV

IRB: Indiana University IRB #13133 (approved 10/8/2021)

Catastrophizing as a Predictor of Vestibular Treatment Outcomes

Danielle M. Gillard, MD; Maxwell Hum; Adam Gardi
Lind Centore, PhD, NP; Jeffrey D. Sharon, MD

Objective: Determine the levels of catastrophizing in patients with vestibular disorders and evaluate their relationship with patient reported outcome measures.

Study Design: Prospective cohort study.

Setting: Tertiary care neurotology clinic.

Patients: Patients presenting to clinic with various vestibular disorders who were recruited to participate in in a prospective treatment outcomes study.

Interventions: Patients were given the Dizziness Handicap Inventory (DHI) and the Dizziness Catastrophizing Scale (DCS) both pre- and post-treatment. The DCS is a modified Pain Catastrophizing Scale (PCS).

Main outcome measures: A linear regression was performed to determine the relationship between DCS and pre an post-treatment DHI.

Results: 46 subjects completed both the DHI and the DCS pre and post treatment. Pretreatment patients with higher DCS scores had higher DHI scores ($p<0.001$). There was a significant improvement in both DHI score ($P<0.001$) and DCS ($p<0.001$) after treatment. Patients with higher baseline DCS scores showed less improvement in their post-treatment DHI scores ($p=0.025$). Patients who had improved DCS scores during treatment were more likely to show improved DHI scores ($p<0.001$). There were 10 patients who reported worse DHI after treatment and they had lower improvement in DCS score ($p=0.004$) and were more likely to report worse DCS scores after treatment ($p=0.047$).

Conclusions: Catastrophizing is associated with higher pre-treatment DHI scores, and worse treatment outcomes.

Professional Practice Gap & Educational Need: Patients with vestibular disorders can be difficult to treat and often present with high levels of anxiety surrounding their diagnosis and it can be difficult to determine why certain patients fail treatment or show less improvement than expected.

Learning Objective: 1. To understand the relationship between dizziness handicap and patient catastrophizing. 2. Understand how catastrophizing may affect the results of treatment interventions for vestibular disorders.

Desired Result: Understand that patients with high levels of catastrophizing may have higher subjective handicap due to their dizziness and may be less likely to show improvement with treatment interventions. Understand that interventions that focus on catastrophizing and anxiety regarding diagnosis may help improve treatment outcomes.

Level of Evidence: V

Indicted IRB or IACUC: IRB Approval 18-25365- February 26, 2019 and 21-33311, May 18, 2021

Characterizing Demographic and Treatment Parameters in Gamma Knife Radiosurgery for Vestibular Schwannoma

Neelima Panth, MD, MPH; Hisham Abdou, BS; Amar H. Sheth, BS
Kanwar Singh, MBBS; Sunitha S. Varghese, MD; Amit Mahajan, MD
Nofrat Schwartz, MD

Objective: 1) Introduce the use of efficiency index (EI) as an alternate method for evaluating efficacy and safety of radiosurgical treatment plans and 2) characterize the relationship between EI, conformity index (CI) and tumor and cochlea volumes in Gamma Knife radiosurgery (GKRS) for vestibular schwannoma

Methods: Retrospective chart review was performed for 181 patients who underwent GKRS for vestibular schwannoma at a tertiary care center between 2006-2021. CI and EI, which refers to a ratio of useful energy to total energy deposited, were calculated. Linear regression analyses were conducted to evaluate associations between EI, CI and tumor and cochlea volumes.

Results: Mean tumor EI was 43.36% and mean tumor CI was 0.78. Mean cochlea EI was 1.38%. There was a positive correlation (R^2= 0.356) between EI and smaller tumors (volume < 1cc), though there was a lack of correlation (R^2= 0.001) between EI and tumor volume overall. Correlation between CI and tumor volume was weak (R^2= 0.080) irrespective of size. There was no significant association between EI and CI (R^2=0.015) or between cochlea EI and cochlea volume (R^2= 0.041).

Conclusions: EI is a novel measure for assessing treatment plan quality in GKRS, combining conformity, gradient and mean dose. EI appears to be higher in tumors with smaller volume (< 1cc), suggesting that GKRS may allow for more effective delivery of energy within the tumor matrix for smaller vestibular schwannomas. Forthcoming analyses exploring the relationship between EI and tumor progression will prove critical in determining its utility in effective treatment planning for GKRS.

Professional Practice Gap & Educational Need: GKRS represents an important modality in the management of vestibular schwannomas. Literature on how to optimize radiosurgical treatment planning based on tumor and cochlea characteristics, as well as likelihood of tumor progression, remains limited.

Learning Objective: Attendees will be able to 1) describe the efficiency index as an alternate measure for evaluating the quality of a radiosurgical treatment plan 2) describe the relationship between tumor volume, cochlea volume and efficiency and conformity indices in GKRS for vestibular schwannoma

Desired Result: Optimizing the quality of GKRS planning in the treatment of vestibular schwannomas

Level of Evidence - IV

Indicate IRB or IACUC: Yale University Institutional Review Board. IRB Protocol ID: 0704002523.

Middle Ear Secretions following Surgery for Cerebrospinal Fluid Leak is Often Effusion and Not a Residual Leak

Ophir Handzel, MD; Omer Ungar, MD; Rosh Sethi, MD, MPH
Lei Ouyang Tanaka, MD; Rani Abu Ita, MD
Daniel J. Lee, MD; Judith S. Kempfle, MD

Objective: Characterize middle ear effusion present two months after surgery for temporal bone cerebrospinal fluid (CSF) leak.

Study Design: A retrospective chart review.

Setting: Two tertiary referral academic centers.

Patients: All patients with middle ear effusion two months after surgery for temporal bone CSF leak were included. The indication for surgery was an active CSF leak with or without a history of otogenic meningitis. The presence of effusion was established based on microscopic otoscopy aided by tympanometry.

Interventions: All middle ears with effusion two months after surgery were sampled for the presence of β 2transferrin or had a ventilation tube placed.

Main Outcome Measures: Persistent fluid leakage from tympanostomy tube, p resence or absence of β 2transferrin, residual air-bone gap recorded on audiogram.

Results: 93 ears underwent surgery to repair a CSF leak, 82 via middle fossa, 11 through transmastoid approaches. Twenty-seven ears (29%) had middle ear effusion two months after surgery. Fourteen ears were sampled for β 2transferrin and seven (50%) were positive. Additional thirteen patients received a tympanostomy tube. Seven (54%) of these middle ear remained dry and required no further interventions. In six persistent pulsatile secretions indicated the need for revision surgery. The β 2transferrin positive ears underwent revision surgery.

Conclusions: Postoperative middle ear fluid after surgery for temporal bone CSF leak may represent effusion rather than an ongoing leak. Revision surgery should be reserved for patients with a proven active leak. Middle ear effusion is likely caused by mucosal irritation from long-standing CSF rather than Eustachian tube dysfunction.

Professional Practice Gap & Educational Need: The prevalence of temporal bone CSF leaks is rising. Middle ear effusion in the presence of a bone defect can represent CSF, especially following corrective surgery. It is often assumed that in these circumstances, revision surgery is necessary. We present data demonstrating a high prevalence of middle ear effusion that is not an ongoing leak following primary surgery for CSF leak and does not necessitate revision surgery.

Learning Objective: Be aware of the possibility that middle ear effusion after corrective surgery for CSF leak is an effusion that does not a revision surgery.

Desired Result: Clinicians will include the presented data in their work-up of patients with middle ear effusion after surgery for CSF leak and will not offer all patients revision surgery.

Level of Evidence - IV

IRB: The study was approved by the Tel-Aviv Sourasky medical center (Israel) ethics committee number TLV-10-0312 and by the Massachusetts Eye and Ear (Boston, MA) IRB number 2019P000714.

Sporadic Vestibular Schwannoma in a Pediatric Population: A Case Series

Nikitha Kosaraju, BA; Lindsay S. Moore, MD
Jip Y. Mulders, MSc; Nikolas H. Blevins, MD

Objective: To describe the characteristics, management, and outcomes of pediatric patients with sporadic vestibular schwannoma (VS).

Study Design: Retrospective case review

Setting: Tertiary care center

Patients: 8

Interventions: Microsurgery, stereotactic radiosurgery (SRS), or observation

Main Outcome Measures: Tumor control

Results: 8 patients fulfilled inclusion criteria (sporadic unilateral VS; age < 21) with a mean age of 17 years (range 14-20). 62.5% were female. Average tumor size was 17.5mm (range 3-37mm). 50% underwent genetic testing with unremarkable findings. 5/8 (62.5%) were treated with microsurgery, 2/8 (25%) with observation, and 1/8 (12.5%) with Cyberknife SRS. 1 (20%) surgical patient had recurrence after a subtotal resection and went on to have SRS. 2 surgical patients had poor facial nerve outcomes (HB 6/6), while the other 6 patients remained HB1. One observed patient has remained radiographically stable for 2.5 years. The other experienced tumor growth and underwent microsurgery. The patient who underwent SRS has remained radiographically stable for 7 years.

Conclusions: We describe one of the largest reported cohorts of sporadic VS in the pediatric population. Genetic testing is critical to exclude neurofibromatosis type 2 but is often otherwise unrevealing. Given long expected lifespan and subsequent high risk of growth/regrowth and need for intervention, along with risk of secondary malignancy with SRS, microsurgery remains the preferred treatment. However, SRS or observation could be considered in select situations, with the potential benefit of preserved facial nerve function. Patients who elect for either should be counseled on the need for lifelong surveillance and the higher risk of poor facial nerve outcomes in salvage surgery if SRS fails.

Professional Practice Gap & Educational Need: Sporadic VS in the pediatric population is rare. Early identification and referral to tertiary care center can facilitate the most appropriate treatment and surveillance plan.

Learning Objective: To better understand the management of pediatric patients presenting with VS and negative genetic testing.

Desired Result: Pediatric patients with radiographic findings of VS will be referred to genetic testing and tertiary care centers.

Level of Evidence - V

Indicate IRB or IACUC : Stanford University IRB #39350

Speech Perception is Related to Quality of Life after Cochlear Implantation in Older Adults

James W. Bao, MSCI; Amit Walia, MD; Dorina Kallogjeri, MD
Matthew A. Shew, MD; Kevin Y. Zhan, MD; Craig A. Buchman, MD
Cameron C. Wick, MD

Objective: To assess the relationship between quality of life and speech perception outcomes in older adult cochlear implant (CI) recipients.

Study Design: Retrospective review and cross-sectional survey study.

Setting: Tertiary care center.

Patients: Traditional CI recipients 65-years and older implanted between 2015 and 2020.

Interventions: Cochlear Implant Quality of Life (CIQOL-35) survey completed within 1-year of most recent speech perception testing.

Main Outcome Measures: CNC words in the implanted ear; AzBio in quiet and + 10 dB SNR in the binaural everyday listening condition; CIQOL-35 responses

Results: 217 CI recipients returned CIQOL-35 surveys. Their demographics, otologic history, comorbidity index, and cognitive screen were collected alongside pre- and postoperative speech perception outcomes. Median age at implantation was 76 years (range 65-97) and median age at CIQOL-35 was 78 years (range 65-100). Datalogging showed mean daily use was 12 hours; 8 users were < 4-hours per day. The mean CIQOL-35 global was 48.1 (SD 10.8), which is comparable to normative data. Subdomain scores ranged from 35.3 ± 14.2 (listening effort) to 63.0 ± 20.5 (social). Bivariate analysis showed CIQOL-35 global had moderate correlation with AzBio quiet (r=0.413) and AzBio noise (r=0.537). A multivariable regression model using AzBio in noise, duration of hearing loss, age, and cognitive screen explained 38% of the CIQOL-35 global score variability (R^2=0.378). AzBio in noise was the most significant single variable.

Conclusions: Older adult CI users demonstrate CIQOL-35 scores inline with normative adult data. AzBio in noise performance is the strongest predictor of global CIQOL-35 performance.

Professional Practice Gap & Educational Need: Cochlear implant outcomes are more than just speech perception scores. This study evaluates how speech perception and quality of life are related in older adult recipients, which will help better inform patient expectations.

Learning Objective: Appreciate what factors influence cochlear implant quality of life in older adult recipients.

Desired Result: Improve preoperative patient counseling by learning about how patient variables and speech outcomes influence the CI users' experience.

Level of Evidence: IV

Indicate IRB or IACUC : IRB# 202108164

Long-term Contralateral Hearing Outcomes following Labyrinthectomy

Kavan Babu, BS; Christian G. Fritz, MD; Jonathan S. Choi, MD; Garrett G. Casale, MD
Caleb J. Fan, MD; Jake C. Lucas, MD; Seilesh C. Babu, MD

Objective: To quantify contralateral hearing loss after labyrinthectomy for Ménière's disease (MD) over a 14-year follow-up period.

Study Design: Retrospective chart review.

Setting: Tertiary neurotology referral center.

Patients: A total of 1394 adult patients were identified, of which 356 underwent labyrinthectomy (LAB). The remainder were translabyrinthine (TLAB) acoustic neuroma resection cases that served as a control group in which contralateral MD was unlikely to develop.

Interventions: Labyrinth removal with or without tumor resection.

Main Outcome Measures: Pure-tone average (PTA) 4-tone (500, 1000, 2000, 4000); PTA-Low (250, 500, 1000); PTA-High (2000, 4000); SRT, speech recognition threshold; SRS, speech recognition score.

Results: The average follow-up period was 5.8 years. The change in 4-tone PTA from baseline to last follow-up was similar for both LAB and TLAB groups (5.5 ± 7.1 dB and 4.4 ± 8.0 dB, $p = 0.634$). Likewise, upon PTA stratification there was minimal difference in the change of PTA-High (6.5 ± 7.5 dB and 5.4 ± 10.1 dB, $p = 0.700$) and PTA-Low (3.6 ± 9.0 dB and 2.9 ± 7.7 dB, $p = 0.778$) at last follow-up. SRT and SRS metrics were also similar [(4.3 ± 9.2 dB and 3.5 ± 8.8 dB, $p = 0.758$) and (0.0 ± 0.1 dB and 0.1 ± 0.2 dB, $p = 0.493$)].

Conclusions: We report minimal new-onset contralateral hearing loss after labyrinth removal for unilateral MD. This suggests that the audiometric manifestation of contralateral MD is clinically insignificant in the post-operative period.

Professional Practice Gap & Educational Need: Some neurotologists are interested in using vestibular-evoked myogenic potential (VEMP) testing to predict the development of contralateral MD. Given our finding of minimal contralateral sensorineural hearing loss after labyrinthectomy, such VEMP testing may not be necessary for routine cases.

Learning Objective: When unilateral MD is refractory to medical management, treatment with labyrinthectomy may be indicated. Violation of the labyrinth results in complete loss of hearing on the operated ear. For this reason, careful evaluation of hearing function in the contralateral ear prior to surgery is required to ensure that the patient's iatrogenic single sided deafness does not progress to bilateral hearing loss in the post-operative period.

Desired Result: This report suggests that few post-labyrinthectomy MD patients develop contralateral low-frequency (<2000Hz) sensorineural hearing loss in two contiguous frequencies at 30 dB or higher, which would be consistent with MD.

Level of Evidence: Level III

Indicate IRB or IACUC: Ascension Providence Hospital, RMI20220175.

Cochlear Implantation Outcomes in Non-surgical Vestibular Schwannoma Patients

Samuel J. Cler, BS; Matthew Shew, MD; Nedim Durakovic, MD; Kevin A. Zhan, MD
Jacques A. Herzog, MD, Craig A. Buchman, MD, Cameron C. Wick, MD

Objective: To assess the clinical scenarios and speech perception outcomes of patients with a vestibular schwannoma (VS) managed non-surgically who received an ipsilateral cochlear implant (CI).

Study Design: Retrospective review

Setting: Tertiary care center

Patients: Sporadic or Neurofibromatosis Type-2 (NF-2) VS patients with bilateral sensorineural hearing loss and tumors managed by observation or stereotactic radiation.

Interventions: Cochlear implantation ipsilateral to a VS

Main Outcome Measures: Audibility; CNC words

Results: Six patients with ages ranging from 13-86 years underwent cochlear implantation ipsilateral to an observed or irradiated VS. Mean tumor size was 15.5 mm (range 11-25 mm). Five of the patients demonstrated no tumor growth in the preceding 18-months, the exception being a 13-year-old with an observed NF-2 tumor. All patients achieved meaningful sound awareness with a mean CI PTA of 21.3 dB HL (range 18-38 dB HL). Two patients underwent gamma knife radiation and subsequent CI achieving CNC scores of 0% and 48%, respectively; the poor result associated with NF-2. Four patients observed their tumors and achieved CNC scores of 36%, 42%, 78%, and 0%; the poor result associated with NF-2. Both NF-2 patients had sound awareness without open-set speech and performance waned over time.

Conclusions: The decision to forgo surgical intervention for a VS does not preclude hearing rehabilitation with a CI. This report adds to the limited published data on this topic. While open-set speech can be achieved, CI results are expected to be more variable and likely worse in NF-2 patients afflicted with a higher tumor burden.

Professional Practice Gap & Educational Need: Off-labeled cochlear implantation with vestibular schwannomas is increasing. This report is meant to help educate clinical decision making in these challenging scenarios.

Learning Objective: Understand outcomes associated with cochlear implants in the setting of non-surgically managed vestibular schwannomas.

Desired Result: Improve patient counseling for those considering cochlear implantation in the setting of an ipsilateral vestibular schwannoma.

Level of Evidence: V

Indicate IRB or IACUC : Washington University School of Medicine - IRB #202111194 (approved: 11-30-2021)

Validating Automated Segmentation for Vestibular Schwannoma Volumetric Measurement

Krish Suresh, MD; Guibo Luo, PhD; Amy F. Juliano, MD; Daniel J. Lee, MD
D. Bradley Welling, MD, PhD; Wenli Cai, PhD
Matthew G. Crowson, MD, MPA, MASc

Objective: There is a trend towards measuring vestibular schwannoma (VS) tumor volumes on MRI, however this has been limited by difficulties with tumor segmentation (delineating tumor boundaries). Manual segmentation is laborious and subject to human variability. Machine learning approaches could automate segmentation in a reliable fashion. Our objective is to validate an automated MRI segmentation tool for VS.

Study Design: Retrospective study

Setting: Tertiary referral centers

Patients: 242 patients with VS from a single institution on The Cancer Imaging Archive (TCIA); 10 individuals with VS from our institution.

Interventions: A nnU-Net was trained on the TCIA data to develop a model to automatically segment VS on T1-post contrast MRI. This model was applied to 10 MRIs from our institution, and the automated segmentation results were compared with our manual segmentations.

Main Outcome Measures: Dice coefficient, which measures agreement between ground truth (manual) and predicted (automated) segmentations on a scale from 0-1 (1 indicating perfect agreement).

Results: The model detected 7/10 VS; the 3 that were not detected were <0.02 cc. For those that were detected, the mean Dice was 0.87 (SD 0.14). There was one outlier with Dice of 0.55 (manual 0.361 cc, automated 0.901 cc) – on review, hyperintense petrous bone had been included as tumor in the automated segmentation.

Conclusions: Automated segmentation for VS is a promising approach that can be translated to patient populations from different institutions and MRI technologies. Failure to detect small tumors may reflect biases in training data. Further work is needed to refine accuracy, and human review of automated results is warranted.

Professional Practice Gap & Educational Need: VS tumor volumes more accurately reflect the size of these irregularly shaped masses and have been shown to be more sensitive in detecting tumor growth than linear measurement. However, volumetric measurement is not being done in practice at most institutions because of difficulties with tumor segmentation. An understanding of the approaches and challenges in measuring tumor volumes is increasingly important and relevant in the management of VS.

Learning Objective: To understand the challenges in development and implementation of automated segmentation tools for VS.

Desired Result: Attendees will understand the importance of volumetric measurement for VS and gain an appreciation for the approaches and challenges in implementing this.

Level of Evidence – Level IV

Indicate IRB or IACUC: Exempt under Mass General Brigham IRB Protocol # 2021P000710, approved 3/17/2021

The Role of Machine Learning and Motion Analysis in Enhancing Multidisciplinary Neurovestibular Care: A Systematic Review

Munib Ali, BSc; Christopher Yam, MSc; Mariam Kabalan, BA
Katie de Champlain, MSc, MD; Justin K. Chau, MD

Objective: Various modalities evaluating human posture and dynamics are used to assist in characterizing balance disorders. Limited tools have attained adequate testing parameters to help delineate inner ear pathology. Machine learning shows promise to aid in the diagnosis and classification of vestibular pathologies. This systematic review synthesizes the latest evidence on the efficacy of machine learning as an adjunct to various motion analysis tools in the detection of vestibular disorders.

Data sources: MEDLINE, Cochrane, Web of Science & SCOPUS were searched for English studies, using synonyms and keywords from inception to October 5, 2022.

Study selection: Studies were screened by two independent reviewers. Primary investigations assessing machine learning-based motion analysis data (eg. posture, stability, and gait) on patients with vestibular disorders were included.

Data extraction: The Risk of Bias tool for Non-randomized Studies (RoBANS) was utilized by two reviewers independently for quality appraisal. Reported demographics, testing modalities, hardware, algorithms, and testing parameters were extracted.

Data synthesis & results: 949 abstracts were identified; 45 studies eligible for full text review. 16 studies with 2173 individuals were extracted with 8-69% female patients and age range 22-64 years. Posturography with force-plate center-of-pressure was most common (63%) followed by gait/pose estimation with inertial measurement unit accelerometry (37%). The support-vector machine (SVM) +/- Gaussian kernel was the strongest machine learning algorithm. Overall test parameters of these algorithms performed well (area under the curve 0.86-0.98, sensitivities 65-100%, specificities 63-93%, and accuracies 78-98%).

Conclusions: Machine-learning augmentation of motion analysis data achieves excellent testing parameters for detecting various vestibular pathologies. Emerging paradigms including machine vision should be explored.

Professional Practice Gap & Educational Need: Machine learning is a rapidly growing enterprise that will continue to enhance the quality of neurovestibular care in otolaryngology. As such, students, trainees, and clinicians alike should be aware of its uses and applications.

Learning Objective: By the end of this session, the participants will be able to appraise and compare the role of various machine learning models as well as the utility of motion analysis for the detection of vestibular pathology.

Desired Result: Otologists and neuro-otologists should consider autonomous and cost-effective adjuncts and alternatives to vestibular testing.

Level of Evidence – Level III

Indicate IRB or IACUC: Exempt.

Designing an Evaluation and Treatment Algorithm for Patients with Ear Fullness and No Objective Abnormalities

Kelly Lee, BS; Richard Adamovich-Zeitlin, BS; Maja Svrakic, MD

Objective: To make recommendations for an evaluation and treatment algorithm for patients who present with ear fullness without abnormalities on external/middle ear exam, standard audiometric studies, or imaging results.

Study Design: Retrospective chart review.

Setting: Tertiary referral center.

Patients: Adult patients presenting with ear fullness and/or otalgia without external, middle, and/or inner ear pathologies.

Interventions: Review of clinical diagnosis and treatment.

Main Outcome Measures: Demographics; laterality and duration of symptoms; rates of temporomandibular joint (TMJ) dysfunction, intermittent Eustachian tube dysfunction (iETD), anxiety/depression, migraine disorder, and NOS (not otherwise specified); and efficacy of treatments used.

Results: Women were more likely than men to complain of ear fullness and/or otalgia, and were also more likely to present with no objective abnormalities ($p<0.05$). Most of these patients were diagnosed with a single condition, with temporomandibular joint (TMJ) dysfunction representing 55.5% of cases. TMJ dysfunction was also most prevalent in patients who were diagnosed with multiple conditions, making up 31.2%. Anxiety/depression made up only 1.0% of patients who were diagnosed with a single condition, but 15.9% of multiple assessments.

Conclusions: 84.6% of patients presenting with unexplained ear fullness were diagnosed with TMJ dysfunction, iETD, migraine disorder, anxiety/depression, or a combination of these conditions. Anxiety/depression may have a role in contributing to otologic symptoms, and optimizing treatment may further alleviate symptoms of ear fullness.

Professional Practice Gap & Educational Need: Ear fullness is a common complaint among otolaryngology clinics, but its etiology is not always well-known, presenting a diagnostic and treatment challenge.

Learning Objective: To illustrate that ear fullness can present in conditions such as TMJ dysfunction, intermittent Eustachian tube dysfunction, and migraine disorders, and that anxiety/depression can be a contributing factor.

Desired Result: Provide a systematic approach in assessing and treating ear fullness in patients with no otologic objective abnormalities.

Level of Evidence - Level IV

Indicate IRB or IACUC : IRB Exempt #22-0321-NH, Northwell Health

Characterizing the Cognitive Burden of Peripheral and Central Vestibular Disorders

Ricky Chae; Steven D. Rauch, MD; Divya A. Chari, MD

Objective: Cognitive impairment has been reported to be the major determinant of low quality of life (QOL) scores in vestibulopathic patients. There is no consensus about whether cognitive impairment presents differently in patients with peripheral and central vestibular disorders.

Study Design: Cross-sectional cohort.

Setting: Tertiary referral center.

Patients: Adults with peripheral vestibular disorders (benign paroxysmal positional vertigo, Meniere's disease, unilateral vestibular hypofunction, labyrinthitis, superior canal dehiscence syndrome) and central vestibular disorders (vestibular migraine, persistent postural perceptual dizziness).

Interventions: Patient reported outcomes measures.

Main Outcome Measures: Subjects completed surveys to assess dizziness, general cognitive function, and specific cognitive domains, including memory, executive function, attention, and spatial ability. Comorbid anxiety and depression were assessed with validated questionnaires.

Results: Patients with peripheral vestibular disorders (n=18) reported significantly less subjective burden as measured by surveys of dizziness ($p<0.01$), general cognition ($p<0.01$), and memory and executive function ($p<0.05$) compared to patients with central vestibular disorders (n=12). Cognitive domains of attention and spatial ability were not significantly different in the two populations. Positive correlations were observed between anxiety/depression and memory for both peripheral ($r^2=0.48$, $p<0.05$) and central ($r^2=0.68$, $p<0.01$) vestibular disorders.

Conclusions: The type and degree of cognitive impairment may differ in patients with peripheral and central vestibular disorders. Further work is needed to elucidate the relationship between comorbid anxiety and depression and subjective cognitive impairment.

Professional Practice Gap & Educational Need: Cognitive impairment may present differently in patients with peripheral and central vestibular disorders. Psychiatric comorbidities like anxiety and depression may be more common in patients with central vestibular disorders.

Learning Objective: Assess the cognitive burden of central and peripheral vestibular disorders.

Desired Result: Improved awareness of the potential effect of cognitive impairment in patients with peripheral and central vestibular disorders.

Level of Evidence - Choose one value between Level I thru Level V

Indicate IRB: Massachusetts Eye and Ear (IRB# 2019P000438); University of Massachusetts Chan Medical School (IRB# 00000374)

Longitudinal Quantification of Endolymphatic Hydrops on Delayed Contrast-Enhanced FLAIR MRI and its Correlation with Changes in Hearing in Patients with Hearing Instability: A Pilot Study

Dillon Strepay; Bing Li; J. Dixon Johns, MD
Li-Yueh Hsu, PhD; John A. Butman, MD, PhD; Michael Hoa, MD

Objective: To characterize longitudinal variations in endolymphatic hydrops (EH) on delayed contrast-enhanced MRI and its correlation to changes in hearing in patients with hearing instability (HI).

Study Design: Observational prospective cohort study

Setting: Tertiary referral center

Patients: Adults ages 18-65 with HI.

Interventions:
Contrast-enhanced delayed FLAIR (fluid attenuated inversion recovery) MRI was performed 4-8 hours following intravenous gadoteridol (0.2 mmol/kg) in a cohort of HI patients at 3-6 month intervals, under a deep phenotyping protocol. MRI were performed at 3.0 T with an 8-channel head coil using 3D FLAIR and STIR (short tau inversion recovery) sequences with 0.8 mm isotropic resolution requiring ~ 12 and 4 minutes. Based on STIR (representing perilymph and endolymph combined fluid) and delayed FLAIR (representing perilymph fluid) MRI sequences, a custom developed MRI processing and analysis pipeline was utilized to quantify the volume of the perilymph and endolymph in the inner ear.

Main Outcome Measures: Volume of endolymph, volume of perilymph, changes in speech, hearing thresholds, and cervical and ocular vestibular evoked myogenic potentials.

Results: Changes in EH volume were quantified in a longitudinal fashion and correlated with clinical measures of hearing.

Conclusions: Longitudinal assessment of patients with HI utilizing contrast-enhanced delayed FLAIR MRI allows for detection of quantifiable changes in EH that correlate with changes in hearing. This methodology has the potential to better monitor HI over time and to help better evaluate potential treatments for HI in which EH hydrops is present.

Professional Practice Gap & Educational Need: HI disorders are poorly characterized and hearing loss in these disorders is often ineffectively treated. Using contrast-enhanced delayed FLAIR MRI and different clinical measures of hearing at multiple timepoints, we can better characterize the underlying pathophysiology of these disorders and its correlation to changes in hearing.

Learning Objective: Improved understanding of the correlation between endolymphatic hydrops and changes in hearing.

Desired Result: Clinicians will eventually have access to a reliable, easy to use, automated pipeline to quantify EH in patients with HI. This methodology will produce measurements of EH that correlate with hearing loss and may aid in the evaluation of potential therapies for EH in HI.

Level of Evidence - III

Indicate IRB or IACUC : NIH, NIDCD IRB: 000141-DC

Correlating VM-PATHI to Daily Dizziness Symptoms

Eric K. Kim, BA; Maxwell Hum, BS; Jeffrey D. Sharon, MD

Objective: Investigate the relationship between VM-PATHI (Vestibular Migraine Patient Assessment Tool and Handicap Inventory) scores and daily dizziness symptoms.

Study Design: Prospective cohort analysis of 49 patients with vestibular migraine (VM).

Setting: Tertiary referral center.

Patients: 49 patients diagnosed with vestibular migraine or probable vestibular migraine according to Barany Society criteria.

Interventions: Subjects reported their dizzy symptoms (on a scale from 0=no symptoms, 1=mild, 2=moderate, 3=severe) everyday for one month via automated text messaging linked to a cloud-based research database. Subjects completed VM-PATHI and Dizziness Handicap Inventory (DHI) scores at the end of the month. We examined the correlation between a composite of daily dizzy scores with VM-PATHI and DHI scores through linear regression.

Main Outcome Measures: Pearson's correlation coefficient, R-squared value.

Results: VM-PATHI showed a moderate correlation with daily dizziness symptoms (correlation coefficient: 0.51, R-squared: 0.26). DHI showed a lower correlation with daily dizziness (correlation coefficient: 0.27, R-squared: 0.07). Daily dizziness was a strong predictor of VM-PATHI score with univariate linear regression ($p=0.002$).

Conclusions: Daily dizziness symptoms are highly correlated with VM-PATHI score, providing further validation of VM-PATHI as a disease-specific outcome measure for patients with VM. VM-PATHI score is more closely linked with daily dizziness than DHI total score.

Professional Practice Gap & Educational Need: A reliable patient-reported outcome measure is required to objectively measure and track a VM patient's symptom severity. VM-PATHI was designed to address this need and requires further validation.

Learning Objective: Describe the relationship between VM-PATHI and daily dizziness symptoms in VM patients.

Desired Result: Clinicians and researchers will recognize the utility of VM-PATHI in caring for and studying VM patients, respectively.

Level of Evidence – IV.

Indicate IRB or IACUC : IRB # 19-29340, approved 02/03/2020.

RECIPIENTS OF ANS AWARDS

RECIPIENTS OF THE ANS RESEARCH GRANT AWARD
Up to three $25,000 annual awards; established in 2014/15
Funding provided by the American Neurotology Society

The purpose of the American Neurotology Society (ANS) Research Grant is to encourage and support academic research in sciences related to the investigation of otology and neurotology. Appropriate areas of research include diagnosis, management, and pathogenesis of diseases of the ear and/or skull base. Grants that focus on addressing clinical gaps are especially encouraged. Grants may involve cell/molecular studies, animal research, or human subjects research.
The maximum award request is $25,000 per year (US dollars) and is annually renewable on a competitive basis. ANS may distribute up to three $25,000 grants each finding cycle. Indirect costs (overhead) are not allowed. **Grants are available to physician investigators in the United States and Canada only.** We particularly encourage those individuals without a history of K08, R03, R21, or R01 funding to apply.
If you would like to submit a grant for consideration in 2023-24, the deadline for applications is March 1, 2023. Email a cover letter and application to Dr. Ronna Hertzano, RHertzano@som.umaryland.edu, Chair of the ANS Research Committee and ANS Admin, Kristen Bordignon.

Christine T. Dinh, MD - 2015
"Cochlear Irradiation and Dosimetry: Apoptosis, Necrosis, and Hearing Loss"
University of Miami - *Miami, FL*

Harrison Lin, MD - 2016
"Chronic Implantation of the Facial Nerve for Selective Facial Muscle Contraction"
University of California - Irvine*, Orange, CA*

Michael S. Harris, MD -2017
"Verbal Memory as Outcome Predictor in Adults Receiving Cochlear Implants"
Medical College of Wisconsin - Milwaukee, WI

Ksenia A. Aaron, MD - 2018
"Modelling and Restoring Hearing and Vestibular Deficit of Non-Syndromic Deafness"
University of California - Los Angeles, CA

Dunia Abdul-Aziz, MD - 2019
"Targeting Epigenetic Modifying Enzymes for Hair Cell Regeneration"
Massachusetts Eye & Ear - Boston, MA

Douglas Bennion, MD and Megan (Foggia) Jensen, MD - 2020
"Durable Zwitterionic Thin Film Coatings for Cochlear Implant Biomaterials"
University of Iowa - Iowa City, IA

Courtney C.J. Voelker, MD, PhD – 2020
"In Vivo Neuronal Mapping of the Auditory Pathway in Pediatric Patients with Congenital Unilateral Sensorineural Hearing Loss and those with Normal Hearing"
University of Southern California - Los Angeles, CA

Tatiana Correa, MD, MPH - 2020
"Comparison of Surgical Routes for Localized Inner Ear Viral Vector-Mediated Gene Therapy in the Guinea Pig Using Helper-Dependent Adenovirus Type 5"
University of Iowa - Iowa City, IA

Ashley Kita, MD - 2021
"Prolonged Elution of Cytokines for Inner Ear Rehabilitation"
University of California (UCLA) - Los Angeles, CA

Bing Teh, MBBS, PhD - 2021
"*The Impact of Vestibular Dose on Post Gamma Knife Balance Function"*
Columbia and Cornell Universities - New York, NY

Aida Nourbakhsh, MD, PhD – 2022 (*ANS 2023 Spring Meeting presentation, Friday, May 5 at 3:55 pm*)
"Molecular Mechanisms of Hypofractionation and Radiation Resistance in Vestibular Schwannoma."
University of Miami – Miami, FL

Vivian F. Kaul, MD – 2022
"Improving Patient Satisfaction and Quality of Life Outcomes for Cochlear Implant Patients Through an Interactive Web and Mobile-Based Patient Education Platform"
Ohio State University - Columbus, OH

Amit Walia, MD – 2022
"Predicting Performance in Background Noise for Cochlear Implant Recipients using Electrocochleography"
Washington University - St. Louis, MO

NEW IN 2023

ANS Advancing Diversity, Equity, Inclusion, and Accessibility (DEIA) in Otology and Neurotology Grant
Click here for detailed submission instructions.

In an effort to incorporate, recognize, and foster diversity, equity, inclusion, and accessibility within Otology and Neurotology, the ANS seeks to fund proposals that address these concepts in the areas of patient care, education, research, and membership. As it relates to the mission of the ANS, these endeavors will contribute to a better understanding of our increasingly intersectional organization and patient populations and allow for initial steps towards improving alignment of our membership with the needs of our clinical populations. This is particularly important as one focus is to translate knowledge to quality care for our patients.

Applications will be accepted and reviewed at the same time as the ANS Research grant applications.
$25,000 is allocated for this grant mechanism annually.
Applicants may be any member of the ANS in good standing at the time of the application and award. In addition, an applicant who is not a member of the ANS may be sponsored by an ANS member in good standing.

Many thanks to the ANS Research Committee, led by Dr. Ronna Hertzano.

Ronna Hertzano, MD, PhD. Chair
Jason Brant, MD
Matthew Crowson, MD, MPA, MASc
Christine Dinh, MD
Susan Emmett, MD, MPH
Samuel Gubbels, MD
Theodore McRackan, MD
Aaron Remenschneider, MD
Courtney Voelker, MD, PhD
Michael Hoa, MD (D/I Committee representative)

HOUSE/HITSELBERGER
LIFETIME ACHIEVEMENT AWARD

In honor of the 50th anniversary of the American Neurotology Society, 1965 - 2015, the House/Hitselberger Lifetime Achievement Award was established to honor the legacy of two giants in the field of neurotology, Dr. William F. House and Dr. William E. Hitselberger. The award recognized those individuals who have demonstrated superb surgical skills and patient care, a commitment toward education and cumulative scientific contributions that have profoundly impacted the field of neurotology.

These awards were presented to nine neurotologists from the USA and Europe at the 50th Annual Fall meeting in Dallas, TX on September 26, 2015.

Derald E. Brackmann, MD
House Ear Clinic - Los Angeles, CA

Prof. Ugo Fisch, MD
Fisch International Microsurgery Foundation
Zurich, Switzerland

Emilio García-Ibáñez, MD
Instituto De Otologia Garcia-Ibanez - Barcelona, Spain

Michael E. Glasscock, III, MD
The Otology Group, Nashville, TN
The Glasscock Hearing Center - Houston, TX

Malcolm D. Graham, MD
Emory University - Atlanta, GA

David A. Moffat, PhD, FRCS
Addenbrooks Hospital - Cambridge, UK

Joseph B. Nadol, Jr., MD
Massachusetts Eye & Ear Infirmary - Boston, MA

Prof. Mario Sanna, MD
Gruppo Otologico, Piacenza-Rome, Italy

Prof. Jean-Marc Sterkers, MD
Paris, France

RECIPIENTS OF THE NOEL L. COHEN AWARD FOR SIGNIFICANT CONTRIBUTIONS TO OTOLOGY AND NEUROTOLOGY

Through a generous gift from our late colleague, ANS has established the Noel L. Cohen, M.D. Award for Significant Contributions to Otology and Neurotology. The establishment of the award is a fitting tribute to Dr. Cohen — a gifted physician, surgeon, academician, educator, administrator and leader. His contributions brought distinction to Otology & Neurotology, New York University, and our society.

The first recipient of this esteemed award, Dr. Thomas Balkany, was announced at the 55th Annual virtual Fall meeting on Sept 12, 2020.

Thomas J. Balkany, MD – 2020 – Miami, FL
University of Miami Miller School of Medicine

Robert K. Jackler, MD – 2021 – Palo Alto, CA
Stanford University

Bruce J. Gantz, MD – 2022 – Iowa City, IA
University of Iowa

NEUROTOLOGY FELLOWSHIP AWARD

Colin L.W. Driscoll, MD - 1998, Palm Beach, FL

Robert M. Owens, MD - 1999, Palm Desert, CA

Katrina R. Stidham, MD - 2000, Orlando, FL

Zoran Becvarovski, MBBS - 2001, Palm Desert, CA

John S. Oghalai, MD - 2002, Boca Raton, FL

Anthony O. Owa, MD - 2002, Boca Raton, FL

Richard J. Kennedy, MD - 2003, Nashville, TN

Ana H. Kim, MD - 2006, Chicago, IL

Marc D. Eisen, MD - 2007, San Diego, CA

Benjamin T. Crane, MD, PhD - 2008, Orlando, FL

R. Mark Wiet, MD - 2008, Orlando, FL

Kevin D. Brown, MD, PhD - 2009, Phoenix, AZ

Jerry W. Lin, MD, PhD - 2009, Phoenix, AZ

John C. Goddard, MD - 2010, Las Vegas, NV

Matthew L. Bush, MD - 2011, Chicago, IL

Felipe Santos, MD - 2011, Chicago, IL

Alicia Quesnel, MD - 2012, San Diego, CA

Mia Miller, MD - 2013, Orlando, FL

Peter L. Santa Maria, MBBS, PhD -2014, Las Vegas, NV

Christine T. Dinh, MD - 2015, Boston, MA

Seth E. Pross, MD - 2016, Chicago, IL

Michael S. Harris, MD – 2017, San Diego, CA

Kathryn Y. Noonan, MD – 2018, National Harbor, MD

Enrique Perez, MD – 2018, National Harbor, MD

Ksenia A. Aaron, MD – 2019, Austin, TX

James G. Naples, MD – 2019, Austin, TX

Matthew G. Crowson, MD, MPA – 2020, Virtual

Kenny F. Lin, MD – 2020, Virtual

Matthew A. Shew, MD – 2021, Virtual

Alexander L. Luryi, MD – 2021, Virtual

Nathan R. Lindquist, MD – 2022, Dallas, TX

Mallory J. Raymond, MD – 2022, Dallas, TX

Pawina Jiramongkolchai, MD - 2023, Boston, MA

ANS TRAINEE AWARD

Thomas R. Pasic, MD - 1990, Palm Beach, CA
University of Washington, Seattle, WA

Charles A. Syms III, MD - 1991, Hawaii, HI
USAF Medical Center, Lackland AFB, TX

Eric Tallan, MD - 1992, Palm Desert, CA
Mayo Clinic, Rochester, MN

Mark E. Reiber, MD - 1993, Los Angeles, CA
Vanderbilt University Medical Center, Nashville, TN

Gary B. Coleman, MD - 1994, Palm Beach, FL
University of Michigan, Ann Arbor, MI

Donald D. Robertson, MD - l995, Palm Desert, CA
University of Manitoba, Winnipeg, Manitoba Canada

Greg A. Krempl, MD - l997, Scottsdale, AZ
University of Texas, San Antonio, TX

Bac H. Nguyen, MD - 1998, Palm Beach, FL
University of Minnesota, Minneapolis, MN

Jennifer L. Maw, MD - 1999, Palm Desert, CA
Hearing Institute for Children & Adults, San Jose, CA

Wayne E. Berryhill, MD - 2000, Orlando, FL
University of Minnesota, Minneapolis, MN

Dmitriy Niyazov - 2001, Palm Desert, CA
Medical Student, Los Angeles, CA

Stacey L. Halum, MD - 2003, Nashville, TN
Medical College of Wisconsin

Norman N. Ge, MD - 2004, Phoenix, AZ
Davis Medical Center, Sacramento, CA

Ritvik P. Mehta, MD - 2005, Boca Raton, FL
Massachusetts Eye & Ear; Harvard Medical School

Wade Chien, MD - 2006, Chicago, IL
Massachusetts Eye & Ear, Harvard Medical School

Hideko Heidi Nakajima, MD, PhD - 2009, Phoenix, AZ
Massachusetts Eye & Ear; Harvard Medical School

Yuri Agrawal, MD - 2012, San Diego, CA
Johns Hopkins University, Baltimore, MD

Samuel A. Spear - 2013, Orlando, FL
The Ohio State University, Columbus, OH

Christine T. Dinh, MD - 2014, Las Vegas, NV
University of Miami, Miami, FL

James Naples, MD - 2015, Boston, MA
University of Connecticut, Farmington, CT

Jacob B. Hunter, MD - 2016, Chicago, IL
Vanderbilt University, Nashville, TN

Yarah M. Haidar, MD – 2017, San Diego, CA
University of California at Irvine, Orange, CA

Ashley M. Nassiri, MD - 2018, National Harbor, MD
Vanderbilt University Medical Center, Nashville, TN

Matthew Shew, MD – 2019, Austin, TX
Washington University, St Louis, MO

Armine Kocharyan, MD - 2020, Virtual Platform
Case Western Reserve University

John P. Marinelli, MD – 2020, Virtual Platform
Mayo Clinic

Susan E. Ellsperman, MD – 2021, Virtual Platform
University of Michigan

Douglas M. Bennion, MD, PhD – 2021, Virtual Platform
University of Iowa

Hunter L. Elms, MD – 2022 - Dallas, TX
Duke University

Amit Walia, MD – 2022 - Dallas, TX
Washington University

Lisa Zhang, MD – 2023 - Boston, MA
The Ohio State University

Ankita Patro, MD – 2023 - Boston, MA
Vanderbilt University

NICHOLAS TOROK VESTIBULAR AWARD

Stephen P. Cass, MD - l990, Palm Beach, FL
Michigan Ear Institute, Farmington Hills, MI

P. Ashley Wackym, MD - 1992, Palm Desert, CA
University of Iowa Hospitals and Clinics, Iowa City, IA

Robert P. Muckle, MD - 1993, Los Angeles
University of Minnesota, Minneapolis, MN

Thomas A. Salzer, MD - 1994, Palm Beach
Baylor College of Medicine, Houston, TX

Akira Ishiyama, MD - 1995, Palm Desert
UCLA School of Medicine, Los Angeles, CA

Anil K. Lalwani, MD - 1998, Palm Beach, CA
University of California, San Francisco, CA

Lloyd B. Minor, MD - 1999, Palm Desert, FL
Johns Hopkins University, Baltimore, MD

Vincent B. Ostrowski, MD - 2000, Orlando, FL
Northwestern University Medical School, Chicago, IL

D. Bradley Welling, MD, PhD - 2001, Palm Desert, CA
The Ohio State University, Columbus, OH

John P. Carey, MD - 2003, Nashville, TN
Johns Hopkins University, Baltimore, MD

John C. Li, MD - 2005, Boca Raton, FL
Loyola University Medical Center, Chicago, IL

Judith A. White, MD, PhD - 2006, Chicago, IL
The Cleveland Clinic, Cleveland, OH

Abraham Jacob, MD - 2007, San Diego, CA
The Ohio State University - Columbus, OH

Rahul Mehta, MD - 2014, Las Vegas, NV
Louisiana State University - New Orleans, LA

Benjamin T. Crane, MD, PhD - 2015, Boston, MA
University of Rochester Medical Center - Rochester, NY

Jeffrey D. Sharon, MD - 2016, Chicago, IL
Johns Hopkins University - Baltimore, MD

Anne K. Maxwell, MD – 2017, San Diego, CA
University of Colorado Hospital – Aurora, CO

Renee M. Banakis Hartl, MD – 2018, National Harbor, MD
University of Colorado Hospital – Aurora, CO

Tiffany P. Hwa, MD – 2020, Virtual
University of Pennsylvania- Philadelphia, PA

Steven D. Curry, MD, MPH – 2021 - Virtual
University of Nebraska Medical Center

Miriam R. Smetak, MD, MS – 2022 - Dallas, TX
Vanderbilt University

Eric J. Formeister, MD, MS – 2023 - Boston, MA
Duke University

RECIPIENTS OF THE SILVERSTEIN AWARD
ANS/AAO-HNS Otology/Neurotology Research Award
Funding provided by Dr. Herbert Silverstein/ANS/AAO

Lawrence R. Lustig, MD - 7/1999
Johns Hopkins University

David R. Friedland, MD - 7/00-6/02
Johns Hopkins University

Rose Mary Stocks, MD - 7/02-6/204
University of Tennessee

Clifford R. Hume, MD, PhD - 7/03-6/05
University of Washington

Alan G. Micco, MD - 7/04-6/06
Northwestern University

Romaine Johnson, MD - 7/05-6/07
Children's Hospital Cincinnati

Joseph P. Roche, MD - 7/08-6/10
University of North Carolina

Alan Cheng, MD - 07/10 - 06/12
Stanford University

Yuri Agrawal, MD - 07/10 - 06/12
Johns Hopkins University

Nathan Schularick, MD - 07/12 - 06/14
The University of Iowa

Dylan Chan, MD, PhD - 07/14 - 06/16
University of California-SF

David H. Jung, MD, PhD - 07/16 - 06/18
Harvard University/ MEEI

David H. Jung, MD, PhD – 07/16 - 06/18
Massachusetts Eye and Ear Infirmary/Harvard Medical School

Elliot D. Kozin, MD - 7/18 - 6/20
Massachusetts Eye and Ear Infirmary/Harvard Medical School

NO AWARD GIVEN - 7/20-6/22

Lindsay Scott Moore, MD - 7/22-6/24
Stanford University

Research Fund of the American Neurotology Society
Progress Report Date: 02/13/2023
Principal Investigator: **Vivian F. Kaul, MD** (The Ohio State University)
Project Title: *Improving Patient Satisfaction and Quality of Life Outcomes for Cochlear Implant Patients Through an Interactive Web and Mobile-Based Patient Education Platform*

Project Summary:

The cochlear implant (CI) is a widely successful hearing rehabilitation device; however, there are patients who are still not completely satisfied with their implant and/or do not display optimal speech perception outcomes. An area that has not been explored for its effects on outcomes, besides patient and treatment factors, is the patient educational experience surrounding cochlear implantation. There is a **gap in our knowledge** regarding how best to provide patient education in adults receiving CIs, which results in a **critical barrier to progress** in optimizing patient satisfaction and speech perception outcomes. It is clear that a mismatch between preoperative expectations and postoperative outcomes can lead to worse patient satisfaction rates. We propose that this mismatch can be mitigated through extensive and structured patient education. Due to baseline moderate-to-profound hearing loss, patients undergoing cochlear implantation are already at high risk for miscommunication and misunderstanding surrounding the cochlear implantation process.

The objective of the proposed research is to test the effects of a novel, structured, electronic multimedia patient education program in adults undergoing CI surgery, by investigating its effects directly on CI knowledge, objective outcomes, and subjective outcomes. We will address this objective by carrying out three Specific Aims:

***Specific Aim 1:* Development and Testing of CI Patient Educational Program on CI Knowledge.**
Progress: We developed an script for the electronic multimedia educational program to improve patient knowledge regarding the CI process. A disease-specific questionnaire related to CI knowledge was created, which was ensured that it was at 6th grade reading level, to assess their understanding of their hearing loss and treatment, before and after surgery. The program at our institution responsible for video production halted our video production due to unrelated issues. Therefore we have pivoted to producing our own video productions. Once the videos are created, we plan to start enrollment of our two patient cohorts. Patients will be randomly assigned to either the multimedia educational program group or a control group through an unbiased patient clinical trial coordinator. Both groups of patients will be tested using our CI knowledge test created with our patient-education language specialist.

***Specific Aim 2:* Determination of Effects of CI Patient Educational Program on Objective Patient Compliance, Data-Logging Hours and Speech Perception.**
Progress: Once we start enrolling patients, we will see how compliant they are with the perioperative instructions (such as obtaining the pneumococcal vaccine, perioperative computed tomography (CT) scans, not eating anything by mouth, attending all clinical/audiology/aural rehabilitation appointments), device hour usage from data-logging, and speech perception scores, serving as our main outcomes for Aim 2.

***Specific Aim 3:* Determination of Effects of CI Patient Educational Program on Subjective Patient Satisfaction Rates and Quality of Life.**
Progress: Patient satisfaction and quality of life (QOL), serving as our main outcomes for Aim 3 were digitized onto REDCap and ready for deployment once we start enrolling patients.

American Neurotology Society Research Grant
Progress Report Date: February 13th, 2023
Project Title: Molecular Mechanisms of Hypofractionated Radiation in Vestibular Schwannoma: A Study of Radiation Resistance
Principal Investigator: Aida Nourbakhsh, M.D., Ph.D.
Mentor: Christine Dinh, M.D.
Institution: Department of Otolaryngology, Head & Neck Surgery, University of Miami, Florida

Background:

Vestibular schwannomas (VS) are benign intracranial tumors deriving from Schwann cells of the 8th cranial nerve that cause hearing loss and dizziness. They are caused by mutations in the NF2 tumor suppressor gene that encodes merlin protein. The main treatment options for VS are observation, stereotactic radiosurgery (SRS), and microsurgical resection, of which SRS has become more prevalent. The goal of SRS is to deliver sufficient radiation to halt tumor growth while minimizing radiation toxicity to surrounding structures, like the cochlea. Clinical experiences have led physicians to de-escalate radiation dosages and trial fractionated protocols to reduce non-tumor toxicities; common protocols use a marginal tumor dose of 12 Gray (Gy) in single fraction or 6 Gy weekly for 3 doses using a hypofractionation plan. However, SRS protocols continue to cause high rates of unserviceable hearing loss long term and the emergence of radiation resistance in ~15% of cases. The biological mechanisms leading to radiation ototoxicity and resistance in VS are not well understood, and investigations into understanding VS radiobiology will provide insight into potential targets and novel therapies to improve patient outcomes.

In a recent study, we demonstrated that single fraction radiation caused cell death in primary VS cells in a dose-dependent manner by producing double stranded breaks in DNA, which can be quantified by measuring γ-H2AX. In response to DNA damage, VS cells activate cell cycle checkpoint, p21, to initiate DNA repair mechanisms, of which RAD51 is a major player. Pre-treatment with a RAD51 inhibitor, RI-1, further promoted radiation-induced cell death in most tumors *in vitro*, which is advantageous for lower doses of radiation (i.e., 6 Gy) that were not as effective in initiating cell death alone. Our prior investigations have also shown (data to be published) that a hypofractionated protocol of 6 Gy daily x 3 is superior to 12 Gy single fraction for hearing preservation in rats *in vivo*. Although hypofractionation may improve hearing outcomes, we do not know whether hypofractionation activates DNA repair enzymes that can adversely affect tumor control in VS. Thus, in this proposal, we hypothesize that hypofractionation (6 Gy daily x 3 doses) is as effective in initiating cell death in VS cells as a biologically equivalent dose of single fraction radiation (12 Gy), and RAD51 inhibition can further improve tumor control by blocking DNA repair after irradiation.

AIM 1. Does hypofractionation (6 Gy daily x 3) cause a greater reduction in the viability of primary human VS cells when compared to single fraction (12 Gy) radiation?

Sub-AIM 1a. Does treatment with a RAD51 inhibitor promote further radiation-induced loss of primary VS tumor cells?

Progress: Primary cells from 8 VS tumors were cultured on either 96-well plates or 16-well chamber slides. We pre-treated VS cells with 0 or 10 μM RI-1 (RAD51 inhibitor) 1 hour prior to irradiation. We then exposed 8 primary VS cell lines to either 0 Gy, 6 Gy, or 12 Gy of single fraction radiation, or a hypofractionated protocol of 6 Gy daily x 3 doses. Viability and cleaved caspase-3/7 activity were performed using cell-based assays at 96 and 2 hours, respectively. We are in the process of conducting immunocytochemistry to quantify γ-H2AX, RAD51, as well as key players in cell cycle arrest (p53 and p21) and apoptosis (cleaved caspase-3/7) at 6 hours. We aim to perform the experiments in AIM 1 and Sub-AIM 1a on 2 more VS.

Preliminary Findings: VS cells demonstrate a variable response to radiation. On viability assays (Figure 1A), one VS (#8) was resistant to radiation. The remaining 7 VS had significant reductions in

viability after radiation, with greater reductions seen with 6 Gy daily x 3 when compared to 12 Gy single fraction. Only two VS (#2 and #3) had further reductions in viability with 1 hour pretreatment with 10 μM RI-1, and longer pre-treatment times with RI-1 may be needed to initiate further radiation toxicity. On cleaved caspase-3/7 assays (Figure 1B), two of eight VS (#2 and #5) showed statistically significant increases at 6 Gy and 12 Gy single fraction, respectively; however, this may be related to the time point tested and additional time points may need to be tested in the future. We aim to analyze immunocytochemistry results in the next 2 months and determine whether the heterogeneity seen in viability and cleaved caspase-3/7 may be related to cell cycle arrest and activation of DNA repair mechanisms.

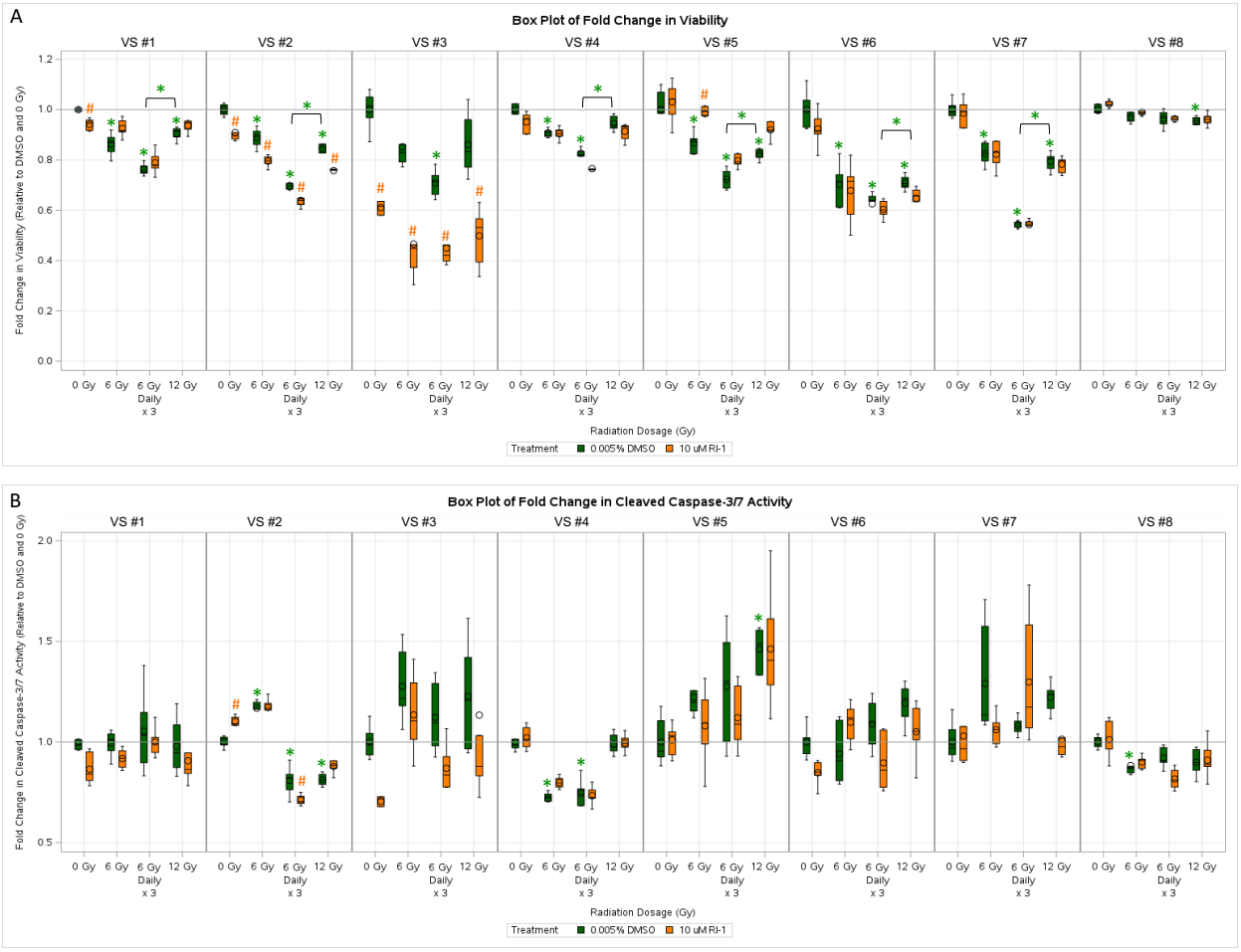

Figure 1. Effect of Single and Hypofractionated Radiation on 8 VS. Eight primary VS cell lines were treated with 0.005% DMSO (vehicle) or 10 μM RI-1 (RAD51 inhibitor) for 1 hour prior to exposure to 0 Gy, 6 Gy, 12 Gy, or 6 Gy daily x 3. **(A) Fold Change in Viability.** Viability assays were performed at 96 hours after final radiation dose. One VS (#8) was resistant to radiation. The remaining 7 VS had significant reductions in viability after radiation, with the great reductions seen with 6 Gy daily x 3 over 12 Gy single fraction. Only two VS (#2 and #3) had further reductions in viability with 1 hour pretreatment with 10 μM RI-1. **(B) Change in Cleaved Caspase-3/7 Activity.** Cleaved caspase-3/7 activity was measured at 2 hours post radiation treatment. At this time point, statistically significant increases in cleaved caspase-3/7 activity was noted in 2 VS (#2 and #5). Box plot = 25^{th}-50^{th}-75^{th} percentiles. Error bars represents minimum and maximum values. Circles = mean. * $p<0.05$. # $p<0.001$ when comparing RI-1 to 0.005% DMSO. n= 6 replicates each.

AIM 2. Are multiple DNA repair enzymes associated with radiation resistance in VS?

Progress: VS cells were cultured in T32 flasks until at least 70% confluent and then exposed to 0 or 12 Gy of single fraction radiation. RNA and protein were collected from primary VS cells at 6 hours and 24 hours, respectively. When Aim 1 is complete, we will identify one VS that is radiation sensitive and one VS that is resistant to radiation. When possible, we will match the 2 VS by tumor size, age, and gender. We plan to perform RNA sequencing and pathway analysis on both samples and use Western blot to confirm differential expression of top DNA repair proteins.

Research Fund of the American Neurotology Society
Progress Report Date: 02/13/2023
Principal Investigator: **Amit Walia, MD, MSCI** (Washington University in St. Louis)
Project Title: *Predicting performance in background noise for cochlear implant recipients using electrocochleography*

Background: The wide variability in cochlear implant (CI) performance postoperatively makes it challenging to counsel patients on realistic expectations. Duration of hearing loss, age at implantation, and positioning of the electrode within the cochlea together explain only ~25% of the variance in speech perception scores in quiet using the CI. More recently, electrocochleography (ECochG) responses account for ~50% of the variance in the same speech perception measures. The ECochG recording can be performed at the round window (RW), prior to electrode insertion, and measures acoustically evoked electrical potentials from hair cells and the auditory nerve. A single measure of residual cochlear function, ECochG total response (ECochG-TR), can be calculated from ECochG responses by summing the tonal stimuli of different frequencies across the speech spectrum. ***Prior studies have exclusively evaluated ECochG as a tool to predict CI performance in quiet and have not investigated it as a predictor of performance in noise, a more accurate measure of typical, real world listening situations.*** Our central hypothesis is that a measure of cochlear function, ECochG-TR, can be used to predict CI performance in noise. To evaluate the relationship between ECochG-TR and performance in noise, we will measure ECochG responses at the RW and compare the ECochG-TR to performance in noise at 6 months (Aim 1). We will then assess preoperative (audiologic and demographic) and intraoperative data (electrode location within the cochlea from CT reconstructions) and its relationship with CI performance in noise to build a multivariate model to predict CI performance in noise at 6 months (Aim 2). Finally, we will correlate ECochG responses at the RW with responses at the promontory as this is a location that potentially could be accessed trans-tympanically during the patient's preoperative candidacy evaluation (Aim 3). Participants are recruited at Washington University where >300 CIs are performed yearly. Measurements of ECochG responses are routine and patients with low-frequency acoustic hearing are recruited through a funded NIH study (U01DC018920, CA Buchman, PI). In this grant, we propose to utilize ECochG responses to build a prediction model for CI performance in noise and then assess the feasibility of recording these responses from the cochlear promontory with the goal of being able to predict CI performance during preoperative evaluation.

Aim 1: Correlate RW ECochG responses to postoperative CI performance (AzBio +10 dB signal-to-noise ratio [SNR]) in noise at 6 months. We *hypothesize* that RW ECochG-TR will moderately correlate with CI performance in noise at 6 months. The ECochG recording is performed using a sterile monopolar probe with various acoustic stimuli (250 Hz – 2 kHz), and the resulting waveforms are processing using Fast Fourier transformation to quantify both outer hair cells and auditory nerve function; this value is known as the ECochG-TR. A univariate linear regression model will be used to correlate ECochG-TR with AzBio +10 dB SNR at 6 months.

Progress: We have performed ECochG-TR measurements at the RW in 100 patients over the past 6 months. Only 53 patients have completed audiologic follow up at the 3-month time period. There is a moderate linear correlation between ECochG-TR as measured at the RW and AzBio +10 dB SNR (Figure 1). This suggests that good cochlear function is required for good performance in noise. However, not all patients that have good cochlear function (as measured by ECochG-TR) have good performance in noise. Thus, other factors may be important in being able to predict performance in noise (Aim 2).

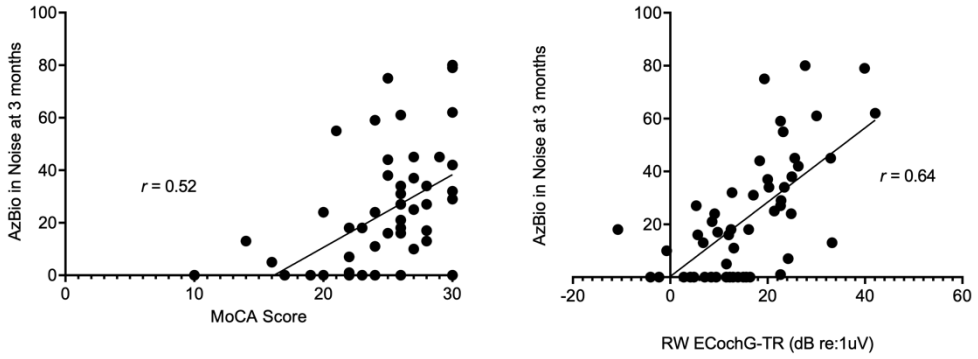

Figure 1: (left) AzBio in noise as a function of MoCA score; (right) AzBio in noise as a function of RW ECochG-TR

Aim 2: Develop a multivariate model to predict speech-perception performance in noise at 6 months. We *hypothesize* that a large ECochG-TR value and good cognition are both necessary for excellent CI performance in noise at 6 months. For patients undergoing CI, preoperative demographic and audiologic data will be obtained in addition to the ECochG data described in Aim 1. Using this information, a linear multivariate model will be built to predict speech performance in noise. Cognition will be measured preoperatively using the Montreal Cognitive Assessment (MoCA) score. Up to 9 variables will be used to build the prediction model, which will also include presence of residual hearing after CI, age, duration of hearing loss, prior hearing aid use, electrode placement as evaluated by CT scans, use of hybrid stimulation (CI and hearing aid in ipsilateral ear), and daily usage of CI.

Progress: We have collected demographic variables in our patients receiving CIs which include the same variables listed above. However, our current analysis is limited to not having sufficient follow-up (i.e., 6 months) for our prediction models and not having collected a sufficient sample size to assess the impact of each individual variable. We were able to assess the impact of both MoCA score and ECochG-TR to predict performance in noise (Figure 1). Our preliminary data shows that the combination of the two can explain ~60% of the variability in performance in noise. Specifically, a patient needs both a good ECochG-TR and a MoCA score to perform well in noise; not one is sufficient for good performance in noise. This is a critical concept as performance in noise is likely impacted by cognition and cochlear function.

Aim 3: Compare ECochG responses measured at the promontory with responses measured at the RW. We *hypothesize* that ECochG measures taken along the promontory will have a strong linear correlation with measures taken along the RW. The promontory can be readily accessed trans-tympanically in nearly all patients in the preoperative clinical setting, whereas transtympanic access to the RW is challenging. To use ECochG-TR as a preoperative measure, the promontory recordings must be of a similar quality to RW recordings. Prior to CI insertion, promontory measurements will be performed using a probe (as described in Aim 1) to determine the relationship between promontory and RW ECochG responses.

Progress: We have successfully compared responses measured at the promontory with those measured at the RW. This work was recently published in Otology & Neurotology - Walia A et al. Promontory Electrocochleography Recordings to Predict Speech-Perception Performance in Cochlear Implant Recipients. Otol Neurotol. 2022 Sep 1;43(8):915-923. doi: 10.1097/MAO.0000000000003628. Epub 2022 Jul 19. PMID: 35861658; PMCID: PMC9621328. We measured ECochG-TR at both the promontory and at extra- and intra-cochlear sites (i.e., round window membrane, just barely inside scala tympani, and after full insertion using the most apical electrode). We found that there were strong linear correlations with the ECochG-TR measured at the promontory and that measured just inside scala tympani (r = 0.91), RW membrane (r = 0.95), and after full insertion (r = 0.83; Figure 1). This work is critical in being able to translate these intraop recordings to promontory recordings that can potentially be performed in the clinic.

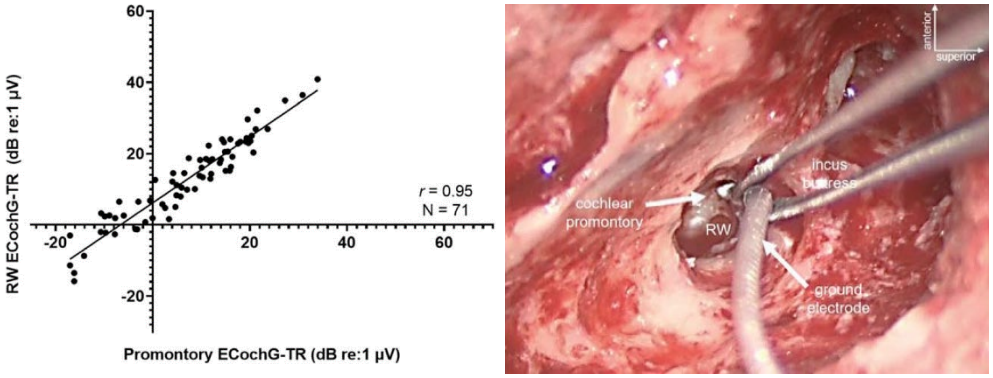

Figure 2: RW ECochG-TR is highly correlated with Promontory ECochG-TR

AMERICAN NEUROTOLOGY SOCIETY PAST PRESIDENTS

1965-69 Fred Harbert, MD
1969-70 Richard E. Marcus, MD
1970-71 Wallace Rubin, MD
1971-72 Malcolm H. Stroud, MD
1972-73 Martin Spector, MD
1973-74 Nicholas Torok, MD
1974-75 Cecil W. Hart, MD
1975-76 Sidney N. Busis, MD
1976-77 Brian F. McCabe, MD
1977-78 Bruce Proctor, MD
1978-79 David A. Dolowitz, MD
1979-80 Fred H. Linthicum Jr., MD
1980-81 Harold Schuknecht, MD
1981-82 Hugh Barber, MD
1982-83 Kenneth H. Brookler, MD
1983-84 Richard Gacek, MD
1984-85 Derald Brackmann, MD
1985-86 Robert J. Keim, MD
1986-87 Jack D. Clemis, MD
1987-88 Malcolm Graham, MD
1988-89 Robert A. Jahrsdoerfer, MD
1989-91 Shokri Radpour, MD
1992-92 Antonio De La Cruz, MD
1992-93 Fredric W. Pullen II, MD
1993-94 Charles M. Luetje II, MD
1994-95 Sam E. Kinney, MD
1995-96 Joseph DiBartolomeo, MD
1996-97 Jack M. Kartush, MD
1997-98 Bruce J. Gantz, MD
1998-99 John W. House, MD
1999-00 Richard J. Wiet, MD
2000-01 Richard T. Miyamoto, MD
2001-02 Stephen G. Harner, MD
2002-03 Newton J. Coker, MD
2003-04 Paul R. Lambert, MD
2004-05 Robert K. Jackler, MD
2005-06 Debara L. Tucci, MD
2006-07 Joel A. Goebel, MD
2007-08 D. Bradley Welling, MD, PhD
2008-09 Karen J. Doyle, MD, PhD
2009-10 Samuel H. Selesnick, MD
2010-11 J. Douglas Green Jr., MD
2011-12 Jeffrey T. Vrabec, MD
2012-13 Clough Shelton, MD
2013-14 Hilary A. Brodie, MD, PhD
2014-15 Anil K. Lalwani, MD
2015-16 John T. McElveen, Jr., MD
2016-17 Lawrence R. Lustig, MD
2017-18 Moisés A. Arriaga, MD, MBA
2018-19 Barry E. Hirsch, MD
2019-20 Nikolas H. Blevins, MD
2020-21 Bradley W. Kesser, MD
2021-22 Craig A. Buchman, MD
2022-23 Fred F. Telischi, MD

AMERICAN NEUROTOLOGY SOCIETY PAST SECRETARY-TREASURERS

1965-68 Richard E. Marcus, MD

1968-70 Bruce Proctor, MD

1970-71 F. Blair Simmons, MD

1971-72 Cecil Hart, MD

1972-74 Sidney Busis, MD

1974-76 Jack Pulec, MD

1976-79 Michael Glasscock III, MD

1979-85 Robert Keim, MD

1985-88 Shokri Radpour, MD

1988-92 Charles M. Luetje II, MD

1992-95 Jack M. Kartush, MD

1995-98 Richard J. Wiet, MD

1998-01 Newton J. Coker, MD

2001-04 Debara L. Tucci, MD

2004-07 Karen J. Doyle, MD, PhD

2007-10 Jeffrey T. Vrabec, MD

2010-13 Anil K. Lalwani, MD

2013-16 Moisés A. Arriaga, MD, MBA

2016-19 Bradley W. Kesser, MD

2019-22 Elizabeth H. Toh, MD, MBA

2022-current David S. Haynes, MD, MMHC

DISCLOSURE INFORMATION

AMERICAN NEUROTOLOGY SOCIETY: 58TH ANNUAL SPRING MEETING
MAY 5-6, 2023
BOSTON, MA

In accordance with the ACCME Accreditation Criteria, the American College of Surgeons must ensure that anyone in a position to control the content of the educational activity (planners and speakers/authors/discussants/moderators) has disclosed all financial relationships with any commercial interest (termed by the ACCME as an "ineligible company", defined below) held in the last 24 months (see below for definitions). Please note that first authors were required to collect and submit disclosure information on behalf all other authors/contributors, if applicable.

Ineligible company: Any entity producing, marketing, re-selling, or distributing health care goods or services used on or consumed by patients. Providers of clinical services directly to patients are NOT included in this definition.
Financial Relationships: Relationships in which the individual benefits by receiving a salary, royalty, intellectual property rights, consulting fee, honoraria, ownership interest (e.g., stocks, stock options or other ownership interest, excluding diversified mutual funds), or other financial benefit. Financial benefits are usually associated with roles such as employment, management position, independent contractor (including contracted research), consulting, speaking and teaching, membership on advisory committees or review panels, board membership, and other activities from which remuneration is received, or expected. ACCME considers relationships of the person involved in the CME activity to include financial relationships of a spouse or partner.
Conflict of Interest: Circumstances create a conflict of interest when an individual has an opportunity to affect CME content about products or services of an ineligible company with which he/she has a financial relationship.

The ACCME also requires that ACS manage any reported conflict and eliminate the potential for bias during the educational activity. Any conflicts noted below have been managed to our satisfaction. The disclosure information is intended to identify any commercial relationships and allow learners to form their own judgments. However, if you perceive a bias during the educational activity, please report it on the evaluation.

SPEAKERS / MODERATORS / DISCUSSANTS/AUTHORS	NOTHING TO DISCLOSE	DISCLOSURE		
		COMPANY	ROLE	RECEIVED
Fred F. Telischi, MD	X			
Suhrud M. Rajguru, PhD	X			
Meredith E. Adams, MD	X			
Jay W. Reddy, PhD		Advanced Optronics Inc.	executive	Owns stocks
Pawina Jiramongkolchai, MD	X			
Alexander R. Geerardyn, MD	X			
Evan P. Nix, MD, MBA	X			
J. Thomas Roland Jr., MD	X			
Amit Walia, MD	X			
Nathan R. Lindquist, MD	X			
Cole Pavelchek, BS	X			
Ashley M. Nassiri, MD, MBA	X			
Aida Nourbakhsh, MD, PhD	X			
J. Walter Kutz, MD	X			
Hamid Djalilian, MD	X			
Jeffrey Kuhn, MD	X			
Jennifer Maw, MD	X			
Jeffrey Sharon, MD	X			
Kristen Steenerson, MD	X			

Peter C. Weber, MD, MBA	X			
Nicholas A. George-Jones, MD	X			
Ankita Patro, MD, MS	X			
Hasan Abdulbaki, BA	X			
Allison Reeder, MD	X			
George S. Liu, MD	X			
James R. Dornhoffer, MD	X			
Courtney C.J. Voelker, MD, PhD	X			
Sudhir Manickavel, MD	X			
Lisa Zhang, MD	X			
Judith S. Kempfle, MD		Frequency 3NT Medical	Consultant Consultant	share holder share holder (no COI in regards to this project)
Caio A. Neves, MD	X			
John P. Marinelli, MD	X			
Michael H. Freeman, MD		EndoTheia, Inc.	consultant	developing endoscopes, and their work does not pertain to the content of this presentation.
Scott R. Plotkin, MD, PhD	X			
Ronna Hertzano, MD, PhD	X			
Tracy Cheng, MD, MHSc	X			
Guangwei Zhou, ScD	X			
Karen Tawk, MD	X			
Evan L. Tooker, MS	X			
Zachary G. Schwam, MD	X			
Eric J. Formeister, MD, MS	X			
Daniel Zeitler, MD	X			
Emily Stucken, MD	X			
Jacques Morcos, MD	X			
Seilesh Babu, MD	X			
Myriam Loyo Li, MD MCR	X			
PLANNING COMMITTEE	**NOTHING TO DISCLOSE**	**DISCLOSURE**		
		COMPANY	**ROLE**	**RECEIVED**
Fred F. Telischi, MD	X			
Elizabeth H. Toh, MD, MBA		Envoy medical	Consultant	none
David S. Haynes, MD, MMHC		Cochlear Med EL Advanced bionics Stryker Grace Medical	Consultant for all	Honoria for consulting for all
Craig A. Buchman, MD		Cochlear Advanced bionics Envoy Iotamotion	Consultant for all	Nothing Nothing Consultant fees Consultant fees
Yuri Agrawal, MD, MPH	X			
Stephanie Moody Antonio, MD	X			
Hussam K El-Kashlan, MD	X			
Sarah Mowry, MD		Cochlear America MedTronic Cook Medical Stryker	Educational content for all	Consulting fees Honoraria Consulting fees Travel costs

Alan G, Micco, MD	X			
Christine Dinh, MD	X			
J. Thomas Roland, MD		Cochlear Americas	Consultant/ Executive Advisory Board Member	Advisory Board Payments/ Travel
Brian Nicholas, MD		Pulaski Law Firm	Consultancy fee	Medical Expert Consultancy
Meredith Adams, MD		Advanced Bionics	Travel expenses	Medical Advisory Council
Sean Wise, MD	X			
Greg Basura, MD	X			
Susan Emmett, MD		hearX	Speaking honoraria	Speaking on Viewpoint (filmed in October 2021)
Alex Sweeney, MD		Cochlear Americas	Paid Travel to Scientific Meeting (12/2021)	Consultancy
Courtney Voelker, MD		Advanced bionics Cochlear Americas	Consultant fee Educational Grant Teach temporal bone course	Consultant Consultant
Cameron Wick, MD		Stryker Cochlear Corporation	Travel Stipend Consultant Consultant Fee	Surgical Course Instructor Consultant
Daniel Sun, MD	X			
Syed Ahsan, MD	X			
Mark Bassim, MD	X			
Eleanor Chan, MD	X			
Peter Weber, MD, MBA	X			
Brian P. Perry, MD	X			
Esther X. Vivas, MD	X			
Brandon Isaacson, MD	X			
Marc Eisen, MD	X			
Selena Briggs, MD	X			
Laura Brainard, MD	X			
Matthew Stewart, MD, PhD	X			
Erika M. Walsh, MD	X			
Nael Shoman, MD	X			
Daniel M. Zeitler, MD	X			
Mark Wiet, MD	X			
Jeffrey J.Kuhn, MD	X			
Shawn M. Stevens, MD	X			
Ronna Hertzano, MD, PhD	X			

AMERICAN NEUROTOLOGY SOCIETY

2023 Membership Roster
(includes new members inducted at 2023 Spring meeting)

Mehdi Abouzari, MD, PhD
Orange, CA
Associate

Meredith E Adams, MD
Minneapolis, MN
Fellow

Jason K Adams, MD
San Antonio, TX
Trainee

Oliver F Adunka, MD
Columbus, OH
Fellow

Yuri Agrawal, MD
Lutherville, MD
Fellow

Jumah G Ahmad, MD
Houston, TX
Trainee

Sameer Ahmed, MD
Downey, CA
Fellow

Syed F Ahsan, MD
Irvine, CA
Fellow

Mohammad Al Saadi, MD
Brussels, Belgium
Trainee

Pedro Luiz M Albernaz, MD, PhD
Sao Paulo, Brazil
Senior Fellow

Thomas H Alexander, MD
La Jolla, CA
Fellow

George Alexiades, MD
New York, NY
Fellow

Kyle P Allen, MD
Tampa, FL
Fellow

Sean R Althaus, MD
Georgetown, TX
Emeritus

Jennifer Alyono, MD
Stanford, CA
Fellow

Ronald G Amedee, MD
New Orleans, LA
Fellow

James C Andrews, MD
Manhattan Beach, CA
Fellow

Simon I Angeli, MD
Miami, FL
Fellow

Kristen Angster, MD
Troy, MI
Fellow

Philip F Anthony, MD
Fort Worth, TX
Senior Fellow

Patrick J Antonelli, MD
Gainesville, FL
Fellow

Charles Lane Anzalone, MD
Crowley, LA
Associate

Eric N Appelbaum, MD
Marietta, GA
Associate

Irving Arenberg, MD
Centennial, CO
Emeritus

Moises A Arriaga, MD
Metairie, LA
Fellow

H Alexander Arts, MD
Ann Arbor, MI
Fellow

Gregory J Artz, MD
Grand Rapids, MI
Fellow

Leena Asfour, MD
New York, NY
Trainee

Peter E Ashman, MD
Jersey City, NJ
Trainee

James S Atkins, Jr, MD
Celebration, FL
Fellow

Gregory A Ator, MD
Kansas City, KS
Senior Associate

Jason R Audlin, MD
Syracuse, NY
Trainee

Michael P Avillion, MD
Los Angeles, CA
Trainee

John W Ayugi, ChB, MB
Nairobi, Kenya
Associate

Eric E Babajanian, MD
Salt Lake City, UT
Trainee

Seilesh C Babu, MD
Farmington Hills, MI
Fellow

Douglas D Backous, MD
Edmonds, WA
Fellow

R Stanley Baker, MD
Oklahoma City, OK
Fellow

Robert L Baldwin, MD
Birmingham, AL
Senior Fellow

Thomas J Balkany, MD
Long Key, FL
Senior Fellow

Ben J Balough, MD
Sacramento, CA
Fellow

Renee M Banakis Hartl, MD
Ann Arbor, MI
Associate

Manohar L Bance, MD
Cambridge, United Kingdom, United Kingdom
Fellow

David M Barrs, MD
Phoenix, AZ
Senior Fellow

Michael Bartellas, MD
Ottawa, ON Canada
Trainee

Loren J Bartels, MD
Tampa, FL
Fellow

Richard M Bass, MD
Springfield, IL
Senior Fellow

Mark K Bassim, MD
Abu Dhabi, YT United Arab Emirates
Fellow

Gregory J Basura, MD, PhD
Ann Arbor, MI
Fellow

Alex S Battaglia, MD, PhD
San Rafael, CA
Fellow

Robert A Battista, MD
La Grange, IL
Fellow

Carol A Bauer, MD
Springfield, IL
Emeritus

David D Beal, MD
Anchorage, AK
Senior Fellow

Charles W Beatty, MD
Rochester, MN
Emeritus

James E Benecke, MD
Scottsdale, AZ
Senior Fellow

Jaime Benitez, MD
Farmington Hills, MI
Senior Fellow

Marc L Bennett, MD
Nashville, TN
Fellow

Brent J Benscoter, MD
Sacramento, CA
Fellow

Aaron G Benson, MD
Greenfield, WI
Fellow

Karen I Berliner, PhD
Marina Del Rey, CA
Associate

Jason A Beyea, MD, PhD
Kingston, ON Canada
Associate

Sanjay Bhansali, MD
Atlanta, GA
Fellow

Alexander G Bien, MD
Oklahoma City, OK
Fellow

Robin T Bigelow, MD
Los Angeles, CA
Trainee

Douglas C Bigelow, MD
Philadelphia, PA
Fellow

Brian W Blakley, MD, PhD
Winnipeg, MB Canada
Senior Fellow

Nikolas H Blevins, MD
Stanford, CA
Fellow

Dennis I Bojrab, MD
Farmington Hills, MI
Fellow

Dennis I Bojrab II, MD
Bloomfield Hills, MI
Fellow

Kestutis P Boyev, MD
Tampa, FL
Fellow

Derald E Brackmann, MD
Los Angeles, CA
Senior Fellow

Laura Brainard, MD
Detroit, MI
Fellow

Thomas G Brammeier, MD
Belton, TX
Fellow

Robert E Brammer, MD
St Clr Shores, MI
Fellow

Jason A Brant, MD
Wallingford, PA
Fellow

Joseph T Breen, MD
Jacksonville, FL
Fellow

Arnold K Brenman, MD
Jenkintown, PA
Emeritus

Robert J S Briggs, MD
Kooyong, Australia
Fellow

Selena E Briggs, MBA, MD, PhD
Washington, DC
Fellow

B Hill Britton, MD
San Antonio, TX
Emeritus

Hilary A Brodie, MD, PhD
Davis, CA
Senior Fellow

Gerald B Brookes, MD
London,
Fellow

Kenneth H Brookler, MD
Norwalk, CT
Emeritus

Morgan Brosnan, MD
Thorold, ON Canada
Senior Fellow

Jeffrey J Brown, MD, PhD
Portland, OR
Emeritus

C. Scott Brown, MD
Atlanta, GA
Fellow

Kevin D Brown, MD
Chapel Hill, NC
Fellow

J Dale Browne, MD
Winston Salem, NC
Fellow

Patrick Cody Buchanan, DO
Tulsa, OK
Associate

Craig A Buchman, MD
St Louis, MO
Fellow

Cameron L Budenz, MD
Sleepy Hollow, NY
Fellow

Hana T Bui, MD
Fullerton, CA
Senior Associate

Mustafa G Bulbul, MD
Morgantown, WV
Trainee

Don L Burgio, MD
Scottsdale, AZ
Senior Fellow

Matthew L. Bush, MBA, MD, PhD
Lexington, KY
Fellow

Melissa Castillo Bustamante, MD
Medellin, Colombia
Associate

Audrey P Calzada, MD
Carlsbad, CA
Fellow

Robert W Cantrell, MD
Charlottesville, VA
Emeritus

John P Carey, MD
Baltimore, MD
Fellow

Matthew J Carfrae, MD
Clive, IA
Fellow

Matthew L Carlson, MD
Rochester, MN
Fellow

Garrett GA Casale, MD
Royal Oak, MI
Trainee

Geoffrey Cole Casazza, MD
Omaha, NE
Fellow

Stephen P Cass, MD, MPH
Aurora, CO
Fellow

Nathan D Cass, MD
Lexington, KY
Associate

Ryan M Casserly, MD
Monterey, CA
Associate

Adam M Cassis, MD
Chandler, AZ
Fellow

Eleanor Y Chan, MD
Farmington Hills, MI
Fellow

Sujana S Chandrasekhar, MD
New York, NY
Fellow

C Y Chang, MD
Houston, TX
Fellow

Guyan A Channer, MD
Kingston, Jamaica
Fellow

Ewen A Chao, MD
Stony Brook, NY
Trainee

Divya Chari, MD
Boston, MA
Associate

Brian S Chen, MD
Tripler, HI
Fellow

Si Chen, MD
Gainesville, FL
Fellow

Douglas A Chen, MD
Wexford, PA
Fellow

Joseph M Chen, MD
Toronto, ON Canada
Fellow

Alexander Chern, MD
New York, NY
Trainee

Steven W Cheung, MD
San Francisco, CA
Fellow

Wade W Chien, MD
Baltimore, MD
Fellow

Rebecca C Chiffer, MD
Philadelphia, PA
Associate

Edgar L Chiossone, MD
Miami, FL
Senior Fellow

Edward I Cho, MD
Los Angeles, CA
Associate

Won-Taek Choe, MD
New York, NY
Fellow

Janet S Choi, MD
Minneapolis, MN
Trainee

Jonathan Choi, MD
West Bloomfield, MI
Trainee

Richard A Chole, MD, PhD
Saint Louis, MO
Emeritus

Laura H Christopher, MD
Jackson, MS
Fellow

Jack Clemis, MD
Chicago, IL
Senior Fellow

Francois Cloutier, MD
Longueuil, QC Canada
Fellow

Daniel H Coelho, MD
Richmond, VA
Fellow

Burton J Cohen, MD
Louisville, KY
Senior Fellow

Newton J Coker, MD
Santa Fe, NM
Senior Fellow

Candice Colby, MD
Midland, MI
Fellow

George H Conner, MD
Lebanon, PA
Emeritus

Robert M Conway, MD
Berkley, MI
Trainee

Timothy Cooper, MD
Edmonton, AB Canada
Associate

C. Eduardo Corrales, MD
Boston, MA
Fellow

Maura K Cosetti, MD
New York, NY
Fellow

Justin Cottrell, MD
New York, NY
Trainee

Matthew D Cox, MD
Winter Park, FL
Associate

Benjamin T Crane, MD, PhD
Rochester, NY
Fellow

James V Crawford, MD
Boise, ID
Fellow

Francis X Creighton, MD
Baltimore, MD
Fellow

Matthew G Crowson, MD, MSC
Boston, MA
Associate

Roberto A Cueva, MD
San Diego, CA
Senior Fellow

Robert D Cullen, MD
Kansas City, MO
Fellow

Evan C Cumpston, MD
Indianapolis, IN
Trainee

Calhoun D Cunningham III, MD
Raleigh, NC
Fellow

Steven D Curry, MD
Omaha, NE
Trainee

Frank S Curto, Jr, MD
Bethesda, MD
Senior Fellow

Robert L Daniels, MD
Grand Rapids, MI
Fellow

Christopher J Danner, MD
Tampa, FL
Fellow

D Spencer Darley, MD
Provo, UT
Associate

Christopher De Souza, MD
Bombay, India
Fellow

Nicholas L Deep, MD
Phoenix, AZ
Associate

Charles C Della Santina, MD, PhD
Baltimore, MD
Fellow

M Jennifer Derebery, MD
Los Angeles, CA
Senior Fellow

Nicholas A Dewyer, MD
Tucson, AZ
Fellow

Joseph Di Bartolomeo, MD
Santa Barbara, CA
Senior Fellow

Rodney C Diaz, MD
Sacramento, CA
Fellow

John RE Dickins, MD
Fayetteville, AR
Emeritus

Elizabeth A Dinces, MD
Scarsdale, NY
Fellow

Christine T Dinh, MD
Miami, FL
Fellow

Michael J Disher, MD
Fort Wayne, IN
Fellow

Peter R Dixon, MD
San Diego, CA
Trainee

Hamilton S Dixon, MD
East Ellijay, GA
Emeritus

Hamid R Djalilian, MD
Irvine, CA
Fellow

Edward Dodson, MD
Dublin, OH
Fellow

Karl W Doerfer, MD
Milwaukee, MI
Associate

Joni K Doherty, MD, PhD
Los Angeles, CA
Fellow

Katsumi Doi, MD, PhD
Osaka, Japan
Associate

James R Dornhoffer, MD
Rochester, MN
Trainee

John L Dornhoffer, MD
Little Rock, AR
Fellow

Karen Jo Doyle-Enright, MD, PhD
Wyandotte, MI
Fellow

David A Drachman, MD
Worcester, MA
Emeritus

Colin L W Driscoll, MD
Rochester, MN
Fellow

Larry Duckert, MD, PhD
Seattle, WA
Senior Fellow

Brian E Duff, MD
Greenwich, RI
Fellow

Nedim Durakovic, MD
St Louis, MO
Associate

Paul Dutcher, MD
Rochester, NY
Senior Fellow

Shubha Ranjan Dutta, MD
Memphis, TN
Trainee

Thomas L Eby, MD
Jackson, MS
Fellow

Marc D Eisen, MD, PhD
Farmington, CT
Fellow

David J Eisenman, MD
Baltimore, MD
Fellow

Hussam K El-Kashlan, MD
Ann Arbor, MI
Fellow

Susan E Ellsperman, MD
Glendale, CA
Trainee

Mohamed Elrakhawy, MD
Buffalo, NY
Trainee

Susan D Emmett, MD, MPH
Little Rock, AR
Associate

John R Emmett, MD
Germantown, TN
Senior Fellow

Margaret I Engelhardt, MD
Minneapolis, MN
Trainee

Sherise Epstein, MD
Seattle, WA
Trainee

Isaac Erbele, MD
San Antonio, TX
Associate

Adrien A Eshraghi, MD
Weston, FL
Fellow

Mana Espahbodi, MD
Salt Lake City, UT
Trainee

Abhinav R Ettyreddy, MD
Pittsburgh, PA
Trainee

Abraham Eviatar, MD
Scarsdale, NY
Senior Fellow

Caleb J Fan, MD
New York, NY
Trainee

Joseph B Farrior, MD
Tampa, FL
Senior Fellow

Jose N Fayad, MD
Dhahran, Saudi Arabia
Fellow

Robert S Feehs, MD
Englewood, CO
Fellow

Joseph G Feghali, MD
Bronx, NY
Fellow

Bruce A Feldman, MD
Potomac, MD
Emeritus

Bruce L Fetterman, MD
Germantown, TN
Fellow

Terry D Fife, MD
Phoenix, AZ
Fellow

Dennis C Fitzgerald, MD
Philadelphia, PA
Senior Fellow

Eric J Formeister, MD, MSC
Durham, NC
Associate

Michael F Foster, DO
Ada, MI
Associate

David Foyt, MD
Albany, NY
Fellow

Howard W Francis, MBA, MD
Durham, NC
Fellow

Daniel J Franklin, MD
Houston, TX
Fellow

Douglas W Frerichs, MD
Flagstaff, AZ
Senior Fellow

David R Friedland, MD, PhD
Milwaukee, WI
Fellow

Rick A Friedman, MD, PhD
La Jolla, CA
Fellow

David R Friedmann, MD, MSC
New York, NY
Fellow

Michael H Fritsch, MD
Indianapolis, IN
Fellow

Michael J Fucci, MD
Chandler, AZ
Fellow

Rance JT Fujiwara, MD
Los Angeles, CA
Trainee

Richard R Gacek, MD
Worcester, MA
Emeritus

Deepa Galaiya, MD
Rockville, MD
Associate

Michele M Gandolfi, MD
Winston-Salem, NC
Fellow

Jay A Gantz, MD, PhD
Portland, OR
Associate

Bruce J Gantz, MD
Iowa City, IA
Fellow

Juan M Garcia, MD
Miami, FL
Fellow

L Gale Gardner, MD
Shreveport, LA
Senior Fellow

George A Gates, MD
Boerne, TX
Senior Associate

Bechara Y Ghorayeb, MD
Houston, TX
Fellow

Soha N Ghossaini, MD
Astoria, NY
Fellow

Gerard Joseph Gianoli, MD
Covington, LA
Fellow

William P R Gibson, MD
Birchgrove, Australia
Senior Fellow

Neil A Giddings, MD
Spokane, WA
Senior Fellow

Paul W Gidley, MD
Houston, TX
Fellow

Martin Gizzi, MD, PhD
Hackensack, NJ
Fellow

Michael B Gluth, MD
Chicago, IL
Fellow

John C Goddard, MD
Clackamas, OR
Fellow

Joel A Goebel, MD
Saint Louis, MO
Emeritus

Robert A Goldenberg, MD
Dayton, OH
Emeritus

Elliot Goldofsky, MD
Great Neck, NY
Associate

M Miles Goldsmith, MD
Savannah, GA
Senior Fellow

Hernan Goldsztein, MD
La Jolla, CA
Fellow

Justin S Golub, MD, MSC
New York, NY
Fellow

Stefania Goncalves, MD
Miami, FL
Trainee

Quinton Gopen, MD
Los Angeles, CA
Fellow

Michael A Gordon, MD
West Hempstead, NY
Senior Fellow

Malcolm Graham, MD
Atlanta, GA
Emeritus

J Douglas Green, Jr, MD
Jacksonville, FL
Fellow

Lawrence R Grobman, MD
Miami, FL
Fellow

Samuel P Gubbels, MD
Aurora, CO
Fellow

A Julianna Gulya, MD
Locust Grove, VA
Senior Fellow

Sachin Gupta, MD
seattle, WA
Fellow

Richard K Gurgel, MD
Salt Lake City, UT
Fellow

Thomas J Haberkamp, MD
Cleveland, OH
Senior Fellow

Rex S Haberman, MD
Gainesville, FL
Fellow

Kevin S Hadley, MD
Aiea, HI
Fellow

Yoav Hahn, MD
Dallas, TX
Fellow

G Michael Halmagyi, MD
Sydney, Australia
Honorary

Mickie J Hamiter, MD
New York City, NY
Trainee

Paul E Hammerschlag, MD
New York, NY
Emeritus

Marlan R Hansen, MD
Iowa City, IA
Fellow

Matthew B Hanson, MD
Brooklyn, NY
Fellow

Lee Harker, MD
Omaha, NE
Emeritus

Stephen G Harner, MD
Rochester, MN
Senior Fellow

Jeffrey P Harris, MD, PhD
San Diego, CA
Senior Fellow

Michael S Harris, MD
Milwaukee, WI
Fellow

Cecil W Hart, MD
Palm Springs, CA
Emeritus

Steven A Harvey, MB, MD
Milwaukee, WI
Fellow

George T Hashisaki, MD
Charlottesville, VA
Fellow

Jonathan Hatch, MD
Murray, UT
Fellow

David S Haynes, MD
Nashville, TN
Fellow

Katherine Do Heidenreich, MD
Ann Arbor, MI
Associate

Edward Hendershot, MD
Lodi, OH
Senior Fellow

Ronna Hertzano, MD, PhD
Baltimore, MD
Fellow

Jacques A Herzog, MD
St Louis, MO
Fellow

Thomas O Hester, MD
Charleston, SC
Fellow

Mitchell L Heuermann, MD
Springfield, IL
Trainee

George Hicks, MD
Indianapolis, IN
Fellow

Michelle K Higgins, MD
Iowa City, IA
Trainee

Douglas M Hildrew, MD
New Haven, CT
Fellow

Todd A Hillman, MD
Wexford, PA
Fellow

Christopher W Hilton, MD
St Paul, MN
Fellow

Taylor P Hipp, MD
Shreveport, LA
Trainee

Barry Hirsch, MD
Pittsburgh, PA
Senior Fellow

Michael Hoa, MD
Washington, DC
Fellow

Candace E Hobson, MD
Atlanta, GA
Fellow

Sarah E Hodge, MD
Augusta, GA
Associate

Michael E Hoffer, MD
Miami, FL
Fellow

Ronald A Hoffman, MD
New York, NY
Senior Fellow

Dick L Hoistad, MD
Seattle, WA
Fellow

James J Holt, MD
Marshfield, WI
Senior Fellow

Robert S Hong, MD, PhD
Farmington Hills, MI
Fellow

Vicente Honrubia, MD
Los Angeles, CA
Senior Fellow

Arata Horii, MD
Niigata, Japan
Fellow

Karl L Horn, MD
Santa Fe, NM
Senior Fellow

Melton J Horwitz, MD
Houston, TX
Senior Fellow

John W House, MD
Los Angeles, CA
Senior Fellow

James R House, III, MD
Jackson, MS
Fellow

May Y Huang, MD
Seattle, WA
Fellow

Tina C Huang, MD
Minneapolis, MN
Fellow

Mikayla J Huestis, MD
Norfolk, VA
Trainee

Dominic W Hughes, PhD
West Linn, OR
Senior Associate

Timothy E Hullar, MD
Portland, OR
Fellow

Jacob B Hunter, MD
Dallas, TX
Fellow

Tiffany Peng Hwa, MD
Philadelphia, PA
Associate

Makoto Igarashi, MD
Tokyo, Japan
Senior Associate

Takao Imai, MD, PhD
Suita-City, Japan
Fellow

Terence E Imbery, MD
Chicago, IL
Fellow

Brandon Isaacson, MD
Dallas, TX
Fellow

Jon E Isaacson, MD
Hershey, PA
Fellow

Akira Ishiyama, MD
Los Angeles, CA
Fellow

Huseyin Isildak, MD
Stony Brook, NY
Fellow

Robert K Jackler, MD
Stanford, CA
Fellow

Neal M Jackson, MD
New Orleans, LA
Fellow

Carol Jackson, MD
Newport Beach, CA
Fellow

Lance E Jackson, MD
San Antonio, TX
Fellow

Abraham Jacob, MD
Tucson, AZ
Fellow

Taha A Jan, MD
Associate

Herman A Jenkins, MD
Aurora, CO
Senior Fellow

Daniel Jethanamest, MD
New York, NY
Fellow

Nicole Tin-Lok Jiam, MD
Boston, MA
Trainee

Pawina JIramongkolchai, MD
San Diego, CA
Trainee

Benjamin R Johnson, MD
Cleveland, OH
Trainee

Alan J Johnson, MD, MPH
Temple, TX
Fellow

Raleigh O Jones, MD
Lexington, KY
Fellow

Timothy T K Jung, MD, PhD
Riverside, CA
Fellow

David H Jung, MD, PhD
Boston, MA
Fellow

Jacob Kahane, MD
Albuquerque, NM
Associate

Donald B Kamerer, MD
Pittsburgh, PA
Emeritus

Romain E Kania, MD, PhD
Paris, France
Associate

Vivek V Kanumuri, MD
Miami, FL
Trainee

Howard M Kaplan, MD
Plantation, FL
Senior Fellow

Elina Kari, MD
La Jolla, CA
Fellow

Alexandre Karkas, MD, PhD
Saint-Etienne, France
Fellow

Jack Kartush, MD
Bloomfield Hills, MI
Senior Fellow

Rustin G Kashani, MD
Menlo Park, CA
Trainee

Athanasios Katsarkas, MD
Montreal, Canada
Emeritus

Adam C Kaufman, MD, PhD
Baltimore, MD
Associate

Vivian F Kaul, MD
Columbus, OH
Trainee

David M Kaylie, MD
Durham, NC
Fellow

Emily Kay-Rivest, MD, MSC
Montreal, QC Canada
Associate

Ken Kazahaya, MBA, MD
Miami Beach, FL
Associate

Brian Kellermeyer, MD
Morgantown, WV
Associate

Robert Kellman, MD
Syracuse, NY
Senior Fellow

Elizabeth A Kelly, MD
Elkhorn, NE
Fellow

David C Kelsall, MD
Englewood, CO
Associate

Nathan C Kemper, MD
Iowa City, IA
Trainee

Catherine L Kennedy, MD
Baltimore, MD
Trainee

Bradley W Kesser, MD
Charlottesville, VA
Fellow

Jeffrey Keyser, MD
Providence, UT
Associate

Paul Kileny, PhD
Ann Arbor, MI
Senior Associate

Daniel E Killeen, MD
Cleveland, OH
Fellow

Hung Jeffrey Kim, MD
Washington, DC
Fellow

Ana H Kim, MD
New York, NY
Fellow

Harold H Kim, MD
Portland, OR
Fellow

Susan M King, MD
San Antonio, TX
Fellow

Matthew L Kircher, MD
Maywood, IL
Fellow

Ruwan Kiringoda, MD
Fremont, CA
Fellow

Tadashi Kitahara, MD, PhD
Kashihara-city, Japan
Fellow

Glenn W Knox, MD
Jacksonville, FL
Fellow

Pelin Kocdor, MD
Istanbul, Turkey
Associate

Darius Kohan, MD
New York, NY
Fellow

Gavriel D Kohlberg, MD
Seattle, WA
Fellow

Robert Kohut, MD
Woodleaf, NC
Emeritus

Horst R Konrad, MD
Springfield, IL
Senior Fellow

Richard D Kopke, MD
Oklahoma City, OK
Senior Fellow

Harold W Korol, MD
Palo Alto, CA
Senior Fellow

Ali Kouhi, MD
Tehran, Iran
Associate

Elliott D Kozin, MD
Boston, MA
Associate

Wesley WO Krueger, MD
San Antonio, TX
Senior Fellow

Thomas C Kryzer, MD
Wichita, KS
Associate

Jeffery J Kuhn, MD
Virginia Beach, VA
Fellow

Brian Kung, MD
Las Vegas, NV
Fellow

J Walter Kutz, Jr, MD
Dallas, TX
Fellow

John Kveton, MD
New Haven, CT
Fellow

Jed Kwartler, MBA, MD
South Orange, NJ
Fellow

Robert F Labadie, MD, PhD
Charleston, SC
Fellow

David J Lafferty, MD
Philadelphia, PA
Trainee

Anil K Lalwani, MD
New York, NY
Fellow

Paul R Lambert, MD
Charleston, SC
Senior Fellow

Alan W Langman, MD
Seattle, WA
Fellow

Michael J LaRouere, MD
Northville, MI
Senior Fellow

John M Lasak, MD
Wichita, KS
Fellow

Lorenz F Lassen, MD
Suffolk, VA
Senior Fellow

Daniel J Lee, MD
Brookline, MA
Fellow

Lawrance Lee, MD
Richmond, VA
Trainee

Joel F Lehrer, MD
Teaneck, NJ
Senior Fellow

John P Leonetti, MD
Maywood, IL
Senior Fellow

S George Lesinski, MD
Cincinnati, OH
Emeritus

Samuel C Levine, MD
Eden Prairie, MN
Senior Fellow

John C Li, MD
Jupiter, FL
Fellow

Daqing Li, MD
Philadelphia, PA
Fellow

Jeffrey Liaw, MD
Columbia, MO
Trainee

Charles J Limb, MD
San Francisco, CA
Fellow

Brian Lin, MD
Boston, MA
Associate

Harrison W Lin, MD
Irvine, CA
Associate

Kenny F Lin, MD
Houston, TX
Associate

Vincent Y W Lin, MD
Toronto, ON Canada
Fellow

James Lin, MD
Kansas City,
Fellow

Roger Lindeman, MD
Seattle, WA
Senior Fellow

Nathan R Lindquist, MD
Nashville, TN
Trainee

Alan F Lipkin, MD
Englewood, CO
Senior Fellow

Philip D Littlefield, MD
San Diego, CA
Fellow

Brenda L Lonsbury-Martin, PhD
Palm Springs, CA
Senior Associate

Benjamin D Lovin, MD
Houston, TX
Trainee

Jacob C Lucas, MD
Novi, MI
Trainee

Charles M Luetje, MD
Olathe, KS
Senior Fellow

Larry B Lundy, MD
Ponte Vedra Beach, FL
Senior Fellow

Michal Luntz Kaminski, MD
Tel Aviv, Israel
Associate

J Eric Lupo, MD
Englewood, CO
Fellow

Alexander L Luryi, MD
Camden, NJ
Associate

Lawrence R Lustig, MD
New York, NY
Fellow

William Luxford, MD
Los Angeles, CA
Fellow

John D Macias, MD
Phoenix, AZ
Fellow

Robert J Macielak, MD
Rochester, MN
Trainee

Hossein Mahboubi, MD, MPH
Downey, CA
Associate

Tomoko Makishima, MD, PhD
Galveston, TX
Associate

Bulent Mamikoglu, MD
Rochester, NY
Fellow

Charles A Mangham, Jr, MD
Hailey, ID
Emeritus

Sudhir Manickavel, MD
Birmingham, AL
Trainee

Gauri Mankekar, MD
Shreveport, LA
Associate

Wolf J Mann, MD, PhD
Mainz, Germany
Senior Associate

RaviSankar Manogaran, MD
Lucknow, India
Associate

Nauman Manzoor, MD
Richmond, VA
Associate

Robert Marlan, MD
Dupont, WA
Senior Associate

Michael A Marsh, MD
Fort Smith, AR
Fellow

Sam J Marzo, MD
Maywood, IL
Fellow

Theodore P Mason, MD
Springfield, MA
Fellow

Adam Master, MD, MSC
New Orleans, LA
Fellow

Kenneth Mattucci, MD
Orient, NY
Senior Fellow

Jennifer Maw, MD
San Jose, CA
Fellow

Anne K Maxwell, MD
Omaha, NE
Associate

John May, MD
Winston Salem, NC
Fellow

Jacob S McAfee, MD
Neptune City, NJ
Fellow

Andrew A McCall, MD
Pittsburgh, PA
Fellow

Don E McCleve, MD
Monte Sereno, CA
Senior Fellow

John T McElveen, MD
Raleigh, NC
Fellow

William J McFeely Jr, MD
Huntsville, AL
Fellow

Michael McGee, MD
Oklahoma City, OK
Senior Fellow

Benjamin M McGrew, MD
Birmingham, AL
Fellow

Larry D McIntire, DO
Joplin, MO
Senior Associate

Michael J McKenna, MD
Boston, MA
Fellow

Kevin X McKennan, MD
Sacramento, CA
Fellow

Brian J McKinnon, MBA, MD, MPH
Galveston, TX
Fellow

Sean McMenomey, MD
New York, NY
Fellow

Gorden T McMurry, MD
Louisville, KY
Senior Fellow

Beth N McNulty, MD
Lexington, KY
Fellow

Robert D McQuiston, MD
Indianapolis, IN
Emeritus

Theodore R McRackan, MD
Charleston, SC
Fellow

Cliff A Megerian, MD
Cleveland, OH
Fellow

Rahul Mehta, MD
New Orleans, LA
Associate

Lawrence Z Meiteles, MD
Yorktown Heights, NY
Fellow

Thomas Meyer, PhD
Basel, Switzerland
Affiliate

Ted A Meyer, MD, PhD
Charleston, SC
Fellow

Alan G Micco, MD
Chicago, IL
Fellow

Elias Michaelides, MD
Elmhurst, IL
Fellow

Josef M Miller, PhD
Ann Arbor, MI
Senior Associate

Mia E Miller, MD
Encino, CA
Fellow

Lloyd B Minor, MD
Stanford, CA
Fellow

Richard T Miyamoto, MD
Indianapolis, IN
Senior Fellow

Aaron C Moberly, MD
Brentwood, TN
Fellow

Aage R Moller, MD
Dallas, TX
Senior Fellow

Timothy B Molony, MD
New Orleans, LA
Fellow

Ashkan Monfared, MD
Washington, DC
Fellow

Edwin Monsell, MD, PhD
Detroit, MI
Senior Fellow

Stephanie A Moody Antonio, MD
Norfolk, VA
Fellow

Lindsay S Moore, MD
Menlo Park, CA
Trainee

Gary F Moore, MD
Omaha, NE
Senior Fellow

Dennis M Moore, MD
Maywood, IL
Senior Associate

William H Moretz, MD
Augusta, GA
Senior Fellow

William Morgan, MD
Charleston, WV
Emeritus

Daniel Morrison, MD
Charlottesville, VA
Trainee

Howard S Moskowitz, MD, PhD
Bronx, NY
Fellow

Maggie M Mouzourakis, MD
Lebanon, NH
Trainee

Sarah Mowry, MD
Beachwood, OH
Fellow

Robert Muckle, MD
Englewood, CO
Fellow

Thomas J Muelleman, MD
Shawnee, KS
Associate

Terrence P Murphy, MD
Baton Rouge, LA
Senior Fellow

Euan Murugasu, MD, PhD
Clementi Park, Singapore
Associate

Marc-Elie Nader, MD, MSC
Houston, TX
Associate

Joseph B Nadol, MD
Boston, MA
Senior Fellow

James G Naples, MD
Needham, MA
Fellow

Ashley M Nassiri, MD
Aurora, CO
Trainee

Julian M Nedzelski, MD
Toronto, Canada
Senior Fellow

Brian A Neff, MD
Rochester, MN
Fellow

Rick F Nelson, MD, PhD
Indianapolis, IN
Fellow

Erik G Nelson, MD
Lake Forest, IL
Fellow

James Nelson, MD
La Jolla, CA
Emeritus

Ralph Nelson, MD
Manchester, WA
Senior Fellow

Matthew Ng, MD
Las Vegas, NV
Fellow

Anh T Nguyen-Huynh, MD, PhD
Shaker Heights, OH
Fellow

Brian D Nicholas, MD
Syracuse, NY
Fellow

Carrie Nieman, MD, MPH
Baltimore, MD
Associate

Alan J Nissen, MD
Lincoln, NE
Senior Fellow

Evan Nix, MD
Chapel Hill, NC
Trainee

Yasuya Nomura, MD
Tokyo, Japan
Honorary

Kathryn Y Noonan, MD
Boston, MA
Associate

Michael A Novak, MB, MD
Champaign, IL
Fellow

Brendan O'Connell, MD
Charlotte, NC
Fellow

Lars Odkvist, MD, PhD
Linkoping, Sweden
Senior Associate

John S Oghalai, MD
Los Angeles, CA
Fellow

Michael J Olds, MD
Spokane, WA
Associate

Dennis P O'Leary, PhD
Pasadena, CA
Senior Associate

Eric R Oliver, MD
Roanoke, VA
Fellow

Robert C O'Reilly, MD
Philadelphia, PA
Fellow

Vincent B Ostrowski, MD
Indianapolis, IN
Fellow

Robert M Owens, MD
Plano, TX
Fellow

Levent N Ozluoglu, MD
Ankara, Turkey
Fellow

Joshua Cody Page, MD
Keller, TX
Associate

Dorothy W Pan, MD, PhD
Los Angeles, CA
Trainee

Michael M Paparella, MD
Minneapolis, MN
Senior Associate

James J Pappas, MD
Little Rock, AR
Senior Fellow

Dennis G Pappas, MD
Birmingham, AL
Senior Fellow

Dennis G Pappas, Jr, MD
Birmingham, AL
Fellow

Simon C Parisier, MD
New York, NY
Senior Fellow

James L Parkin, MD
Salt Lake City, UT
Senior Fellow

Lorne S Parnes, MD
London, ON Canada
Senior Fellow

Steven M Parnes, MD
Albany, NY
Fellow

Tirth Patel, MD
Chicago, IL
Trainee

Neil S Patel, MD
Salt Lake City, UT
Fellow

Ankita Patro, MD
Nashville, TN
Trainee

Cole Pavelchek, MD
Saint Louis, MO
Trainee

Stanley Pelosi, MD
New Hyde Park, NY
Fellow

Angela Peng, MD
Houston, TX
Fellow

Kevin A Peng, MD
Los Angeles, CA
Fellow

Myles L Pensak, MD
Cincinnati, OH
Senior Fellow

Enrique R Perez, MBA, MD
New York City, NY
Associate

Rodney Perkins, MD
Woodside, CA
Senior Associate

Elizabeth L Perkins, MD
Nashville, TN
Associate

Brian P Perry, MD
San Antonio, TX
Fellow

Brian R Peters, MD
Dallas, TX
Fellow

Bradley P Pickett, MD
Albuquerque, NM
Fellow

Harold C Pillsbury, MD
Banner Elk, NC
Senior Fellow

Dennis S Poe, MD
Boston, MA
Fellow

Ryan G Porter, MD
Urbana, IL
Fellow

W Hugh Powers, MD
Simi Valley, CA
Senior Fellow

Sanjay Prasad, MD
Rockville, MD
Fellow

Leonard R Proctor, MD
Baltimore, MD
Emeritus

Seth E Pross, MD
San Jose, CA
Fellow

James C Prueter, DO
Dayton, OH
Associate

Fredric W Pullen, MD
Wellington, FL
Emeritus

Alicia M Quesnel, MD
Boston, MA
Fellow

Alexandra E Quimby, MD
Philadelphia, PA
Trainee

Steven D Rauch, MD
Boston, MA
Fellow

Mallory J Raymond, MD
Jacksonville, FL
Associate

Miriam I Redleaf, MD
Chicago, IL
Fellow

Aaron K Remenschneider, MD, MPH
Boston, MA
Fellow

Yin Ren, MD, PhD
Columbus, OH
Fellow

Bradford D Ress, MD
Bigfork, MT
Senior Fellow

William J Rice, MD
Grosse Pointe, MI
Emeritus

Alejandro Rivas, MD
Cleveland, OH
Fellow

Jose A Rivas, MD
Bogota, Colombia
Emeritus

Arnaldo L Rivera, MD
Columbia, MO
Fellow

Habib Rizk, MD, MSC
Charleston, SC
Fellow

Joseph B Roberson, MD
E Palo Alto, CA
Fellow

Daniel S Roberts, MD
Farmington, CT
Fellow

Mendell Robinson, MD
Rehoboth, MA
Emeritus

Joseph Roche, MD
Middleton, WI
Fellow

Grayson Rodgers, MD
Birmingham, AL
Fellow

Brian Rodgers, MD
Dallas, TX
Fellow

Pamela C Roehm, MD, PhD
Philadelphia, PA
Fellow

Peter S Roland, MD
Eden, UT
Senior Fellow

J Thomas Roland, Jr, MD
New York, NY
Fellow

Max L Ronis, MD
Philadelphia, PA
Senior Fellow

Seth I Rosenberg, MD
Sarasota, FL
Fellow

Steven D Rowley, MD
Lehi, UT
Senior Fellow

Robert J Ruben, MD
New York, NY
Emeritus

Allan M Rubin, MD, PhD
Perrysburg, OH
Senior Fellow

Jay T Rubinstein, MD, PhD
Seattle, WA
Fellow

Michael J Ruckenstein, MD, MSC
Philadelphia, PA
Fellow

Douglas S Ruhl, MD
DuPont, WA
Fellow

Christina L Runge, PhD
Milwaukee, WI
Affiliate

Leonard P Rybak, MD, PhD
Springfield, IL
Emeritus

Doron Sagiv, MD
Davis, CA
Associate

Hamed Sajjadi, MD
Los Gatos, CA
Fellow

Masafumi Sakagami, MD, PhD
Hyogo, Japan
Fellow

Ravi N Samy, MD
Cincinnati, OH
Fellow

Peter L Santa Maria, MB, PhD
Palo Alto, CA
Fellow

Felipe Santos, MD
Boston, MA
Fellow

Joshua M Sappington, MD
Saint Louis, MO
Fellow

Eric W Sargent, MD
Farmington Hills, MI
Fellow

Robert Sataloff, MD
Philadelphia, PA
Fellow

James E Saunders, MD
Lebanon, NH
Fellow

David G Schall, MD, MPH
Colorado Springs, CO
Associate

William R Schmitt, MD
Spokane, WA
Associate

Desi P Schoo, MD
Baltimore, MD
Trainee

David R Schramm, MD, MSC
Ottawa, ON Canada
Fellow

Arnold G Schuring, MD
Warren, OH
Senior Fellow

Christopher A Schutt, MD
Farmington Hills, MI
Associate

Mitchell K Schwaber, MD
Nashville, TN
Senior Fellow

Zachary G Schwam, MD
New York, NY
Trainee

Nofrat Schwartz, MD
New Haven, CT
Associate

Seth R Schwartz, MD, MPH
Seattle, WA
Fellow

Michael D Seidman, MD
Celebration, FL
Fellow

Samuel H Selesnick, MD
New York, NY
Fellow

Maroun T Semaan, MD
Moreland Hills, OH
Fellow

Levent Sennaroglu, MD
Sihhiye 06100, Turkey
Fellow

Mark A Severtson, MD
Louisville, KY
Fellow

Alexander BG Sevy, MD
Union City, CA
Fellow

Mohammad Seyyedi, MD
Augusta, GA
Associate

Wayne T Shaia, MD
henrico, VA
Fellow

Fred T Shaia, MD
Richmond, VA
Emeritus

Weiru Shao, MD, PhD
Auburndale, MA
Fellow

Scott B Shapiro, MD
New Brunswick, NJ
Associate

Jeffrey D Sharon, MD
San Francisco, CA
Fellow

Edward F Shaver, Jr, MD
Charlotte, NC
Senior Fellow

M Coyle Shea, MD
Memphis, TN
Emeritus

Paul F Shea, MD
Memphis, TN
Fellow

Clough Shelton, MD
Walla Walla, WA
Senior Fellow

Neil T Shepard, PhD
Missoula, MT
Emeritus

Matthew Shew, MD
St Louis, MO
Associate

Lucy Shih, MD
Pasadena, CA
Senior Fellow

Michael J Shinners, MD, MD
Fargo, ND
Fellow

Jack A Shohet, MD
Newport Beach, CA
Fellow

Nael Shoman, MD
Halifax, NS Canada
Fellow

Abraham Shulman, MD
Hollis Hills, NY
Emeritus

Jonathan Sillman, MD
Brookline, MA
Fellow

Herbert Silverstein, MD
Sarasota, FL
Senior Fellow

L Clark Simpson, MD
Birmingham, AL
Fellow

George T Singleton, MD
Gainesville, FL
Emeritus

Pedrom C Sioshansi, MD, MSC
Winston-Salem, NC
Associate

Aristides Sismanis, MD
Richmond, VA
Senior Fellow

Henryk Skarzynski, MD, PhD
Warsaw, Poland
Associate

Piotr H Skarzynski, MD, PhD
Warsaw, Poland
Associate

Patrick W Slater, MD
Austin, TX
Fellow

William H Slattery III, MD
Los Angeles, CA
Fellow

Eric L Slattery, MD
Salt Lake City, UT
Fellow

Tine Smets, MD
Nieuwerkerken, Belgium
Trainee

Peter G Smith, MD, PhD
Grover, MO
Senior Fellow

Eric E Smouha, MD
New York, NY
Fellow

Samuel A Spear, MD
San Antonio, TX
Fellow

Gershon J Spector, MD
St Louis, MO
Emeritus

Neil M Sperling, MD
New York, NY
Fellow

Jeffrey P Staab, MD
Rochester, MN
Associate

Hinrich Staecker, MD, PhD
Kansas City, KS
Fellow

Konstantina M Stankovic, MD
Palo Alto, CA
Fellow

Ted N Steffen, MD
Louisville, KY
Senior Fellow

Shawn M Stevens, MD
Phoenix, AZ
Fellow

C Matthew Stewart, MD, PhD
Baltimore, MD
Fellow

Katrina R Stidham, MD
Tuckahoe, NY
Fellow

Ian S Storper, MD
New York, NY
Fellow

Barry Strasnick, MD
Norfolk, VA
Fellow

Emily Z Stucken, MD
Ann Arbor, MI
Fellow

Daniel Q Sun, MD
Baltimore, MD
Associate

Krish Suresh, MD
Boston, MA
Trainee

Jun-Ichi Suzuki, MD
Tokyo, Japan
Emeritus

Maja Svrakic, MD
New Hyde Park, NY
Fellow

Alex D Sweeney, MD
Houston, TX
Fellow

Charles A Syms, MBA, MD
San Antonio, TX
Fellow

Mark J Syms, MD
Phoenix, AZ
Fellow

Kareem O Tawfik, MD
Nashville, TN
Associate

Michael T Teixido, MD
Newark, DE
Fellow

Steven A Telian, MD
Ann Arbor, MI
Senior Fellow

Fred F Telischi, MD
Miami, FL
Fellow

Nirmal Thapa, MD
Jacksonville, FL
Trainee

Britt A Thedinger, MD
Omaha, NE
Fellow

Bradley S Thedinger, MD
Kansas City, MO
Senior Fellow

Nicholas J Thompson, MD
Chapel Hill, NC
Trainee

Scott W Thompson, MD
Columbia, SC
Fellow

Adam Thompson-Harvey, MD
Milwaukee, WI
Trainee

Jens Thomsen, MD, PhD
Hellerup, Denmark
Senior Associate

Elizabeth Toh, MBA, MD
Boston, MA
Fellow

Anthony M Tolisano, MD
Kensington, MD
Fellow

B Joseph Touma, MD
Huntington, WV
Associate

Joseph B Touma, MD
Huntington, WV
Senior Associate

Betty Tsai Do, MD
Danville, CA
Fellow

Nathan Chin-yau Tu, MD
Albany, NY
Fellow

Debara L Tucci, MD MBA, MS
Bethesda, MD
Senior Fellow

Aaron Tward, MD
San Francisco, CA
Fellow

Safter Arif Ulubil, MD
Istanbul, Turkey
Associate

Joseph A Ursick, MD
Kansas City, MO
Fellow

Carla V Valenzuela, MD
Ann Arbor, MI
Trainee

Galdino E Valvassori, MD
Wilmette, IL
Senior Associate

Andrea Vambutas, MD
New Hyde Park, NY
Fellow

Mark J Van Ess, DO
Springfield, MO
Associate

Jonathon W Vargo, MD
Lakewood, OH
Trainee

David M Vernick, MD
West Roxbury, MA
Senior Fellow

Eloy Villasuso III, MD
Weston, FL
Fellow

Christophe G Vincent, MD, PhD
Lille, France
Associate

Esther X Vivas, MD
Atlanta, GA
Fellow

Courtney C J Voelker, MD, PhD
Los Angeles, CA
Fellow

Peter G Volsky, MD
Norfolk, VA
Fellow

Peter G Von Doersten, MD
Missoula, MT
Fellow

Richard Voorhees, MD
Seattle, WA
Senior Fellow

Nopawan Vorasubin, MD
Los Angeles, CA
Fellow

Jeffrey T Vrabec, MD
Houston, TX
Fellow

P Ashley Wackym, MD
New Brunswick, NJ
Fellow

David D Walker, MD
Chicago, IL
Fellow

Erika M Walsh, MD
Birmingham, AL
Fellow

Hayes H Wanamaker, MD
Syracuse, NY
Senior Fellow

George B Wanna, MD
New York, NY
Fellow

Bryan K Ward, MD
Baltimore, MD
Fellow

Frank M Warren III, MD
Portland, OR
Fellow

Theodore A Watson, MD
Anderson, SC
Senior Fellow

Jack J Wazen, MD
Sarasota, FL
Fellow

Michael M Weber, MD
Brooklyn, NY
Trainee

Peter Weber, MBA, MD
Boston, MA
Fellow

Roger E Wehrs, MD
Tulsa, OK
Senior Fellow

Heather M Weinreich, MD, MPH
Wilmette, IL
Fellow

Alfred Weiss, MD
Meadville, PA
Senior Fellow

Peter A Weisskopf, MD
Phoenix, AZ
Fellow

Christopher M Welch, MD, PhD
Ann Arbor, MI
Fellow

D Bradley Welling, MD, PhD
Boston, MA
Fellow

Louis W Welsh, MD
Huntingdon Vy, PA
Senior Fellow

Brian D Westerberg, MD
Vancouver, BC Canada
Fellow

Stephen J Wetmore, MD
Morgantown, WV
Emeritus

Mark E Whitaker, MD
Hershey, PA
Fellow

David W White, MD
Tulsa, OK
Fellow

Thomas White, MD
Oakland, CA
Fellow

Helena Wichova, MD
Tucson, AZ
Associate

Cameron C Wick, MD
St Louis, MO
Fellow

Mark H Widick, MD
Boca Raton, FL
Fellow

Richard J Wiet, MD
Sawyer, MI
Senior Fellow

R Mark Wiet, MD
Chicago, IL
Fellow

Brent J Wilkerson, MD
Piedmont, SC
Fellow

Eric P Wilkinson, MD
Meridian, ID
Fellow

Thomas O Willcox, MD
Philadelphia, PA
Fellow

Robert A Williamson, MD, MPH
Austin, TX
Fellow

Mark L Winter, MD
Lubbock, TX
Senior Fellow

Sean R Wise, MD
Lyme, NH
Fellow

Matthew Wong, MD
Medina, WA
Fellow

Marc Wong, MD
Honolulu, HI
Senior Associate

Kevin Wong, MD
Port Washington, NY
Trainee

Charles I Woods, MD
Syracuse, NY
Fellow

Erika A Woodson, MD
Shaker Heights, OH
Fellow

Benjamin J Wycherly, MD
Farmington, CT
Associate

Takao Yabe, MD, PhD
Tokyo, Japan
Associate

Kristen L Yancey, MD
Dallas, TX
Trainee

Charles W Yates, MD
Indianapolis, IN
Fellow

Robert J Yawn, MD
Germantown, TN
Fellow

Yu-Lan Mary Ying, MD
Millburn, NJ
Fellow

Noriko Yoshikawa, MD
Oakland, CA
Fellow

Nancy M Young, MD
Chicago, IL
Fellow

John W Youngblood, MD
Fredericksburg, TX
Senior Fellow

Heng-Wai Yuen, MD
Singapore, Singapore
Fellow

John J Zappia, MD
Farmington Hills, MI
Fellow

Daniel M Zeitler, MD
Seattle, WA
Fellow

Kevin Y Zhan, MD
St Louis, MO
Trainee

Sheng Zhou, MD
Pasadena, CA
Trainee

Michael Zoller, MD
Savannah, GA
Senior Fellow

Steven A Zuniga, MD
Newport Beach, CA
Fellow

in Memoriam

(in alphabetical order)
The ANS 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.

Sam E. Kinney, MD
Inducted in 1979
ANS President 1994-95
DOD - August 29, 2022

James B. Snow Jr., MD
inducted in 1968
DOD - May 28, 2022

Ronald Steenerson, MD
Inducted in 1984
DOD - May 2, 2022