THE SEVENTY-SEVENTH ANNUAL MEETING

OF THE

Neurosurgical Society of America

PENHA LONGA RESORT
LISBON, PORTUGAL

JUNE 23 – 26, 2024

American Association of Neurological Surgeons

Jointly Provided by the AANS

THE SEVENTY-SEVENTH ANNUAL MEETING

PENHA LONGA RESORT

Lisbon, Portugal

June 23 – 26, 2024

“Tradition, Tenacity, Transformation"

President	**Judy Huang**
Vice President	**Gregory Zipfel**
President-Elect	**Guy McKhann**
Secretary	**Aviva Abosch**
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Web Site: www.neurosurgicalsociety.org

The border of the program book is Brown University Red in honor of our President, Judy Huang, MD

Executive Committee

Judy Huang, President
Greg Zipfel, Vice President
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Mitesh Shah, Past Past Past President
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Jeffrey Blount, Councilor (2023 - 2025)

COMMITTEES FOR 2023

Scientific Program Committee **Amy Lee (2024 Chair)** **Dean Chou, AANS/CME** **Gerry Grant (2025 Chair)**	**Membership** **Matthew Hunt, Chair** **Pat Connolly (2020-2024)** **Amy Lee (2022-2025)** **Ciara Harraher (2023-2027)** **David Hart (2023-2028)**	**Site Selection** **Bernard Bendok, Chair (2019-2024)** **Eldan Eichbaum (2023-24)** **Paul Camarata (2023-24)** **Matt Feldkamp (2023-2028)** **Henry Woo (2023-2028)**
Long-Range Planning/Communications **Louis Kim, Chair** **Patricia Raksin (2023-2026)** **Isaac Yang (2023-2026)**	**Leisure Activities** **Iain Kalfas - Golf** **David Hart - Tennis** **Philip Yazbak - Cycling**	**Audit and Finance** **Richard Byrne, Chair** **Langston Holly (2021-2026)** **Abraham Boskovitz (2023-2025)** **Michelle Clarke (2023-2027)** **Chirag Gandhi (2023-2028)**
Bylaws **David Shafron, Chair** **Langston Holly (2021-2024)** **Web Crowley (2022-2025)** **Sophia Shakur (2023-2026)** **Anand Germanwala (2023-2026)**	**Local Arrangements** **David Hart, Chair (2024 – Portugal)**	**Nominating** **Paul Camarata, Chair 2023-2024** **Eldan Eichbaum, Chair 2024-2025** **Michael Boland (2021-2024)** **Lisa Mulligan (2022 – 2025)** **Carlos David (2023-2024)**
Archivist **Greg Helbig (2023 – 2027)**	**NSA Medal** **Chris Fox, Chair (2022-2025)** **Web Crowley (2022 – 2025)** **Dean Chou (2023-2026)** **Vikram Prabhu (2023-2026)** **Allan Friedman (2023-2026)** **Gail Rosseau (2023-2026)** **Warren Selman (2023-2026)**	**Industry Relations Development** **Web Crowley, Chair** **Mitesh Shah** **Regis Haid** **Praveen Mummaneni**

REPRESENTATIVES

AANS Board of Directors

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American College of Surgeons Advisory Council on Neurosurgery

Gregory Zipfel

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Henry Woo

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Robert Dempsey

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Jeffrey Blount

Residency Review Committee for Neurological Surgery

Shelly Timmons

World Federation of Neurological Surgeons

Giuseppe Lanzino (Primary Delegate)
Christopher Loftus (Secondary Delegate)

Society of Neurological Surgeons

Warren Selman

Neurosurgery Research and Education Foundation

Regis W. Haid, Jr.

SOCIETY OBJECTIVES

The objectives of the Society shall be to enhance the advancement of the specialty of neurological surgery in America:

- By furnishing a *forum for intimate exchange of ideas and information* among a group of representative neurosurgeons;
- By fostering a *personal acquaintanceship among its members* to make free and confident exchange of information possible;
- By *bringing young neurosurgeons of promise into a group* where they can develop full expression of ideas before a cross-section of American neurosurgery;
- By *sponsoring international meetings* on a personal plane of critical but sympathetic discussion of progress in neurological surgery on this continent and abroad through further dissemination of new information in the field of neurological surgery; and
- By maintaining in its membership roll a *balance between academic and practicing neurosurgeons* to promote harmonious balance between teaching of neurosurgery and its practice in American communities.

NEUROSURGICAL SOCIETY OF AMERICA
77th ANNUAL MEETING SCHEDULE 2024
Penha Longa Resort

Sunday, June 23, 2024

1:00-5:00 pm	Registration Desk Open	Mezzanine
3:00-5:00 pm	Executive Committee Meeting	D. Filipa
6:00-9:00 pm	Opening Reception/Dinner (Casual Dress)	Palace Ground Floor

Monday, June 24, 2024

6:15 am-12:30 pm	Meeting Registration Desk	Coroa Foyer
6:30-7:30 am	Members' Business Breakfast Meeting	D. Joao
6:30-7:30 am	Invited Guests' Breakfast	Mercatto Restaurant
6:30-9:30 am	Family/Guests Breakfast	Mercatto Restaurant
7:30-9:40 am	General Scientific Session I	Coroa
9:40-10:00 am	Refreshment Break	Coroa Foyer
10:00-12:30 pm	General Scientific Session II	Coroa
1:00 pm	Dewey Golf Tournament	
6:00-10:00 pm	Reception	Mercatto Restaurant

Tuesday, June 25, 2024

6:15am-12:30 pm	Meeting Registration Desk	Coroa Foyer
6:30-7:30 am	Members/Invited Guests Breakfast	D. Joao
6:30-9:30 am	Family/Guests Breakfast	Mercatto Restaurant
7:30-9:42 am	General Scientific Session III	Coroa
9:42-10:05 am	Refreshment Break	Coroa Foyer
10:05-10:15 am	Welcome to New Members	Coroa
10:15-12:30 pm	General Scientific Session IV	Coroa
5:00-6:00 pm	New Members' Reception	Palace Ground Floor
6:00-10:00 pm	Gala Reception/Dinner (Black Tie/Dark Suit)	Coroa

Wednesday, June 26, 2024

6:15 am-12:30 pm	Meeting Registration Desk	Coroa Foyer
6:30-7:30 am	Members/Invited Guests Breakfast	D. Joao
6:30-9:30 am	Family/Guests Breakfast	Mercatto Restaurant
7:30-9:55 am	General Scientific Session V	Coroa
9:55-10:15 am	Refreshment Break	Coroa Foyer
10:15-12:30 pm	General Scientific Session VI	Coroa
12:30 pm	Adjourn	

FUTURE MEETING SITES

2024 Interim Meeting
September 13 – 15, 2024
New York City, New York

2025 Annual Meeting
June 22 – 25, 2025
Four Seasons at Punta Mita, Mexico

NOTES

Neurosurgical Society of America Medal for Outstanding Service – 2024

David Piepgras, MD

David Piepgras, M.D.**,** is an emeritus Professor of Neurosurgery in the Mayo Clinic College of Medicine and Science. He joined the Mayo Clinic staff in Rochester in 1974 after completing residency at Mayo Clinic.

Dr. Piepgras chaired the Department of Neurologic Surgery from 1992-2004 and is the former John T. and Lillian Mathews Professor of Neuroscience. Dr. Piepgras made significant advances in the management and understanding of unruptured aneurysms and the spectrum of intracranial hypotension and cerebrospinal fluid leaks. He led groundbreaking work on innovative revascularization procedures, decision-making and performance of intracranial and vascular neurosurgery over four decades. His studies and publications on carotid endarterectomy, bypass surgery, and surgery for giant aneurysms and arteriovenous malformations changed the management of cerebrovascular disease.

His leadership in the International Study on Unruptured Intracranial Aneurysms led to more conservative management of small aneurysms. Dr. Piepgras was Chair of the American Board of Neurological Surgery, the Residency Review Committee for Neurological Surgery, and the Joint Section on Cerebrovascular Neurosurgery; President of the American Academy of Neurological Surgery; and has been a member of the Neurosurgical Society of America since 1978, serving as Vice-President from 2000-01.

Dr. Piepgras received the Founders Laurel from the Congress of Neurological Surgeons and the Distinguished Service Award from the Society of Neurological Surgeons.

Neurosurgical Society of America Keynote Speaker – 2024

Dr. Samuel Browd

Dr. Samuel R. Browd, M.D., Ph.D., FACS, FAANS, FAAP is Professor of Neurological Surgery at the University of Washington and Attending Neurosurgeon at Seattle Children's Hospital. He completed an MD/Ph.D at the University of Florida studying neuroplasticity and learning. He completed his residency training at the University of Utah and pediatric neurosurgery fellowship at the University of Washington, Seattle Children's Hospital where he currently serves as the Neurosurgical Director of the Tone Management Program and Pediatric Complex Spine. He is also the Founding Director of the UW Institute 83B (Computation Neurosurgery Institute), Director of The Sports Institute at UW Medicine, and Medical Director of the Seattle Children's Sports Concussion Program. Dr. Browd is an adjunct Professor of Bioengineering and affiliate faculty of the Foster School of Business. He was a UW Presidential Entrepreneurial Faculty Fellow and lectures internationally on biomedical innovation and commercialization. Dr. Browd also serves as an Unaffiliated Neurologic Consultant to the NFL and as an independent neurologic consultant to the Seattle Seahawks.

Dr. Samuel R. Browd is dedicated to advancing the future of neurocare by empowering patients through real-time, continuous care using AI, machine learning, robotics, and immersive medicine. He serves as the Chief Medical Officer and is a founding partner of DeepWell DTx. Additionally, he has co-founded six more venture-backed startups focused on future technologies, including Proprio, VICIS, Aqueduct Neuroscience, Navisonics, AllCylinders, and NeuFluent.

Dr. Browd was recognized as the University of Washington School of Medicine Inventor of the Year in 2016 and has co-developed three products that were listed as Time Magazine's Invention of the Year in 2017, 2019, and 2021. He was honored as the 2021 Congress of Neurological Surgeons Innovator of the Year.

Invited Guest of the Neurosurgical Society of America

Dr. Henry Brem

Henry Brem, Harvey Cushing Professor, Professor of Neurosurgery, Ophthalmology, Oncology, and Biomedical Engineering is the Chair of the Department of Neurosurgery at Johns Hopkins University School of Medicine. His work led to the FDA's approval of the first image guidance computer system for intraoperative localization of tumors. Furthermore, he has changed the surgical armamentarium against brain tumors by inventing and developing Gliadel® wafers to intraoperatively deliver chemotherapy to brain tumors.

He developed new classes of polymers and microchips for drug delivery that are custom synthesized for the agent being developed. The polyanhydrides, which were the first new treatments for brain tumors that the FDA had approved in 23 years, have been shown in his laboratory to be biocompatible and potent. He then designed and led the clinical trials demonstrating safety and efficacy. He has published over 400 research papers, 58 book chapters, 11 patents, and an H index of 100 with over 42,000 citations. In addition to his academic work he has worked closely with biotech companies to develop new technologies.

Dr. Brem's teaching was recognized by the Hopkins Professors Award for Excellence in Teaching in 1996. In 1998 he was elected to the Institute of Medicine of the National Academy of Sciences. In 2000 he was awarded the Grass Award by the Society of Neurological Surgeons for meritorious research; in 2001 he received the Founders Award of the Controlled Release Society; in 2004 he received the New York University Distinguished Alumni Award; in 2005 he was co-recipient of the Society for Biomaterials Technology Innovation and Development Award and was named the Coleman Fellow in Life Sciences at Ben-Gurion University. In 2011 he delivered the commencement address for the Johns Hopkins University School of Medicine. He has been recognized by the Castle Connolly Guide each year from 2002 in “America’s Top Doctors”, and from 2005 – present in “America’s Top Doctors for Cancer”. In 2013, the Society for NeuroOncology and the Section on Tumors of the AANS/CNS named him as the recipient of the Abhijit Guha Award.

Invited Guest of the Neurosurgical Society of America

Professor Oscar L. Alves

Head of Neurosurgery, Hospital Lusíadas Porto
Senior Consultant in Neurosurgery, Centro Hospitalar de Gaia Espinho
Cranial Base Consultant, Centro Hospitalar entre Douro e Vouga
Fulbright Fellow
Executive Board Member, CSRS-E
Treasurer, CSRS-E
Co-Chairman, International Academy of Spine
Board of Directors, International Society for Advancement of Spine Surgery
Chairman of the Supervisory Board, SPPCV (Portuguese Spine Society)
Assistant Professor; Hôpital Lariboisière and Université Paris VII; France
Post-Doctoral Fellow, Department of Neurosurgery, Medical College of Virginia, Richmond, USA

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Accreditation/Designation Statements

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 the AANS and the Neurosurgical Society of America. The AANS is accredited by the ACCME to provide continuing medical education for physicians.

The AANS designates this live activity for *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity. Total available CME will be announced prior to the start of the Annual Meeting.

Disclosure Information

The AANS and the Neurosurgical Society of America control the content and production of this CME activity and attempt to ensure the presentation of balanced, objective information. In accordance with the Standards for Commercial Support established by the Accreditation Council for Continuing Medical Education, (ACCME), faculty, abstract reviewers, paper presenters/authors, planning committee members, staff, and any others involved in planning the educational content and the significant others of those mentioned must disclose any relationship they or their co-authors have with commercial interests which may be related to their content. The ACCME defines "relevant financial relationships" as financial relationships in any amount occurring within the past 12 months that create a conflict of interest.

Those who have disclosed a relationship with commercial interests are listed below:

Name	Industry	Relationship Disclosed
Alan Villavicencio	Premia Spine	Research Support
Anoop Patel	Mirxes Genomics, Servier Pharmaceuticals, Sygnomics	Research Support, Consultant, Stockholder
Aviva Abosch	UNMC, NIH, Medtronic, NSA, Academy	Research Support, Industry Grant, Consultant, Fiduciary Position
Benjamin Waldau	Stryker	Consultant
Bradley Bohnstedt	NIH RO1, Stryker Neurovascular, Penumbra, Rapid Medical, Microvention	Research Support, Consultant, Financial Support
Cargill Alleyne	NeurosurGen, Carmafil LLC, ABNS	Research Support, Stockholder, Fiduciary Position
Chetan Bettegowda	NIH R37, Depuy-Synthes, Bionaut Labs, Galantin Therapeutics, Haystack Oncology, Privo Tech, OrisDx, Belay Diagnostics	Consultant, Stockholder, Fiduciary Position
Christopher Jackson	Biohaven, InCephalo, Grifols, Egret Therapeutics, Vaccitech	Industry Grant Support, Stockholder, Financial Support
Christopher Ogilvy	Bee Foundation, DSMB-Embolize, Medtronic	Research Support, Financial Support
Clemens Schirmer	NIH/NINDS, Penumbra, Medtronic, Balt, Stryker, Microvention, Cerenovus, MIVI, Route 92, Viz.ai, NTI, Reist, Werfen	Research Support, Industry Grant, Consultant, Stockholder, Honorarium
Constantinos Hadjipanayis	Stryker, Synaptive, Integra, Hemerion Therapeutics	Consultant
D. Jay McCracken	GT Medical	Consultant, Speaker
Dean Chou	Globus, Medtronic, Orthofix	Consultant

E. Antonio Chiocca	NIH, Alliance for Cancer Gene Therapy, Department of Defense, Theriva, Insightec, Genenta, bionaut, Seneca, Ternalys, Immunomic, SNS	Research Support, Consultant, Stockholder, Fiduciary Position
Eric Nottmeier	OR Hub, Track X, Globus Robotics, Symgery	Stockholder, Financial Support
Fedor Panov	Neuropace Zimmer Biomet	Consultant
Guy McKhann	NIH, Koh Young, NeuroOne Technologies, Dixi Medical	Industry Grant, Consultant, Speaker (uncompensated)
Isaac Yang	Acoustic Neuroma Association, Stashestrong, Brainlab, Stryker, Baxter	Research Support, Industry Grant, Consultant
J Mocco	PCORI, NIH STEP, NIH StrokeNet, Stryker, Penumbra, Microvention, Viseon, Endostream, RIST, Synchron, Perflow, Viz.ai, CVAid, Imperative Care, Echovate, BlinkTBI, Serenity, Tulavi, Vastrax, Neruolutions, Sim&Cure	Research Support, Industry Grant, Consultant, Stockholder, Fiduciary Position
Judy Huang	Longeviti Neuro Solutions	Stockholder
Kai-Ming Fu	Bioventus, ATEC	Consultant
Kathleen Dlouhy	Medtronic, Penumbra	Consultant
Khoi Than	DePuy Synthes, NuVasive, Cerapedics, Bioventus, Si Bone	Consultant, Speaker
Merritt Kinon	Globus Medical, Sanara Medical	Consultant
Michael Kaplitt	NINDS, ASAP/Michael J Fox Foundation, Meira GTx	Research Support, Consultant, Stockholder
Omar Choudhri	Medtronic Neurovascular, Microvention, Q'apel, Balt, Siemens	Consultant
Patrick Codd	Mente, Thexa, Cerulean Scientific	Stockholder
Richard Price	Augmedics Stryker, FYR Medical	Consultant, Stockholder
Risheng Xu	IPEN	Research Support
Samuel Browd	Propriovision, Neufluent, DeepWellDTx	Stockholder, Ficuciary Position (CMO and Co-founder, Propriovision)

Those who have reported they do not have any relationships with commercial interests:

Name	Name
Alper Dincer	Mark Dannenbaum
Amy Lee	Matthew Hunt
Andrew Chan	Megan Jack
Andrew Gard	Michael Boland
Betty Kim	Michael Lang
Brett Youngerman	Michelle Clarke
Christian Rajkovic	Morgan Foster
Chris Fox	Moustapha Abou-Samra
Christopher Winfree	Owoicho Adogwa
Collin Liu	Patricia Raksin
Daniel Lubelski	Paul Camarata
Eldan Eichbaum	Phillip J Storm
Gregory Zipfel	Rachana Tyagi
Jamal McClendon, Jr	Robert Dempsey
James Johnston	Rushna Ali
Jeffrey Blount	Sandeep Bhangoo
Jeffrey Tomlin	Shawn Hervey-Jumper
Jordina Rincon-Torroella	Spiros Blackburn
Juan Ortega-Barnett	Stephen Dell
Kaisorn Chaichana	Stephen Haines
Kushal Shah	Stephen Johans
Luis Tumialan	Stephen Munich
Mahua Dey	Wuyang Yang
Mani Nathan Nair	Zachary A Smith
Mari Groves	

The 77th ANNUAL MEETING
OF THE NEUROSURGICAL SOCIETY OF AMERICA

EDUCATIONAL GOALS AND OBJECTIVES

The primary goal of the Annual Scientific Meetings of the Neurosurgical Society of America is to provide a forum for the presentation of original ideas and research pertinent to the clinical practice of neurological surgery. This meeting is directed towards practicing neurosurgeons and neurological residents and will consist of spine surgery, cerebrovascular, tumor, pediatrics, trauma, education, and socioeconomics.

Upon completion of this educational activity, participants should be able to:

1.) Identify critical ways that tradition created pathways to the contemporary practice of neurosurgery.
2.) Discuss ways in which camaraderie and support positively impact the well-being of practicing neurosurgeons.
3.) Understand the influence of emerging technologies, such as VR, AR, and AI, in the evolving field of neurosurgery.
4.) Identify how advance surgical tools can change the treatment of spinal neurosurgery.
5.) Understand current state of the art treatment strategies of cerebrovascular disease, both from an endovascular and from an open perspective.
6.) Identify key options in the treatment of brain tumors through an innovative lens with gene therapy and immunotherapy.
7.) Define different options for the treatment of pediatric pathologies.
8.) Discuss options in the treatment of neurotrauma.
9.) Understand the evolving role of functional neurosurgery and modern treatment.
10.) Understand advances in the treatment of epilepsy.
11.) Increase awareness of recoupment tactics by payors to promote advocacy in neurosurgery.

A SPECIAL THANK YOU to our 2024 Abstract Reviewers

Aviva Abosch
James Johnston
Matthew Hunt
Isaac Yang
Kathleen Dlouhy
Michelle Clark
Patti Raksin
Amy Lee

NOTES

GENERAL SCIENTIFIC SESSIONS

Tradition, Tenacity, and Transformation in Neurosurgery

Monday, June 24, 2024	**Tradition** Legacy in Neurosurgery *Cargill Alleyne, MD*
Tuesday, June 25, 2024	**Tenacity** Tenacity in Neurosurgery: It's about More than 'Not Giving Up' *Christopher Ogilvy, MD*
Wednesday, June 26, 2024	**Transformation** Digital Genesis: Neurosurgery 2.0 *Samuel R. Browd, MD*

GENERAL SCIENTIFIC SESSION I

Tradition

MONDAY, JUNE 24, 2023

6:30-7:30 am Breakfast/NSA Members Business Meeting

7:30-7:35 am Welcome/Announcements
Judy Huang, MD, President of the NSA

7:35-7:40 am Scientific Program Overview
Amy Lee, MD, Scientific Program Chair

7:40-8:50 am TRADITION in NEUROSURGERY

7:40-8:00 am Legacy in Neurosurgery
Cargill Alleyne, MD

8:00-8:15 am History of the NSA
Gregory Helbig, MD

8:15-8:20 am Introduction of Professor Oscar Alves
Praveen Mummaneni, MD

8:20-8:40 am **Guest Speaker Professor Oscar Alves**
Brief History of Portuguese Neurosurgery
"Innovative Indications for Cervical Arthroplasty: Beyond the Traditional Soft Single-level Disc Disease in Young Patients"
Professor Oscar Alves, Head of Neurosurgery, Hospital Lusíadas Porto

8:40-8:50 am Discussion

8:50-9:40 am Scientific Session I—Abstracts (Tumor, Functional)
Moderators: John Lee, Isaac Yang

8:50-8:58 am Suppressing Glioblastoma Tumor Invasion/Metastasis by Targeting Pentraxin-3 Mediated Inflammation and Angiogenesis
Robert J Dempsey, MD, University of Wisconsin, Madison WI

8:58-9:06 am Near Real-Time Molecular Characterization of Meningioma and Glioma Using the TumorID: A Novel Spectroscopic Approach
Patrick Codd, MD, Duke University, Durham NC

9:06-9:14 am Real-time Intraoperative Brain Tumor Detection Using the Raman Spectroscopy Sentry System – Results of a Multicenter Study
Costas Hadjipanayis, MD, PhD, U of Pittsburgh Medical Center, Pittsburgh PA

9:14-9:22 am COMMAND Trial: an FDA Approved Earlier Feasibility Study of a Novel Transvascular Brain Computer Interface: Initial Experience and Lessons Learned from the First Ten Human Transvascular Brain Computer Interface Procedures
J Mocco, MD, Mount Sinai Health System, New York NY

9:22-9:30 am Acute Brain Changes in the Limbic Lobe during Loving Kindness Meditation
Fedor Panov, MD, Mount Sinai Health System, New York NY

9:30-9:40 am Discussion

9:40-10:00 am Beverage Break

10:00-10:25 am Point-Counterpoint (Pediatrics, Spine)
Moderator: Edward Ahn

10:00-10:08 am Re-do Untethering – Neurosurgical vs Orthopedic…?
Jeffrey Blount, MD

10:08-10:16 am The Shortest Route: Breaking Barriers for Treatment of Tethered Cord Syndrome
Mari Groves, MD

10:16-10:25 am Discussion

10:25-10:50 am Spiegel Shorts
Moderator: Patricia Raksin

10:25-10:29 am Use of an Ultrasonic Aspirator Significantly Decreases and May Eventually Eliminate Need for Kerrison Rongeurs to Remove Bone in Minimally Invasive Decompressive Laminectomies
Stephen Pirris, MD, Mayo Clinic Jacksonville, Jacksonville FL

10:29-10:33 am Halo Traction and Posterior Correction for Cervical Kyphosis in Neurofibromatosis Type I
Jamal McClendon Jr., MD, Mayo Clinic and Phoenix Children's Hospital, Phoenix AZ

10:33-10:37 am	Socioeconomic Status Associated with Management Outcome of Unruptured Intracranial Arteriovenous Malformation *Wuyang Yang, MD, Johns Hopkins University, Baltimore MD*
10:37-10:41 am	Conduit-assisted Supercharged End-to-side Supinator to Posterior Interosseous Nerve Trances *Megan Jack, MD, PhD, Cleveland Clinic, Cleveland OH*
10:41-10:45 am	New Techniques of Stereotactic Guidance for Vertebroplasty/Kyphoplasty Procedures *Rachana Tyagi, MD, WMC Health, Valhalla NY*
10:45-10:50 am	Discussion
10:50-12:30 pm	**Scientific Session II Abstracts (Spine, Tumor, Pediatrics)** *Moderators: Matthew Hunt, Michelle Clarke*
10:50-10:58 am	Genotype-guided Opioid Therapy in Patients Undergoing Lumbar Spine Surgery Results in Lower Rates of Delirium and Superior Pain Control: A Single Institutional Feasibility Study *Owoicho Adogwa, MD, University of Cincinnati, Cincinnati OH*
10:58-11:06 am	What Factors Predict the Best Outcomes for Elderly Patients Operated for Grade 1 Degenerative Lumbar Spondylolisthesis? A Machine Learning Analysis from the Quality Outcomes Database *Andrew Chan, MD, Columbia University, New York NY*
11:06-11:14 am	Supinator to Posterior Interosseous Nerve Transfer to Restore Hand Opening in Brachial Plexus and SCI: A Systematic Review and Individual Patient Data Meta-analysis *Kevin Swong, MD, Northwestern Medicine, Chicago IL*
11:14-11:22 am	Preoperative ASA Grade Predicts Odds of 90-Day Readmission and Outcome at 24 Months Following Anterior or Posterior CSM Surgery: A Report from the Quality Outcomes Database *Arati Patel, MD, University of California San Francisco, San Francisco CA*
11:22-11:30 am	Progressive Brain Atrophy and Abnormal Brain Connectivity May Play an Important Role in Neurological Disability in Patients with Degenerative Cervical Myelopathy *Zachary A Smith, MD, U Oklahoma Health Sciences Center, Oklahoma, OK*

11:30-11:40 am	Discussion
11:40-11:48 am	Proximal Lumbar Anterior Column Realignment for Iatrogenic Sagittal Plane Adult Spinal Deformity Correction *Khoi Than, MD, Duke University, Durham NC*
11:48-11:56 am	Integrating AI Triage in Neurosurgery, A Real-World Analysis of Incidental Intracranial Aneurysm Detection *Clemens Schirmer, MD, PhD, Geisinger, Mountain Top PA*
11:56-12:04 pm	Proteomic and Phosphoproteomic Characterization of Adamantinomatous Craniopharyngiomas Led to a Clinical Trial and a Novel Surgical Technique *Phillip J Storm, MD, Children's Hospital of Philadelphia, Philadelphia PA*
12:04-12:12 pm	Breaking Tradition: Repurposing Vortioxetine for H3K27M-Midline Gliomas *Afshin Salehi, MD, U of Nebraska Medical Center, Omaha NE*
12:12-12:20 pm	The Effectiveness and Safety of Surgical Management of Brachial Plexus Tumors *Daniel Lubelski, MD, Johns Hopkins University, Baltimore MD*
12:20-12:30 pm	Discussion
12:30 pm	**Dismissal for Afternoon Activities**

TITLE: SUPPRESSING GLIOBLASTOMA TUMOR INVASION/METASTASIS BY TARGETING PENTRAXIN-3 MEDIATED INFLAMMATION AND ANGIOGENESIS.

AUTHORS: Dempsey R, Wesley U, Sutton I, Clark P, Cunningham K, Kuo J.

PRESENTER: Robert J Dempsey, MD

INTRODUCTION: Malignant glioblastomas (GBM) are lethal brain tumors that pose significant challenges to current therapies. It is highly invasive and resistant to multimodal treatment with distorted vasculature and exacerbated inflammation in the brain tumor microenvironment. Dysregulated production of angiogenic and inflammatory cytokines including the glycoprotein pentraxin-3 (PTX3), plays a critical role in the severity of malignancies. The role of PTX3 in GBM pathology is not completely understood.

METHODS: We examined the role of PTX3 in GBM, using patient derived Brain Tumor tissue Micro Arrays (BTMA) representing various grades of the disease, intracranial tumor orthotopic pre-clinical mouse models, immunohistochemistry, GBM cell culture models, molecular and biochemical approaches.

RESULTS: BTMA screening showed that PTX3 expression is substantially increased in more than 70% of GBM patients, particularly in higher grades. Endogenous or exogenous addition of PTX3 enhances pro-angiogenic tube formation, and significantly increases the survival of brain tumor cells, and tumor growth and invasion in xenograft mouse model brains. Upregulation of PTX3 is associated with the increased levels of inflammatory and angiogenic markers including phospho-kinase PI3K/Akt, interleukin-8, vascular endothelial growth factor. Conversely, PTX3 decreases the levels of thrombospondin1, an anti-angiogenic factor.

CONCLUSION: PTX3 expression is dysregulated in malignant glioblastomas. PTX3 increases the growth and migratory/invasive potential of brain tumor cells through enhanced angiogenesis through the IL8-VEGF axis. Thus, inhibiting PTX3 function may reduce tumor burden, and invasion into the healthy brain regions. Overall, PTX3 may represent a potential therapeutic target to mitigate the aggressive and invasive behavior of gliomas.

TITLE: NEAR REAL-TIME MOLECULAR CHARACTERIZATION OF MENINGIOMA AND GLIOMA USING THE TUMORID: A NOVEL SPECTROSCOPIC APPROACH

AUTHORS: T. Zachem, G. Ma, R. Prakash, K.Yamamoto, B. Schleupner, S. Adil, B. Mann, C. Goodwin, W. Eward, P. J. Codd.

PRESENTER: Patrick J. Codd, M.D.

INTRODUCTION: Current intraoperative methods for tumor diagnosis rely on frozen sections limiting information to tissue morphology. This process is time-consuming and with new guidelines requiring molecular and/or genetic characteristics, unable to provide a complete diagnosis rapidly. We demonstrate the application of a non-contact laser-induced endogenous fluorescence spectroscopy device ("TumorID") to provide real-time diagnosis of both meningioma grade and glioma IDH-mutation status on *ex vivo* tumor tissue in the operating room. Furthermore, the device is used in conjunction with a surface tomography sensor and a class IV laser mounted on a robotic arm to automatically detect the tumor tissue boundary and perform surface resection based on the generated pathology map on *ex vivo* mouse sarcoma.

METHODS: The TumorID scanned intraoperative, surgically resected tumor specimens from 10 patients with meningiomas and 10 with gliomas, with many 0.5s scans on each specimen. In two separate machine learning pipelines, the data were analyzed with seven common ML algorithms. Predictions were made on every individual point, classifying it as belonging to grade 1 vs 2 meningioma or IDH-mutant vs IDH-wildtype glioma.

RESULTS: The TumorID pipeline was able to classify between grade 1 and 2 meningiomas with an AUROC of 0.912 (logistic regression, 95% CI: 0.649-1.0), and between IDH-wildtype and IDH-mutant gliomas with an AUROC of 0.950 (logistic regression, 95% CI: 0.81-1.0).

CONCLUSIONS: These results demonstrate near real-time, non-destructive methods of molecular characterization of both meningioma and glioma tissue. Furthermore, this device has been translated onto the sterile field for tissue analysis prior to resection.

TITLE: REAL-TIME INTRAOPERATIVE BRAIN TUMOR DETECTION USING THE RAMAN SPECTROSCOPY SENTRY SYSTEM – RESULTS OF A MULTICENTER STUDY

AUTHORS: Hadjipanayis C, Ember K, Dallaire F, Plante A, Sheehy G, Guiot MC, Agarwal R, Yadav R, Douet A, Selb J, Tremblay J, Harb A, McCarthy L, Schupper A, Umphlett M, Tsankova N, Leblond F, Petrecca K

PRESENTER: **Costas Hadjipanayis, MD, PhD**

INTRODUCTION: Differentiating between brain tumor tissue and the surrounding brain can be a posing challenge and is an unmet need for surgeons. The Sentry System is a new in situ brain tumor detection device that merges Raman spectroscopy with machine learning tissue classifiers. We conducted an international multicenter study testing whether the Sentry System could distinguish the three most common types of brain tumors from brain tissue in a label-free manner.

METHODS: Cancer detection machine learning models were trained from 985 spectroscopy measurements and colocalized tissue specimens acquired from 67 patients undergoing surgery for glioblastoma, brain metastases, or meningioma to assess tumor classification. For each Raman measurement, a tissue biopsy was taken from the same region. The neuropathologist counted the number of normal cells and the number of cancer cells per section and this information was used to compute the percentage of cancers cells based on the average of the three sections.

RESULTS: The Sentry System used machine learning models that were developed based on support vector machines (SVM) for each tumor type by correlating the intraoperative spectral acquisition with gold-standard pathological analysis for each sample. The Sentry System discriminated tumor from brain with >90% sensitivity and achieved diagnostic accuracies of 91% for glioblastoma, 97% for brain metastases, and 96% for meningiomas.

CONCLUSION: We provide results of the first multi-user experience using the Sentry System to detect the most common types of brain tumors label-free during surgery and in real time. The ease of use and high diagnostic accuracy may permit maximal safe resection of the 3 most common brain tumors.

TITLE: THE COMMAND TRIAL, AN FDA APPROVED EARLIER FEASIBILITY STUDY OF A NOVEL TRANSVASCULAR BRAIN COMPUTER INTERFACE: INITIAL EXPERIENCE AND LESSONS LEARNED FROM THE FIRST TEN HUMAN TRANSVASCULAR BRAIN COMPUTER INTERFACE PROCEDURES

AUTHORS: E Levy, R Nogueira, J Mocco, S Majidi

PRESENTER: J Mocco, MD

INTRODUCTION: We present initial results of an FDA approved early feasibility study with the Synchron transvascular brain computer interface.

METHODS: Patients with severe upper limb paralysis were prospectively enrolled into an FDA approved EFS trial evaluating the safety and feasibility of the Synchron transvascular brain computer interface.

RESULTS: Initial safety and efficacy data for the first ten human transvascular brain computer interface implantations will be presented at the Neurosurgical Society of America.

CONCLUSION: The Synchron transvascular brain computer interface demonstrates early indication of safety and clinical benefit for patients with severe upper limb paralysis.

TITLE: ACUTE BRAIN CHANGES IN THE LIMBIC LOBE DURING LOVING KINDNESS MEDITATION

AUTHORS: D D Cummins, L Tortolero, Z Schulman, C Maher, L N Martinez, I Saez, R Davidson, F Panov

PRESENTER: Fedor Panov, MD

INTRODUCTION: The amygdala plays a critical role in emotional reactivity. Meditation has been shown to improve symptoms of depression and anxiety by modulating the limbic lobe and the default mode network. A subset of patients having undergone Neuromodulation for their epilepsy with leads placed in the hippocampus/ amygdala complex can benefit from meditation to aid in the symptoms of their psychiatric comorbidities. Their chronic recordings present an opportunity to evaluate acute and chronic changes in their brain activity during and after meditation.

METHODS: 8 patients with bilaterally implanted RNS and contacts in the limbic lobe were invited to learn about and then practice medication in our Q-Lab (a space designed for follow up of neuromodulation cases) Sessions of learning about mediation (active control) followed by loving kindness meditation (a constructive mode of meditation when love is send to other beings in the world) were recorded and live streaming of their brain recordings from the amygdala was collected.

RESULTS: Significant increase in the low gamma band was seen during early attempts at meditation in the patients. This was statistically different from the active control of learning about meditation, yet not actively meditating.

CONCLUSION: An early biomarker of a meditative state via intracranial chronically implanted contacts is visible in a first meditation experience for participants. Such brain activity, once translated to EEG or other forms of output, can be used as biofeedback and may lead to a broader adoption of a valuable technique to improve wellbeing.

TITLE: USE OF AN ULTRASONIC ASPIRATOR SIGNIFICANTLY DECREASES AND MAY EVENTUALLY ELIMINATE THE NEED FOR KERRISON RONGEURS TO REMOVE BONE IN MINIMALLY INVASIVE DECOMPRESSIVE LAMINECTOMIES

AUTHORS: S Pirris, C McKevitt

PRESENTER: Stephen Pirris, MD

INTRODUCTION: Kerrison rongeurs may be the most commonly utilized tools by spine surgeons to remove bone when performing elective decompressive surgery. Some of the risks of using Kerrison rongeurs include dural tears and occupational risk for the surgeon for developing carpal tunnel syndrome. In addition to the rongeurs, surgeons frequently use a high-speed drill to help remove bone when attempting to access the spinal canal. Ultrasonic aspirators have been utilized for bone removal in other surgical specialties. This case series highlights the use ultrasonic aspirators for removing bone in decompressive laminectomies.

METHODS: 27 patients (40 levels of laminectomies) who were operated on for treatment of degenerative lumbar stenosis using minimally invasive techniques. A high-speed drill was used in 19 patients (24 levels), the ultrasonic aspirator was used in 12 patients (16 levels) and 4 patients had usage of both. The number of Kerrison bites to remove bone was counted by either the surgeon or 1st assistant.

RESULTS: The number of Kerrison bites to remove bone in the ultrasonic aspirator levels was significantly less than the high-speed drill levels 8.06 vs 38.25 (p-value< 0.0001).

CONCLUSION: The use of an ultrasonic aspirator significantly decreases the need for bone bites with a Kerrison rongeur. The authors recognize that there are significant variabilities in technique amongst surgeons that may affect results in the general population. However, this is a safe and effective technique and may help to diminish risk dural tear in certain conditions as well as limit some occupational risk to the spine surgeons.

TITLE: HALO TRACTION AND POSTERIOR CORRECTION FOR CERVICAL KYPHOSIS IN NEUROFIBROMATOSIS TYPE I.

AUTHORS: J McClendon Jr, J Ronecker, H Negri Brito

PRESENTER: **Jamal McClendon Jr., MD**

INTRODUCTION: Severe cervical kyphosis is a rare entity involving patients with neurofibromatosis type I (NF1), and often associated with vertebral dysplasia. This condition in the pediatric population is limited to small sample sizes, with limited descriptions involving surgical treatment for the condition in skeletally-immature children. The literature has supported anteroposterior surgery for kyphosis correction, long hospitalization stays for cervical tractioning, and halo immobilization after surgery, however we will report robust considerations to enhance fixation confidence.

METHODS: The electronic medical record, plain film radiographs, and advanced imaging of all patients < 18 years of age who underwent spinal fusion for cervical kyphosis with a diagnosis if NF1 were reviewed. We aim to describe: (1) freehand spinal fixation techniques involving the lateral masses and the pedicles in the subaxial cervical spine; and (2) report the outcomes of halo traction and posterior correction.

RESULTS: Two children (8, 14 years) presented with neck pain and severe kyphotic deformity. One had severe spontaneous dislocation of the subaxial cervical spine. All patients underwent preoperative Halo tractioning to reduce the mean preoperative kyphotic angle. For child 1 and 2, preoperative kyphosis was 101.4° and 78.5°, respectively. Post halo kyphosis was 78.1° and 70.3°, respectively; and post op kyphosis 54.0° and 17.4°, with maximum 14 days of total hospitalization. Patient 1 had C4-T4 posterior fusion with cervical lateral mass fixation, and patient 2 had C2-T2 posterior fusion with cervical pedicle screw fixation. No intraoperative or postoperative complications.

CONCLUSIONS: Halo traction and posterior instrumentation provide a safe correction of cervical kyphosis in children with NF1. Cervical pedicle screws and lateral mass screws are viable options to enhance fixation.

TITLE: SOCIOECONOMIC STATUS IS ASSOCIATED WITH MANAGEMENT OUTCOME OF UNRUPTURED INTRACRANIAL ARTERIOVENOUS MALFORMATION

AUTHORS: W Yang, J Liu, Y Chen, A Hung, S Sattari, J Feghali, J Huang

Presenter: Wuyang Yang, MD

INTRODUCTION: Longitudinal management of unruptured brain arteriovenous malformation(bAVM) is crucial. To date, no study in the United States(US) has evaluated SES impact on bAVM outcome. We aim to clarify the impact of SES, indicated by the Area of Deprivation Index(ADI), on bAVM outcome.

METHODS: A retrospective analysis was conducted from an institutional bAVM database. Non-HHT patients with single, unruptured bAVM from 1990-2021 were included. ADI was categorized into low-ADI, mid-ADI, and high-ADI at the 15th and 85th percentile(low-ADI being the more advantaged). Patient baseline and follow-up data were analyzed. The primary outcome of interest was non-independence(Modified Rankin Score [mRS]>2) at the last follow-up. A multivariable logistic regression model was performed.

RESULTS: A total of 589 patients with unruptured bAVMs were included in the study. The mean age was 37.2 years, with 283(48.0%) being male. Among these bAVMs, 238(40.4%) were low Spetzler-Martin grade(SMG<3), 194(32.9%) were moderate(SMG=3), and 157(32.9%) were high(SMG>3). Sixty-nine(11.7%) patients were in the low-ADI, 476(80.8%) in mid-ADI, and 44(7.5%) in high-ADI. Increasing age(OR=1.02,CI=[1.01, 1.04], p<0.001), poor baseline mRS(OR=3.27,CI=[1.32, 7.88],p=0.008), treatment with surgery+radiosurgery±embolization(OR=3.21,CI=[1.03, 9.81], p=0.041), mid-SMG(OR=1.94,CI=[1.11, 3.44], p=0.021) and high-SMG(OR=2.08,CI=[1.13, 3.88],p=0.020), longer follow-up duration(OR=1.05,CI=[1.03, 1.08], p<0.001), mid-ADI are significantly associated with poor outcome(OR=3.08,CI=[1.34, 8.39], p=0.015). High-ADI showed a trend towards poor outcome(OR=2.93,CI=[0.92, 9.88], p=0.071). Eventual obliteration of bAVM was a protective predictor of poor outcome(OR=0.55,CI=[0.30, 0.98], p=0.046).

CONCLUSION: Our study found that non-advantaged patients with unruptured bAVM are more likely to experience non-independence at the last follow-up after adjusting for confounding variables. Emphasis on social support might be beneficial for patients with lower SES.

TITLE: CONDUIT-ASSISTED SUPERCHARGED END-TO-SIDE SUPINATOR TO POSTERIOR INTEROSSEOUS NERVE TRANSFER

AUTHORS: E Z Herring, N Yaffe, A Kumar, G Kwiecien, D Kao, M M Jack

PRESENTER: Megan M. Jack, MD, PhD

INTRODUCTION: Novel nerve transfer techniques aim to improve functional outcomes for patients with nerve injuries. We describe a novel supercharged end-to-side (SETS) transfer of two supinator branches to posterior interosseous nerve (PIN) involving a nerve conduit that may limit perineural scarring and improve surgical efficiency.

METHODS: The technique described offers an alternative surgical technique in select patients to restore wrist and finger extension. Two nerve branches to supinator are isolated that have strong intraoperative muscle contraction. An epineurial window is created on the PIN. A commercially available conduit is used to augment the SETS transfer with the end of the donor nerve placed inside the conduit and the leaflets of the cut conduit wrapped around the recipient as opposed to direct coaptation with perineural sutures.

RESULTS: The patient achieved satisfactory results with MRC 4 wrist and finger extension at 6 months following SETS transfer. In select patients, this procedure may provide dual motor reinnervation by allowing for both synergistic innervation from supinator branches but also proximal nerve recovery. Conduit-assisted SETS is less complex compared to epineural microsuturing. Thus, it could also eliminate perineural fibrosis from tissue handling and suture reaction that negatively impact regeneration.

CONCLUSION: Conduit-assisted supinator to PIN SETS is a feasible novel transfer for select patients that present with PIN palsy.

TITLE: NEW TECHNIQUES OF STEREOTACTIC GUIDANCE FOR VERTEBROPLASTY/KYPHOPLASTY PROCEDURES

AUTHORS: C Rajkovic, R Tyagi

PRESENTER: Rachana Tyagi, MD

INTRODUCTION: In cases of tumor resection and arthrodesis, stereotactic navigation has been shown to improve procedure accuracy while reducing procedure duration, radiation exposure, and adverse events. These stereotactic systems also allow a unique option for minimally invasive procedures using spinal navigation for vertebroplasties and diagnostic procedures.

METHODS: We reviewed charts of two cases of spinal pathology where intraoperative stereotactic navigation was combined with a vertebroplasty cannula to facilitate an MIS approach.

RESULTS: A 51-year-old male with a history of deep-brain-stimulator placement presented with worsening back pain, increasing kyphotic deformity, and an associated pressure ulcer due to persistent L1/2 MRSA osteomyelitis/discitis. Intraoperative navigation was used to perform percutaneous posterior spinal instrumentation from T11-L4 followed by debridement of the L1-L2 intervertebral phlegmon with tissue biopsy and application of antibiotics into phlegmon via transpedicular kyphoplasty balloon deployment. At follow-up, the patient had no evidence of persistent infection, improved back pain, and his focal kyphosis was corrected. A 71-year-old female with a history of severe osteoporosis and compression fractures presented with acute sacral pain due to an S2 fracture. An S2 sacroplasty was then performed using intraoperative navigation of the vertebroplasty cannula for safe and accurate cement application. The patient had improved pain following the procedure.

CONCLUSION: This technique for spinal column biopsy and vertebroplasty combines a minimally invasive percutaneous approach using stereotactic navigation with a kyphoplasty cannulation system to improve the speed, efficacy, and safety of MIS procedures for spinal bone or disc pathologies.

TITLE: GENOTYPE-GUIDED OPIOID THERAPY IN PATIENTS UNDERGOING LUMBAR SPINE SURGERY RESULTS IN LOWER RATES OF DELIRIUM AND SUPERIOR PAIN CONTROL: A SINGLE INSTITUTIONAL FEASIBILITY STUDY

Authors: T Xu; A Owoicho

Presenter: Owoicho Adogwa, MD

INTRODUCTION: Lumbar spine surgery has been shown to improve pain and quality of life. Despite the use of multimodal therapies and widespread adoption of Enhanced Recovery Protocols, 33% - 50% of patients report poor pain control after surgery. The CYP2D6 enzyme metabolizes opioids commonly prescribed for spine-related pain, and CYP2D6 polymorphisms may contribute to variability in opioid response. Thus, while some patients achieve the desired therapeutic response from their drug therapy, others do not; and a subset of patients will experience adverse effects, which can range from bothersome to life threatening. **Objective:** To determine the effect of a genotype-guided opioid prescribing strategy on pain control after lumbar spine surgery.

METHODS: Randomized Control Trial. Adult patients were prospectively enrolled into a hybrid implementation-effectiveness clinical trial and randomized to CYP2D6-genotype-guided opioid selection, with clinical recommendations, or usual care. Implementation metrics, including provider response, medication changes consistent with recommendations, and patient-reported pain and symptom scores at baseline and up to 12 weeks, were assessed.

RESULTS: Most (24/25, 96%) patients approached for the study agreed to participate. Of the 24 patients randomized (48% female), 15 were randomized to the genotype guided arm and the rest standard of care. Overall, 50% of patients were normal metabolizers, 25% were intermediate metabolizers, and 25% poor metabolizers. Normal metabolizers were prescribed tramadol for pain control, while intermediate and poor metabolizers were prescribed non-CYP2D6 opioids such as morphine or hydromorphone. At baseline, there were no differences in VAS back pain (p=0.76), VAS leg pain(0.51) and ODI(p=0.60) and EQ-5D(p=0.40) between the genotype-guided and non-genotype cohorts. Post-operatively, patients randomized to the genotype-guided opioid arm reported significantly lower VAS back pain (p=0.04), VAS leg pain (0.03) and ODI(p=0.02) scores compared to those in the standard of care arm. Rates of post-operative delirium was 2-fold lower in the genotype-guided cohort. The majority of patients in the genotype-guided opioid cohort(70%) were discharged directly to home, with only a minority discharged to an rehabilitation facility or nursing home. 30-day hospital readmission rates were similar between groups(p=0.85).

CONCLUSION: In this single institutional RCT, a genotype-guided opioid prescribing strategy was associated with lower rates of post-operative delirium, superior pain control and improvement in functional disability. Furthermore, our study revealed high acceptance of pharmacogenetic testing as part of a clinical trial among patients with spine-related pain.

TITLE: WHAT FACTORS PREDICT THE BEST OUTCOMES FOR ELDERLY PATIENTS OPERATED FOR GRADE 1 DEGENERATIVE LUMBAR SPONDYLOLISTHESIS? A MACHINE LEARNING ANALYSIS FROM THE QUALITY OUTCOMES DATABASE

AUTHORS: A Chan, E Yang, P Mummaneni, M Bydon, E Bisson, C Shaffrey, S Glassman, K Foley, E Potts, M Shaffrey,D Coric, J Knightly, P Park, M Wang, KM Fu, J Slotkin, A Asher, M Virk, G Michalpoulos, R Haid, D Chou

Presenter: **Andrew K. Chan, MD**

INTRODUCTION: The prevalence of degenerative lumbar spondylolisthesis in the elderly population is increasing, yet the factors influencing surgical outcomes remain incompletely defined.

METHODS: Data was obtained from the prospective Quality Outcomes Database registry, including patients with grade 1 degenerative lumbar spondylolisthesis. We included patients age ≥ 65. Principal components analysis was used to generate a composite 24-month patient-reported outcome score. A k-means clustering approach was used to differentiate patients by composite operative outcome.

RESULTS: 233 patients were included with 24-month follow-up. Two distinct clusters were identified: cluster 1, optimal outcomes, and cluster 2, suboptimal outcomes. The optimal-outcomes cluster had 49.3% achieve MCID across both EQ5D and ODI as compared to 0% in the suboptimal-outcomes cluster ($p< 0.001$). Clusters did not differ significantly by age (cluster 1:71.3, cluster 2:73.0, $p=0.18$), though patients with suboptimal outcomes did report higher baseline ODI and VAS leg pain. Patients in the optimal-outcomes cluster (70.5%) were significantly more likely to have received a fusion procedure than were patients in the suboptimal cluster (51.7%)($p=0.01$). Performance of a fusion procedure was the only significant independent predictor of optimal outcomes (OR = 1.57; 95%CI 1.12-2.19; $p=0.01$).

CONCLUSION: For elderly patients undergoing surgery for degenerative lumbar spondylolisthesis, the addition of fusion was associated with superior outcomes, with patients receiving a fusion having nearly 1.5 times the odds of reaching an optimal outcome. There was no evidence that age was significantly different between clusters—failing to support an age cutoff for surgery.

TITLE: SUPINATOR TO POSTERIOR INTEROSSEOUS NERVE TRANSFER TO RESTORE HAND OPENING IN BRACHIAL PLEXUS AND SPINAL CORD INJURY: A SYSTEMATIC REVIEW AND INDIVIDUAL-PATIENT-DATA META-ANALYSIS

Authors: P Texakalidis, L Liu, C L Karras, T D Alden, C K. Franz, K Swong

PRESENTER: Kevin Swong MD

INTRODUCTION: Cervical spinal cord injury (SCI) and lower trunk brachial plexus injury (BPI) result in hand paralysis. Restoring hand function is complex and regaining volitional hand control enhances functionality for patients. We conducted a systemic review of outcomes of hand opening after a supinator to posterior interosseus nerve (PIN) transfer.

METHODS: A systematic literature review was performed according to the PRISMA guidelines.

RESULTS: 16 studies with 88 patients and 119 supinator to PIN transfers were included (87 for SCI; 32 for BPI). Average time from injury to surgery was 6-12 months. Finger extension and thumb extension (MRC ≥3/5) recovered in 86.5% (n:103/119) and 78.1% (n:93/119) of cases, over a median follow-up of 19 months. The rates of recovery were similar for the SCI and BPI populations (finger extension: 87.3% in SCI and 84.3% in BPI; thumb extension: 75.8% in SCI and 84.3% in BPI). The type of injury (OR: 1.05; 95% CI: 0.17-6.4; p=0.95) and time from injury to surgery (OR: 1.01; 95% CI: 0.8-1.29; p=0.88), age (OR: 0.97; 95% CI: 0.90-1.06; p=0.60) were not associated with the odds of a successful outcome. Duration of follow-up was statistically significant associated with successful finger extension (OR: 1.15; 95% CI: 1.01-1.30; p=0.026). No donor-associated supinator weakness was reported post-operatively given patients had an intact bicep muscle.

CONCLUSIONS: Supinator to PIN transfer is a safe and effective procedure that can achieve successful restoration of digital extension in the SCI and BPI population at similar rates. Duration of follow-up was associated with superior outcomes.

TITLE: PREOPERATIVE ASA GRADE PREDICTS ODDS OF 90-DAY READMISSION AND OUTCOMES AT 24 MONTHS FOLLOWING ANTERIOR OR POSTERIOR CSM SURGERY: A REPORT FROM THE QUALITY OUTCOMES DATABASE.

AUTHORS: A Patel, M Macki, V Ambati, A Chan, D Chou, E Bisson, M Bydon, A Asher, D Coric, E Potts, K Foley, M Wang, KM Fu, M Virk, J Knightly, S Meyer, P Park, C Upadhyaya, M Shaffrey, LTumialan, J Uribe, O Gottfried, C Shaffrey, R Haid, A Digiorgio, P Mummaneni

Presenter: Arati Patel MD

INTRODUCTION: Despite the prevalence of cervical spinal myelopathy (CSM), the clinical risk factors for readmission and poor outcomes are not well defined. We aim to identify if American Society of Anesthesiologists (ASA) grade associates with readmission and poor outcomes following CSM surgery.
METHODS: Prospectively collected data from the Quality Outcomes Database registry CSM cohort were used. The primary outcome measures were 90-day readmission rates and 24-month patient reported outcomes. Statistically significant variables in univariate analysis were included in multivariate logistic regression.

RESULTS: Overall, 1,141 CSM patients were enrolled with 1128 reaching 24-month follow-up (median cohort ASA grade:3). Of these, 62 (5.5%) were readmitted within 90 days. Readmission indications (not mutually exclusive) included 6 (0.53%) hematomas, 6 (0.53%) wound dehiscences, 6 (0.53%) new spinal cord deficits, 5 (0.44%) surgical site infections, 2 (0.18%) new nerve root injuries/deficits, 2 (0.18%) pain admissions, 1 (0.09%) hardware revision, and 1 (0.09%) dysphagia case; the remaining were medical complications. Univariate analysis found increased age (OR per 1-year increase: 1.03, p=0.005), coronary artery disease (CAD) (OR:2.5,p=0.007), and increased ASA grade (OR per 1-point increase:2.9, p<0.001) to be significantly associated with increased 90-day readmissions. Multivariate logistic regression controlling for age, BMI, ambulation status, CAD, and baseline mJOA and NDI scores found increased ASA grade (aOR per 1-point increase:2.5, adjusted-p:0.002) to be the only studied variable significantly associated with increased 90-day readmission rates. Further, increased ASA grade was an independent predictor of reduced quality-adjusted life year (QALY) (Lin. Reg. Coeff=-0.04, adjusted-p=0.007), and increased NDI (Lin. Reg. Coeff:3.5, adjusted-p:0.005) scores at 24 months.

CONCLUSION: In patients undergoing CSM surgery, higher ASA grade independently predicts 90-day readmissions and inferior 24-month outcomes, including quality of life and neck-pain-related disability.

TITLE: PROGRESSIVE BRAIN ATROPHY AND ABNORMAL BRAIN CONNECTIVITY MAY PLAY AN IMPORTANT ROLE IN NEUROLOGICAL DISABILITY IN PATIENTS WITH DEGENERATIVE CERVICAL MYELOPATHY (DCM).

AUTHORS: Z A Smith, F Muhammad

PRESENTER: Zachary A. Smith, MD

INTRODUCTION: Degenerative cervical myelopathy is the most common cause of chronic spinal cord injury. The decision to operate is commonly surgeon dependent, and often varies greatly in cases of mild compression. However, during this time-period, significant "upstream" changes in the brain may occur, including cortical atrophy/functional reorganization, suggesting ongoing CNS injury may occur far before symptoms.

METHODS: A 3.0T MRI scanner aquired resting state fMRI (rs-fMRI), functional MRI (fMRI) and structural scans from 30 DCM patients and 22 HCs. Quantitative clinical assessments were performed to associate brain changes and DCM severity.

RESULTS: DCM patients had variations in both cortical thickness and functional connectivity patterns compared to controls. Specifically, pronounced cortical thinning in critical regions including bilateral precentral/prefrontal gyri, pars triangularis, postcentral gyrus, and visual cortices ($p \leq 0.04$). Concurrently, alterations in functional connectivity were significant, characterized by a diminished connection between the sensorimotor cortices and brain areas (ex: insular cortex, Heschl's gyrus). These changes associated with motor deficits ($p < 0.0001$). The reductions in thickness in motor regions were associated with reduced dexterity ($R^2 = 0.33, p < 0.0007; R^2 = 0.34, p = 0.005$). Interestingly, mJOA scores (the gold standard) correlated only with thickness changes in the contralateral precuneus, without a significant link to sensorimotor thickness or functional connectivity alterations.

CONCLUSION: These findings underscore that DCM precipitates significant cortical thinning and functional connectivity modifications key regions of sensory/motor processing, findings associated with quantifiable motor impairments. These findings suggest "upstream" changes play a critical role in this disease and influence response to treatment.

TITLE: PROXIMAL LUMBAR ANTERIOR COLUMN REALIGNMENT FOR IATROGENIC SAGITTAL PLANE ADULT SPINAL DEFORMITY CORRECTION

AUTHORS: J M Frerich, C F Dibble, C Park, S M Bergin, C R Goodwin, M M Abd-El-Barr, C I Shaffrey, K D Than

PRESENTER: Khoi D. Than, MD

INTRODUCTION: Anterior column realignment (ACR) is a minimally invasive surgery (MIS) technique to restore sagittal alignment in adult spinal deformity (ASD) by deliberate sectioning of the anterior longitudinal ligament. ACR can be performed at adjacent disease segments in the proximal lumbar spine. However, about two-thirds of physiologic lumbar lordosis occurs between L4-S1, and concerns remain about altered lumbar morphology.

METHODS: A retrospective case series was performed of consecutive ASD patients who underwent L1-2 or L2-3 ACR (n = 19). All patients were treated using MIS lateral interbody fusion technique with placement of a static hyperlordotic cage and posterior reconstruction with Smith-Peterson osteotomy (SPO) plus instrumented fusion. Pre- and post-operative radiographic and clinical outcomes were obtained and evaluated.

RESULTS: Patients were 49-83 years of age. Mean follow-up was 18-months. Mean intra-operative blood loss was 1.4 L. SVA decreased from 11.9 cm to 6.1 cm, PI-LL decreased from 34.2° to 12.8°, and segmental lordosis increased from -2.7° to 21.9°. Proximal lumbar lordosis increased from -0.4° to 22.6°. Mean ODI decreased from 58.0 to 37.4 and NPRS back pain decreased from 7.9 to 3.4. There were no permanent neurological or vascular injuries, and no deaths.

CONCLUSION: Proximal lumbar ACR plus SPO can achieve powerful spinopelvic correction with relatively low major complication rates in patients with ASD and prior fusion. LL restoration and SVA improvement compare favorably to open techniques, but with lower blood loss and length of stay. Differentially increasing PLL and lowering LDI does not appear to have deleterious effects on radiographic or clinical outcomes.

TITLE: INTEGRATING AI TRIAGE IN NEUROSURGERY: A REAL-WORLD ANALYSIS OF INCIDENTAL INTRACRANIAL ANEURYSM DETECTION

AUTHORS: C Schirmer, P Koul

PRESENTER: Clemens M. Schirmer, MD

INTRODUCTION: Recent technological advancements and the commercial availability of artificial intelligence (AI)-assisted tools have made the automated detection of incidental intracranial pathologies increasingly feasible. This study evaluates the impact of AI support on detecting and managing asymptomatic brain aneurysms, focusing on workflow alterations and clinical implications.

METHODS: Our analysis encompasses one year using the Viz.ai aneurysm triage module within an 11-hospital integrated delivery network, specifically examining its application across three comprehensive and primary stroke centers. The algorithm was integrated into our workflow, processing all Head CTA scans. We conducted a prospective collection of results, with the neurovascular team actively managing the output queue. We assessed the validity of the AI-generated triage alerts against standard radiology reports.

RESULTS: During the study period (12/2022-12/2023), 3,810 scans were analyzed using the Viz.ai algorithm. Of these, 181 patients (4.8%) were flagged for suspected lesions. The median age of these patients was 71 years, with a predominance of females (65%). Alerts were valid in 73% of cases, and 66% of these findings were also reported in the radiology interpretations. Our real-world evidence (RWE) setting revealed a sensitivity of 35% and specificity of 7.4% compared to the standard radiology report.

CONCLUSION: This study underscores the potential of AI-supported triage and decision-making algorithms in revolutionizing established neurosurgical workflows, particularly in managing incidental cerebrovascular pathologies. The integration of such tools can enhance patient-centered care in real-world settings. However, it is crucial to calibrate expectations based on RWE data, which may diverge from parameters outlined in FDA approval documents.

TITLE: PROTEOMIC AND PHOSPHOPROTEOMIC CHARACTERIZATION OF ADAMANTINOMATOUS CRANIOPHARYNGIOMAS LED TO A CLINICAL TRIAL AND A NOVEL SURGICAL TECHNIQUE.

AUTHORS: P B Storm, K Eaise, A J Kundishora, P J Madsen, D K Lerner, N D Adappa, J N Palmer, A C Resnick

PRESENTER: Jay Storm, MD

INTRODUCTION: Our group identified BRAF V600E mutations in papillary craniopharyngiomas[1]; however, not in adamantinomatous craniopharyngiomas(AC) despite WGS and RNAseq. Proteomic analyses demonstrated ACs clustering with low grade gliomas(LGGs) with a V600E mutation and LGGs with elevated immune infiltration and checkpoint protein expression[2]. We launched a clinical trial randomizing patients into 1 of 3 arms: PanRaf inhibitor, checkpoint inhibitor, or both. While waiting to enroll patients into the trial, we began fenestrating cystic ACs of patients who had normal endocrine function to preserve vision and endocrine function.

METHODS: Patients were managed with endonasal, endoscopic fenestration of the cyst and placement of vascularized nasoseptal flaps into the lumen of the tumor. A silastic stent was inserted into the lumen to seal the CSF leak and to keep the fenestration open. It was removed 6 weeks post op.

RESULTS: 15 patients (2-14yrs) underwent 21 fenestrations and 17/21 have preop pituitary function. 2/15 required no further intervention and are out 30- and 20-months. 5/15 had repeat fenestration: 2/5 are being observed with stable pituitary function, 1/5 progressed and received XRT, 2/5 progressed and GTR was achieved with resultant panhypopituitarism. Of the remaining 8, 2 had STRs, 1 is being observed and 1 went on trial, 3 had STR + XRT and 3 had GTR. 2 developed asymptomatic infections and none developed a CSF leak.

CONCLUSIONS: Endonasal fenestration of cystic ACs is safe and can preserve endocrine function and delay definitive treatment. More data is needed to improve patient selection and to evaluate the efficacy of the ongoing trial.

1. Exome sequencing identifies BRAF mutations in papillary craniopharyngiomas. Brastianos PK, Taylor-Weiner A, Manley PE, et al. Nat Genet. 2014 Feb;46(2):161-5.
2. Integrated Proteogenomic Characterization across Major Histological Types of Pediatric Brain Cancer. Petralia F, Tignor N, Reva B, Koptyra M, et al. Cell. 2020 Dec 23;183(7):1962-1985.

TITLE: BREAKING TRADITION: REPURPOSING VORTIOXETINE FOR H3K27M-MIDLINE GLIOMAS

AUTHORS: A Thiraviyam, R Vengoji, M Jain, S Batra, A Salehi

PRESENTER: Afshin Salehi, MD

INTRODUCTION: H3K27M diffuse midline-gliomas (DIPG) presents a dire prognosis with a 5-year survival below 10%. Current chemotherapeutic regimens, mirroring adult glioblastoma treatments, have proven ineffective. In this transformative study, we leverage bioinformatic tools to identify novel drugs, targeting cell signatures specific to H3K27M.

METHOD: Utilizing iLINCS (Library of Integrated network-based cellular Signatures) tool, our lab analyzed a comprehensive set of drugs, identifying those with cell signatures that negatively correlate with differentially expressed genes and proteins in DIPG tumors. Subsequently, these drugs underwent rigorous testing on human-derived H3K27M DIPG cell lines using cell viability (MTT), colony formation, and apoptosis assays. Additionally, Western blots assessed apoptotic and proliferative protein levels, while RNA sequencing unraveled the mechanism of action.

RESULTS: Our investigation revealed that the traditionally used antidepressant, vortioxetine (VORT), remarkably inhibits H3K27M-glioma cell proliferation and induces apoptosis. iLINCS analysis positioned VORT as one of the most negatively correlated drugs, exhibiting high levels of its target receptor, SLC6A4, on DIPG cell lines. The antiproliferation effect was substantiated by increased apoptosis through caspase activation, cleaved PARP, and decreased ERK activation.

CONCLUSIONS: Altogether, out study demonstrates that vortioxetine suppresses the proliferation of H3K27M-glioma cells in vitro. These results nominate the repurposing of vortioxetine as a potentially safe and targeted therapy for H3K27M gliomas. Notably, vortioxetine, with a track record in other clinical trials, FDA approval, and confirmed blood-brain barrier permeability, emerges as a promising candidate for future research. Ongoing work is being conducted in our lab with preclinical in vivo models.

TITLE: THE EFFECTIVENESS AND SAFETY OF SURGICAL MANAGEMENT OF BRACHIAL PLEXUS TUMORS

AUTHORS: A Al-Mistarehi, C Weber-Levine, K Jiang, M Alfonzo Horowitz, Y Xia, F Fayez, P Papali, S Neerumalla, B Z Mendelson, A M Hersh, N Theodore, A J Belzberg, D Lubelski

Presenter: Daniel Lubelski, MD

INTRODUCTION: Brachial plexus tumors represent challenges for neurosurgeons due to complex anatomy, surgery risks, and limited literature. We share our experience in the surgical management of these tumors.

METHODS: We reviewed the records of patients who had surgical resection for brachial plexus tumors at Johns Hopkins Medical Institutes from July 2014 to April 2023. The outcome data were collected from the most recent follow-up visit.

RESULTS: A total of 71 patients were included, with a mean (SD) age of 46.20 (14.88), and 54.9% were women. Most tumors were benign (87.3%), with schwannoma being the most common (71.8%). Almost all patients (97.2%) had at least one symptom at the presentation, commonly a palpable mass (76.1%) or pain (69.0%). Sensory and motor deficits affected 47.9% and 29.6%, respectively. The gross total resection was achieved at 80.3% and was significantly associated with lower recurrence rates and improved motor strength. Five patients developed postoperative complications, with no recorded deaths nor significant neurological deficits. Post-operation, patients had a mean follow-up duration of 40.17 (40.98) months, with 91.8% of patients reporting pain improvements and 53.1% experiencing total pain relief. Among those with preoperative neurological deficits, the recovery rate from sensory deficits was 47.9%, especially with preoperative dysesthesias, and the motor strength recovery rate was 76.2%. However, four patients (5.6%) developed new sensory deficits. Tumor recurrence occurred in 7 (9.9%) patients.

CONCLUSION: The brachial plexus tumors can be cured surgically by gross total resection with favorable outcomes, acceptable risks, minimal complications, and low tumor recurrence rates.

GENERAL SCIENTIFIC SESSION II

Tenacity

TUESDAY JUNE 25, 2023

6:30-7:30 am Breakfast

7:30-8:10 am TENACITY in Neurosurgery

7:30-8:00 am Tenacity in Neurosurgery: It's About More than 'Not Giving Up'
Christopher Ogilvy, MD
8:00-8:10 am Discussion

8:10-9:42 am Scientific Session III—Abstracts (Vascular)
Moderators: Kathleen Dlouhy, Webster Crowley

8:10-8:18 am Impact of CSF Filtration on Clinical Outcomes after Aneurysmal Subarachnoid Hemorrhage: An Individual Patient Level Data Analysis of the PILLAR-XT Results vs. Standard of Care
Spiros Blackburn, MD, University of Texas Houston, Houston TX

8:18-8:26 am Neuromodulation for Neurological Recovery: A Comprehensive Clinical Practice Model
Rushna Ali, MD, Mayo Clinic, Rochester MN

8:26-8:34 am Recent Predictors and Outcomes of Post-Endovascular Thrombectomy Intracranial Hemorrhage: A Large Comprehensive Stroke Center Experience between 2017-2021
Bradley Bohnstedt, MD, Indiana University Hospital, Indianapolis IN

8:34-8:42 am Middle Meningeal Artery Embolization Reduces Recurrence Following Surgery for Septated Chronic Subdural Hematomas
Mark Dannenbaum, MD, University of Texas Health Sciences, Houston TX

8:42-8:50 am A Mast Cell-Specific Receptor Mediates Post-Stroke Brain Inflammation via a Dural-Brain Axis
Risheng Xu, MD, PhD, Johns Hopkins University, Baltimore MD

8:50-9:00 am Discussion

9:00-9:08 am	Targeting the PD-1 Immune Checkpoint to Improve Outcomes after Ischemic Stroke *Christopher Jackson, MD, Johns Hopkins University, Baltimore MD*
9:08-9:16 am	Venous Sinus Diverticula in Patients with Pulsatile Tinnitus: Clinical Presentation and Patient Outcomes Following Endovascular Intervention *Omar Choudhri, MD, University of Pennsylvania, Philadelphia PA*
9:16-9:24 am	Combined Microsurgical and Endovascular Treatment of Complex Anterior Cerebral Artery Aneurysms *Michael Lang, MD, U of Pittsburgh Medical Center, Pittsburgh PA*
9:24-9:32 am	Management of Traumatic Carotid Artery Dissections: From High Flow Bypass to Conservative Management *Collin Liu, MD, University of Texas, Houston TX*
9:32-9:42 am	Discussion
9:42-10:05 am	*Beverage Break*
10:05-10:15	**Introduction of New Members** *Aviva Abosch, MD, PhD, Secretary, NSA*
10:15-10:20 am	**Introduction of the 2024 Neurosurgical Society of America Medalist** *Chris Fox, MD, Chair of the NSA Medal Committee*
10:20-10:30 am	**NSA Medalist Statement** *David Piepgras, MD*
10:30-11:00 am	**"Do as I Say, Not as I do"**
10:30-10:35 am	Vascular Case *Louis Kim, MD*
10:35-10:40 am	Pediatrics Case *David Limbrick, MD, PhD*
10:40-10:45 am	Posterior Cervical Case *Eldan Eichbaum, MD, and Dean Chou, MD*
10:45-11:00 am	Discussion

11:00-11:50 am	**Scientific Session IV – Abstracts (Tumors, Spine), Spiegel Shorts** *Moderators: William Ashley, Jennifer Hong*
11:00-11:08 am	Image-Guided Far Lateral Lumbar Foraminotomy and Microdisectomy: Operative Technique and Outcomes *Eric Nottmeier, MD, Mayo Clinic Florida, Jacksonville FL*
11:08-11:16 am	Sensitive Detection of Central Nervous System Tumors Using a Sequencing Based Cerebrospinal Fluid Test *Chetan Bettegowda, MD, PhD, Johns Hopkins University, Baltimore MD*
11:16-11:24 am	Quantifying the Effect of Circulatory Shear Stress on Molecular Alterations in Lung Adenocarcinoma Cells: Implications for Brain Metastasis *Kaisorn Chaichana, MD, Mayo Clinic Florida, Jacksonville FL*
11:24-11:32 am	MRNA-loaded Exosomes for Targeted Glioblastoma Immunotherapy *Betty Kim, MD, PhD, U of Texas MD Anderson Cancer Center, Houston TX*
11:32-11:36 am	What We Really Learned from the LAPDOG Trial of Endoscopic Disectomy (Spiegel Short) *Stephen Haines, MD, University of Minnesota, Blaine WA*
11:36-11:40 am	Lumbar Facet Arthroplasty for Spondylolisthesis and Stenosis: Interim Analysis of Three-Year Outcomes from a Prospective Randomized Clinical Trial (Spiegel Short) *Alan Villavicencio, MD, Boulder Neurosurgical Associates, Longmont CO*
11:40-11:50 am	Discussion
11:50-12:00 pm	**Introduction of the President of the Neurosurgical Society of America** *Louis Kim, MD*
12:00-12:30 pm	**Presidential Address** **"Tradition, Tenacity, and Transformation – Our Shared Voyage"** *Judy Huang, MD, President, NSA*
12:30 pm	**Dismissal for Afternoon Activities**

TITLE: IMPACT OF CSF FILTRATION ON CLINICAL OUTCOMES AFTER ANEURYSMAL SUBARACHNOID HEMORRHAGE: AN INDIVIDUAL PATIENT LEVEL DATA ANALYSIS OF THE PILLAR-XT RESULTS VS. STANDARD OF CARE

AUTHORS: S Blackburn, H Zeineddine, C Liu, W Wroe, B Dawes

PRESENTER: Spiros Blackburn, MD

INTRODUCTION: Intracranial blood and red blood cell lysis products have been identified as a primary driver of delayed deterioration in patients with aneurysmal subarachnoid hemorrhage (aSAH) patients. CSF aspiration, filtration, and return via the Neurapheresis CSF Management System™ via a dual lumen lumbar catheter is a promising new treatment method to reduce intracranial blood and improve patient outcomes (PILLAR-XT; NCT03607825). Here, we compare the impact of filtration on blood clearance and clinical outcome in Neurapheresis patients vs. aSAH patients treated by standard of care.

METHODS: Similar inclusion/exclusion criteria were applied to a retrospectively collected population to obtain an appropriate control (Retrospective Control Group, RCG: N=156) for comparison of clinical outcomes with the Neurapheresis Cohort (N=27). Intracranial blood reduction (measured via Hijdra Sum Score [HSS] Reduction) from the Neurapheresis Cohort was compared with a sub-group of RCG with the necessary imaging for comparison (Retrospective Control Group-Computed Tomography, RCG-CT Cohort, N=72).

RESULTS: Intracranial blood reduction among the Neurapheresis Cohort was significantly faster and more complete than in the RCG-CT Cohort. Subjects in the Neurapheresis Cohort experienced fewer measures of most Pre-defined Potential Neurological Sequalae (PPNS), with values reaching significance in shunt-dependent hydrocephalus, New Focal Neurological Deficit (NFND), and Delayed Cerebral Ischemia (DCI). The Neurapheresis Cohort subjects were also in significantly better locations at 30-days than the RCG cohort.

CONCLUSION: This analysis supports a role for the Neurapheresis System in accelerating reduction of intracranial blood following aSAH and improving clinical outcomes.

TITLE: NEUROMODULATION FOR NEUROLOGICAL RECOVERY: A COMPREHENSIVE CLINICAL PRACTICE MODEL

AUTHORS: M Khan, RAli

PRESENTER: Rushna Ali, MD

INTRODUCTION: Stroke is a prevalent cause of disability despite survivors undergoing conventional rehabilitation therapies. Neuromodulation in the form of paired vagal nerve and deep brain stimulation has emerged as a promising intervention to enhance neurological recovery, however, developing a robust clinical practice model is key to making this therapy equitably available. We describe the key components of a successful model developed at Mayo Clinic.

METHODS: Patient Population: This comprises of adult patients with moderate to severe impairment due to chronic stroke. Providing personalized neuromodulation interventions based on the specific disability either as on-label therapy or part of a research protocol is key. The success of this model heavily relies on collaboration among diverse stakeholders. This includes vascular neurologists, neurosurgeons, rehabilitation specialists, psychologists, device manufacturers, regulatory bodies, and most importantly, patients and their caregivers. Education and marketing campaigns emphasizing the safety, efficacy, and accessibility of neuromodulation not only facilitates timely intervention but also fosters a supportive environment for patients. The integration of neuromodulation into healthcare faces challenges related to insurance coverage. A disability driven phase of care insurance coverage model incorporating patient needs and evidence-based interventions has the potential to reduce cost and improve outcomes.

RESULTS: This model emphasizes the implementation of post-implant monitoring programs, involving regular follow-ups, objective assessments, and patient-reported outcomes. Participation in registries and clinical trials is a priority.

CONCLUSION: By addressing the diverse needs of patients, fostering collaboration among stakeholders, raising public awareness, tackling insurance issues, and emphasizing the importance of ongoing monitoring, this model aims to establish neuromodulation as a cornerstone in the comprehensive care of chronic stroke population.

TITLE: RECENT PREDICTORS AND OUTCOMES OF POST-ENDOVASCULAR THROMBECTOMY INTRACRANIAL HEMORRHAGE: A LARGE COMPREHENSIVE STROKE CENTER EXPERIENCE BETWEEN 2017-2021

AUTHORS: BM Abraham, MK Tobin, W Troja, J Weyhenmeyer, G Xu, JM Kovoor, BN Bohnstedt

PRESENTER: Bradley Bohnstedt, MD

INTRODUCTION: Thrombectomy is an effective treatment for large vessel occlusions. One feared complication of this procedure is post-prcedural intracranial hemorrhages. We sought here to elucidate some of the predictors of ICH after mechanical thrombectomy.

METHODS: Retrospective analysis was conducted on 590 patients from a single institution who underwent mechanical thrombectomy between January 2017 and October 2021. Inclusion criteria included anterior circulation LVO and non-contrast CTs obtained within 72 hours of thrombectomy. Post-thrombectomy ICH was classified using the Heidelberg Bleeding Classification. Uni- and multivariate analyses were conducted to determine predictors of hemorrhage and to determine predictors of 90-day modified Rankin Scale and 90-day survival.

RESULTS: Significant predictors of hemorrhagic transformation included pre-operative factors such as a longer duration from last known normal to puncture time and higher admission NIHSS. Significant predictors of post-procedural hemorrhage included higher number of passes and higher admission NIH stroke scale. Predictors of good 90-day mRS and 90-day survival included younger age, lower admission NIHSS, lower number of passes, and higher final TICI scores. Shorter duration between last known normal and puncture was also a predictor of good 90-day mRS. Negative predictors of good outcomes included comorbid diabetes. Furthermore, there were significant effects of the interaction between HT and SAH as it pertains to functional outcome and 90-day mortality.

CONCLUSIONS: Post-thrombectomy hemorrhage has significant impact on long term functional outcome and mortality. There are several modifiable predictors of post-procedural hemorrhage that warrant further investigation into how these factors can be better optimized to provide improved care to acute ischemic stroke patients.

TITLE: MIDDLE MENINGEAL ARTERY EMBOLIZATION REDUCES RECURRENCE FOLLOWING SURGERY FOR SEPTATED CHRONIC SUBDURAL HEMATOMAS

AUTHORS: WW Wroe, JC Martinez-Gutierrez, BH Dawes, H A Zeineddine, SA D'Amato, HW Kim, MI Nahhas, PR Chen, SL Blackburn, SA Sheth, CJ Chen, A Mahapatra, RS Kitagawa, MJ Dannenbaum

PRESENTER: Mark J. Dannenbaum, MD

INTRODUCTION: Septated chronic subdural hematomas (cSDH) have high rates of recurrence despite surgical evacuation. Middle meningeal artery embolization (MMAE) has emerged as a promising adjuvant for secondary prevention, yet its efficacy remains ill-defined.

METHODS: This is a retrospective review of septated cSDH cases treated at our institution. The surgery-only group was derived from cases performed before 2018, and the surgery+MMAE group was derived from cases performed 2018 or later. The primary outcome was reoperation rate. Secondary outcomes were recurrence, change in hematoma thickness, and midline shift.

RESULTS: A total of 34 cSDHs in 28 patients (surgery+MMAE) and 95 cSDHs in 83 patients (surgery-only) met the inclusion criteria. No significant difference in baseline characteristics between groups was identified. The reoperation rate was significantly higher in the surgery-only group (n = 16, 16.8%) compared with the surgery+MMAE cohort (n = 0, 0.0%) (p=0.006). A reduced incidence of recurrence (p=0.011) and increased reduction in midline shift (p=0.029) was seen in the surgery+MMAE group.

CONCLUSIONS: MMAE for septated cSDH was found to be highly effective in preventing recurrence and reoperation. MMAE is an adjunct to surgical evacuation may be of particular benefit in this patient cohort.

TITLE: A MAST CELL-SPECIFIC RECEPTOR MEDIATES POST-STROKE BRAIN INFLAMMATION VIA A DURAL-BRAIN AXIS.

AUTHORS: R Kothari, M Abdulrahim, J Oh, D Capuzzi, S Nair, Y Chen, SK Yadav, X Dong, R Xu

PRESENTER: Risheng Xu, MD, PhD

INTRODUCTION: Following ischemic stroke, post-stroke inflammation impairs long-term functional recovery in patients. Here, we investigate Murine Mrgprb2 and human MRGPRX2 as a mast cell-specific G protein-coupled receptor which is key for mast cell and downstream immune system activation after ischemic stroke.

METHODS: Wild type (WT) and Mrgprb2 -/- mice underwent ischemic stroke via a transient middle cerebral artery occlusion (MCAO) model. Stroke volume was assessed via magnetic resonance imaging (MRI). Mrgprb2-Cre mice were crossed with ROSA26-tdTomato (tdT) reporter mice, and flow cytometry was utilized to identify Mrgrprb2 location. Flow cytometry was also used to quantify immune cell populations following ischemic stroke. Skull bone flap transplantation from UBC-GFP mice to WT and Mrgprb2-/- mice were performed, and following MCAO, flow cytometry was used to investigate immune cell recruitment from the skull bone marrow. Finally, immunofluorescence was utilized to confirm the presence of MRGPRX2 in human dura.

RESULTS: Overall, Mrgprb2 -/- mice demonstrated reduced parenchymal inflammation, attenuated functional deficits, and a lower mortality rate compared to WT mice. Mrgprb2 was found to solely reside within the dural meninges. Following ischemia, Mrgrprb2 -/- mice displayed decreased innate inflammation. Additionally, Mrgprb2 -/- mice exhibited reduced neutrophil recruitment from the skull bone marrow into the parenchyma following ischemic stroke. A Mrgprb2 antagonist significantly reduced parenchymal neutrophil count after MCAO. Importantly, the human ortholog of this receptor MRGPRX2 was present in human dura and demonstrate significantly higher rates of degranulation following ischemic stroke.

CONCLUSIONS: Targeting MRGPRX2 may decrease post-stroke inflammatory injury by abrogating the significant mast cell activity that drives neuroinflammation in the brain. Further studies into the role of this receptor in mediating brain inflammation may additionally uncover a potential role for mast cells in other disorders of the central nervous system.

TITLE: TARGETING THE PD-1 IMMUNE CHECKPOINT TO IMPROVE OUTCOMES AFTER ISCHEMIC STROKE

AUTHORS: JE Kim, RP Lee, E Yazigi, L Atta, J Feghali, A Pant, A Jain, I Levitan, E Kim, K Patel, N Kannapadi, P Shah, A Bibic, Z Hou, JM Caplan, LF Gonzalez, J Huang, R Xu, J Fan, B Tyler, H Brem, VA Boussiotis, L Jantzie, S Robinson, R. Koehler, M Lim, RJ Tamargo, CM Jackson

PRESENTER: Christopher M. Jackson, MD

INTRODUCTION: Inflammation is a major source of morbidity and mortality in the subacute period after large territory ischemic strokes. Steroids and other anti-inflammatory agents are ineffective due to non-specific activity. Immune checkpoints are inhibitory molecules upregulated on activated immune cells. Emerging evidence indicates that activation of immune checkpoints can specifically inhibit pathologic inflammation. In this study, we evaluated the potential of activating the PD-1 immune checkpoint to prevent inflammatory damage after strokes.

METHODS: We collected blood daily from 14 patients with MCA occlusions and correlated PD-1 levels with radiographic and clinical outcomes. To test the therapeutic potential of activating PD-1 we administered soluble PD-1 ligand (sPD-L1) by IP injection in a murine transient MCAO model, and measured survival, cerebral edema, and short and long-term functional outcomes. To gain mechanistic insights we performed MCAO in global and myeloid-specific PD-1 knockout mice and performed single-cell RNA sequencing on circulating blood monocytes of treated and untreated mice.

RESULTS: PD-1 expression on circulating monocytes correlated with cerebral edema in patients with M1 occlusions. Administration of sPD-L1 in MCAO mice improved survival and decreased cerebral edema. Measures of both short and long-term functional outcomes were improved in treated mice. Both global and myeloid-specific PD-1 knockout abrogated the treatment effect, confirming PD-1+ monocytes/macrophages as the target cell population. Mechanistically, sPD-L1 skewed blood monocytes to a restorative phenotype with improved metabolic fitness.

CONCLUSION: Activation of PD-1 by administering soluble PD-L1 improves outcomes after stroke by programming monocytes to a restorative phenotype before they traffic into brain.

TITLE: VENOUS SINUS DIVERTICULA IN PATIENTS WITH PULSATILE TINNITUS: CLINICAL PRESENTATION AND PATIENT OUTCOMES FOLLOWING ENDOVASCULAR INTERVENTION

AUTHORS: E Walker, J Gujral, J Brant, D Bigelow, T Hwa, M Ruckenstein, O Choudhri

PRESENTER: Omar Choudhri, MD

INTRODUCTION: Venous diverticula are neurovascular outpouchings in the wall of a venous sinus. Venous diverticula in the sigmoid sinus and jugular bulb are often associated with the presence of bony dehiscence at the skull base. Debilitating symptoms such as pulsatile tinnitus in the presence of venous sinus diverticula often warrant open or endovascular treatment.

MATERIALS AND METHODS: 17 patients at the Hospital of University of Pennsylvania with symptomatic venous sinus diverticula treated endovascularly were included and reviewed for this study. Retrospective analysis was performed to determine the prevalence of dehiscence, laterality of diverticula, predominant symptoms at presentation, and treatment modalities.

RESULTS: Average age of our cohort was 56 years. There was predominance of venous diverticula in females namely 11 females and 6 males within our cohort. Five of Seventeen (16.6%) of patients presented with jugular bulb diverticula while the remaining involved the sigmoid or transverse-sigmoid junction. All patients received a stent-assisted coil embolization for diverticula resolution. Twelve out of Seventeen (70.5%) patients had improvement or complete symptom alleviation following endovascular stent coiling especially if associated with bony dehiscence and transverse sigmoid location. There were no postoperative complications.

CONCLUSION: We bring forth seventeen novel cases of venous diverticula treatment which is the largest single center experience to date. Trends in the incidence and epidemiology of our venous diverticula cases closely adhere to those outlined in the literature. Endovascular treatment for venous sinus diverticula obliteration has favorable outcomes regarding symptom alleviation with minimal complications associated with treatment.

TITLE: COMBINED MICROSURGICAL AND ENDOVASCULAR TREATMENT OF COMPLEX ANTERIOR CEREBRAL ARTERY ANEURYSMS

AUTHORS: MJ Lang, Nayar, Gautam, Schulien, Anthony J., Gross, Bradley

PRESENTER: Michael Lang, MD

INTRODUCTION: Despite technological improvements, some complex aneurysms remain ineffectively treated by microsurgery or endovascular techniques alone. Combined use of intracranial bypass to facilitate definitive endovascular treatment has emerged as a strategy for such cases.

METHODS: A prospectively maintained database of aneurysm treatments from August 2019 to January 2024 was retrospectively reviewed. All aneurysms of the anterior cerebral arteries (ACA) undergoing combined treatment were included. Clinical presentation, location, type, size, procedural complications, clinical and imaging follow-up were included in the analysis.

RESULTS: Seven patients (4 female) with complex aneurysms of the ACA system treated by combined approach were identified. Six were treated electively for unruptured aneurysms, and one presented with subarachnoid hemorrhage. Complex features included giant size, fusiform or dissecting morphology, thrombosis/calcification, or recurrence after prior endovascular treatment. Mean aneurysm size was 14.8 mm (range 6-27mm). Six aneurysms of the A2 +/- proximal A3 segment and one anterior communicating artery aneurysm were treated. Aneurysms were deemed poor candidates for isolated endovascular or microsurgical treatment. All patients underwent A3-A3 in situ bypass via small bicoronal craniotomy with bypass patency in 100% of patients. Six underwent parent vessel/aneurysm coil embolization in a single-stage treatment, and one patient underwent flow diversion in delayed fashion. Complete aneurysm occlusion was achieved in all patients (100%). No new neurological deficits were incurred as a result of treatment.

CONCLUSION: Complex aneurysms of the ACA system not amenable to traditional techniques can be safely and effectively treated using a combined microsurgical and endovascular approach, which may offer significant safety and efficacy advantage over traditional techniques.

TITLE: MANAGEMENT OF TRAUMATIC CAROTID ARTERY DISSECTIONS: FROM HIGH FLOW BYPASS TO CONSERVATIVE MANAGEMENT

AUTHORS: C Liu, L Zima, E Mohan, H Zeineddine, S Blackburn

PRESENTER: Collin Liu, MD

INTRODUCTION: Traumatic Carotid Injury (TCI) resulting in carotid occlusion is associated with high risks of ischemic stroke and death. Management of severe TCI differs from institution to institution in the acute setting with no standard protocol. In these cases, medical management may be insufficient for stroke prevention and endovascular intervention, or high flow bypass may be indicated. We investigate the role of CT-perfusion (CTP) and angiography to identify patients eligible for surgical intervention.

METHODS: A retrospective review between 2013-2023 selected patients with TCI grade IV (occlusion) and V (transection) from a single level 1 tertiary trauma center. Patients with carotid dissection without flow limitation were excluded. Primary end point defined as ischemic stroke identified in patients treated with medical therapy, endovascular therapy, or high flow bypass.

RESULTS: In 43 patients with grade 4 and 5 TCIs, 67.4% had medical management only, 18.6% with endovascular treatment, and 9.3% with bypass flow restoration. 41.4% of the patients with medical management alone developed large territory infarct compared to 37.5% and 0% in the endovascular and bypass cohort, respectively. After 2017, 44% of patients had CTPs to identify salvageable territories. Time to peak had 100% sensitivity and 25% specificity in identifying patients at risk while an increase in cerebral blood volume had 100% specificity and 50% sensitivity.

CONCLUSION: Bypass for flow restoration is a valuable tool to prevent large hemispheric stroke in selected candidates with favorable CTP imaging.

TITLE: IMAGE-GUIDED FAR LATERAL LUMBAR FORAMINOTOMY AND MICRODISCECTOMY: OPERATIVE TECHNIQUE AND OUTCOMES

AUTHORS: G De Biase, D Garcia, S Pirris, E Nottmeier

PRESENTER: Eric Nottmeier, MD

INTRODUCTION: We describe a technique of image-guided far lateral lumbar foraminotomy/microdiscectomy. This technique helps optimize the trajectory to the far lateral space to minimize bone removal. Additionally, because active fluoroscopy is not used with this technique, no radiation exposure occurs to the surgeon and operating room (OR) team.

METHODS: This is a retrospective study of patients undergoing image-guided far lateral foraminotomy/microdiscectomy performed by a single surgeon from January 2018 to July 2021. Operative time and outcomes were collected. All procedures were performed using the Medtronic S7 Stealthstation in conjunction with the O-ARM. The location of the paraspinal incision was ascertained using the image-guided dilator to allow adequate trajectory to the neural foramen which minimizes the amount of bone that needs to be removed. A MetrX tubular retractor was placed using the image-guided dilator. Image guidance was also used in some cases to help guide the foraminotomy/microdiscectomy.

RESULTS: 20 patients were included in our study; 14 (70%) underwent an image-guided far lateral microdiscectomy and 6 (30%) a foraminotomy. Mean total procedure time was 117.4 ± 24.6 minutes; EBL was 21.5 ± 16.6 ml. Average length of stay was 0.85 ± 0.6 days. There were no intraoperative complications and all patients reported significant improvement of their presenting symptoms. Mean follow-up was 19.4 ± 28.7 months.

CONCLUSION: Image guidance is a useful adjunct when performing far lateral lumbar foraminotomies/microdiscectomies allowing for optimal trajectory to the far lateral space and minimizing bone removal. Additionally, because no active fluoroscopy is used with this technique there is no radiation exposure to the surgeon and OR team.

TITLE: SENSITIVE DETECTION OF CENTRAL NERVOUS SYSTEM TUMORS USING A SEQUENCING BASED CEREBROSPINAL FLUID TEST

AUTHORS: C Douville, C Bettegowda

PRESENTER: Chetan Bettegowda, MD, PhD

INTRODUCTION: The current approach to diagnosing and monitoring tumors of the central nervous system relies almost exclusively on radiographic imaging and neurosurgical procedures. Cerebrospinal fluid (CSF) is appealing for diagnosis because it is already part of the standard of care for the diagnosis or management of several types of CNS disease, including cancer, and the tumor DNA is more highly concentrated inside the blood brain barrier than in plasma or other bodily fluids. Even though cytology is widely used, sensitivity remains low ranging from 2% to 50%, depending on cancer type.

METHODS: We report an analytic technique that efficiently introduces identical molecular barcodes to both strands of CSF template DNA molecules for the identification of cancer specific somatic mutations and copy number alterations.

RESULTS: We apply this approach to 126 CSF samples obtained from individuals with known primary or metastatic tumors involving the brain and 36 CSF samples obtained from individuals with non-neoplastic neurological conditions such as multiple sclerosis and another neurologic conditions. We correctly detect 91% of cancers at a specificity of 94.5% (Table 1). In cases (n=20) where standard of care cytology was available, cytology detected 25% of cancers while our molecular assay detected 90%.

CONCLUSION: Our molecular approach has the capacity to be used in combination with other clinical, radiologic, and laboratory-based data to inform the diagnosis and management of patients with suspected cancers of the brain.

TITLE: QUANTIFYING THE EFFECT OF CIRCULATORY SHEAR STRESS ON MOLECULAR ALTERATIONS IN LUNG ADENOCARCINOMA CELLS: IMPLICATIONS FOR BRAIN METASTASIS

AUTHOR and PRESENTER: Kaisorn L. Chaichana, M.D.

INTRODUCTION: Lung cancer (LC) is the most common tumor to metastasize to the brain, as 40% of patients develop brain metastasis (BM). Once diagnosed, survival is only 6.5-10 months. A potential target to prevent BM is circulating tumor cells (CTCs). The mechanisms that mediate CTCs adaptation to circulation and BM have not been elucidated.

METHOD: We engineered a microfluidic device that applies circulatory sheer stress (CSS). LC cells were cultured under circulation, suspension, or plated(2D). Total mRNA was extracted, and RNA sequencing was performed. The side population was evaluated using flow cytometry, and migration was assessed using transwell migration through brain microvascular endothelial cells. Intracardiac injection in athymic, nude mice were used to evaluate the *in vivo* effects of top upstream regulator syndecan binding protein (SDCBP).

RESULT: Gene networks activated in CTCs involved cell survival, migration, invasion, adhesion of tumor cells, and cytoskeletal reorganization ($p<0.05$). LC cells exposed to CSS had a distinct epithelial to mesenchymal transition phenotype, an increase in side population and overexpression of drug efflux pumps involved in cancer resistance and increased migration. The top upstream-regulator SDCBP was identified in regulating invasion, resistance to anoikis, and pre-metastatic niche formation. Moreover, mice injected with SDCBP knockdowns of LC cells demonstrated decreased the number of brain metastasis and improved survival compared to controls ($p<0.01$).

CONCLUSION: CSS induces the activation of gene networks regulated by SDCBP associated with migration, chemoresistance, and BM formation and drives the acquisition of a CTC phenotype in LCCs. Targeting these genes may be a promising approach to prevent BM.

TITLE: MRNA-LOADED EXOSOMES FOR TARGETED GLIOBLASTOMA IMMUNOTHERAPY

AUTHORS: S Dong, Y Ma, K Huntoon, A Antony, Y Wang, J Wen, B Kim

PRESENTER: Betty Kim, MD, PhD

INTRODUCTION: Recent successes of mRNA therapeutics against pathogenic infections have increasedinterest in their investigations for other human diseases including cancer. However, precisely delivering thegenetic cargo to cells and tissues of interest remains challenging. Extracellular vesicles such as exosomeshave gained increased interest recently as potential nucleic acid and drug carriers given their favorable immunogenic profile, long circulatory half-life, and ability to cross biological barriers such as blood-brain barrier. Here, we show an adaptive strategy that enables the docking of different targeting ligands onto the surface of mRNA-loaded exosomes.

METHODS: This was achieved using a microfluidic electroporation approach where a combination ofnano- and milli-second pulse electroporations produced a large quantity of IFN-γ mRNA-loaded exosomes with CD64 overexpressed on their surface. The CD64 molecule serves as an adaptor to docktargeting ligands, such as anti-CD71 and anti-programmed cell death-ligand 1 (PD-L1) antibodies.

RESULTS: The resulting immunogenic exosomes (imExo) selectively targeted glioblastoma cells andgenerated potent antitumor activities in vivo, including against tumors intrinsically resistant to immunotherapy.

CONCLUSION: Together, these results provide a new adaptive approach to engineering mRNA-loadedexosomes with targeting functionality and pave the way for their adoption in cancer immunotherapy applications.

TITLE: WHAT WE REALLY LEARNED FROM THE LAPDOG TRIAL OF ENDOSCOPIC DISCECTOMY

AUTHOR and PRESENTER: Stephen J. Haines, MD

INTRODUCTION: The introduction of endoscopic discectomy in the early 1990's presented an opportunity to evaluate a promising technique for a common neurosurgical procedure. With intense effort from the NIH and AHCRQ a randomized trial comparing microdiscectomy and endoscopic discectomy in patients with accepted criteria for single level lumbar disc herniation was funded and conducted.

METHODS: A ten center randomized clinical trial with blinded assessment of outcome was planned. Each potential center reviewed one year of discectomy procedures to identify patients who would meet the eligibility criteria of the study. Each surgeon also completed an audit of both endoscopic and microdiscectomy operations to document acceptable rates of success and complication. Based on the audits we projected that the 10 centers would have a total of 35 – 36 eligible patients per month. The planned sample size for the study was 660 patients, suggesting that if 50% of eligible patients entered the study it could be completed in approximately 18 months.

RESULTS: Ten centers screened 5735 patients in 30 months. Ninety-five (1.66%) met study eligibility criteria. Of these 36 (38%) enrolled in the trial.

DISCUSSION AND CONCLUSIONS: It was not possible to complete the study. The enormous discrepancy between the results of the pre-study eligibility audit and the actual rate of eligibility rendered satisfactory enrollment impossible. Various reasons for this discrepancy will be discussed. It appears that in the final decade of the 20th Century neurosurgery was not ready for a large randomized trial comparing an innovative procedure to one of its most common operations.

This study was sponsored by the National Institutes of Health National Institute of Neurological Disorders and Stroke (R01-NS/HS30908) and the Agency for Health Care Research and Quality (formerly the Agency for Health Care Policy and Research).

TITLE: LUMBAR FACET ARTHROPLASTY FOR SPONDYLOLISTHESIS AND STENOSIS: INTERIM ANALYSIS OF THREE-YEAR OUTCOMES FROM A PROSPECTIVE RANDOMIZED CLINICAL TRIAL

AUTHORS: AT Villavicencio, S Burneikiene

PRESENTER: Alan T Villavicencio, MD

INTRODUCTION: In June 2023, a new lumbar facet replacement technology was approved by FDA following a multi-center, prospective, randomized, Investigational Device Exemption trial. The interim analysis presents clinical and radiographic outcomes.

METHODS: Three-hundred-five subjects were randomly assigned (2:1) to either facet arthroplasty or transforaminal lumbar interbody fusion (TLIF) at one lumbar level. The primary clinical outcome measures included the Oswestry Disability Index (ODI) and visual analog scale (VAS) for leg and back pain, as well as re-operation rate at up to 36 months of follow-up.

RESULTS: At 36 months, the mean reduction in ODI scores were -47.4 ± 17.3 and -38.3 ± 22.8 for the facet arthroplasty and fusion groups, respectively, equating to a between-group difference of -9.1 (95% CI -16.6 to -1.5). VAS leg pain scores for the facet arthroplasty group showed the mean reduction of -73.2 ± 21.6 while fusion group -69.2 ± 26.8, equating to a between-group difference of -4.0 (95% CI -13.2 to 5.2). VAS back pain scores showed a mean reduction of -54.1 ± 32.3 and -43.6 ± 35.3 for facet arthroplasty and fusion, respectively, equating to a between-group difference of -10.6 (95% CI -23.8 to 2.6). Rates of surgical re-intervention involving removal, revision, or supplemental fixation were 4.8% for the facet arthroplasty and 9.4% for the fusion groups.

CONCLUSION: Lumbar facet replacement appears to be a viable option for treatment of degenerative spondylolisthesis with promising long-term results. Continued follow-up is required to validate early findings and evaluate differences between facet arthroplasty and fusion.

GENERAL SCIENTIFIC SESSION III

Transformation

WEDNESDAY JUNE 26, 2023

6:30-7:30 am Breakfast

7:30-7:35 am Announcements

7:35-7:40 am **Introduction of Invited Speaker Samuel Browd**
Amy Lee, MD

7:40-9:05 am TRANSFORMATION in Neurosurgery

7:40-8:10 am Digital Genesis: Neurosurgery 2.0
Samuel R. Browd, MD

8:10-8:20 am Discussion

8:20-8:35 am Neurosurgery Career Arcs
Gregory Zipfel, MD

8:35-8:50 am Evolution of the Academic Neurosurgeon
Henry Brem, MD

8:50-9:05 am Panel Discussion

9:05-9:55 am Scientific Session V – Abstracts (Career, Tumor, Functional)
Moderators: Spiros Blackburn, Brian Dlouhy

9:05-9:13 am Magnetogenetics Allow Device-free Regulated Gene Therapy in the Brain and Peripheral Nerves
Michael Kaplitt, MD, PhD, Weill Cornell, New York NY

9:13-9:21 am IL12 Secreting CAR-T Cells Reprogram the Tumor Microenvironment and Improve Efficacy Against Heterogenous Tumor Models
Anoop Patel, MD, Duke University Medical Center, Durham, NC

9:21-9:29 am Incidence of Recoupment of Payments by Commercial Insurers after Neurosurgical Procedures
Luis Tumialan, MD, Barrow Brain and Spine, Paradise Valley AZ

9:29-9:37 am Rebuilding a Pediatric Neurosurgery Program through Transformational Leadership: A Case Study
Arnett Klugh III, MD, Children's Hospital of Nebraska, Omaha NE

9:37-9:45 am Diagnostic Biopsy of a Motor Branch of the Femoral Nerve to the Quadriceps Muscle: An Alternative for a Proximal Motor Nerve Biopsy
Christopher Winfree, MD, Columbia University, New York NY

9:45-9:55 am Discussion

9:55-10:15 am Beverage Break

10:15-11:35 am Scientific Session VI – Abstracts (Tumor, Spine, AR, Vascular)
Moderators: Benjamin Kennedy, Sophia Shakur

10:15-10:23 am Oncolytic Immunoactivation is Associated with Survival in a Glioblastoma Clinical Trial
E. Antonio Chiocca, MD, PhD, Brigham and Women's Hospital, Boston MA

10:23-10:31 am Targeted Radionuclide Therapies (TRT) for Breast Cancer Leptomeningeal Disease
Mahua Dey, MD, University of Wisconsin, Madison WI

10:31-10:39 am Hemangioblastoma of the Posterior Cranial Fossa and Spinal Cord. Single Center Retrospective Study
Ciro Vasquez, MD, Neurosurgical Associates, Edina MN

10:39-10:47 am Outcomes of Recurrent Glioblastoma Patients with Radiation Necrosis Following GammaTile Brachytherapy Implantation
Jay McCracken, MD, Piedmont Atlanta Brain Tumor Center, Atlanta GA

10:47-10:55 am Epidemiology and Survival Outcomes of Patients with Brain Metastases: A National Population-based Study
Jordina Rincon-Torroella, MD, Johns Hopkins University, Baltimore MD

10:55-11:05 am Discussion

11:05-11:13 am Augmented Reality Enhanced MIS TLIF: A Technical Description and Case Series
Richard Price, MD, University of California Davis, Sacramento CA

11:13-11:21 am Influence of Sex on Functional Recovery Following Traumatic Spinal Cord Injury
Zachary Ray, MD, Washington University School of Medicine, St Louis MO

11:21-11:29 am Management of Acute Spinal Trauma in Pregnant Patients: A Systematic Review of the Literature
Merritt Kinon, MD, WMC Health, Valhalla NY

11:29-11:37 am Direct Retrograde MMA Embolization through Mini Craniotomy for Subdural Hematoma Evacuation: A Technical Note
Benjamin Waldau, MD, University of California Davis, Sacramento CA

11:37-11:45 am Discussion

11:45-12:25 pm Spiegel Shorts
Moderators: Jeffrey Mai, Patrick Codd

11:45-11:49 am Patients Report Substantial Improvement after Surgery for Grade II Lumbar Spondylolisthesis: A 2-Year Analysis of the Quality Outcomes Database (QOD)
Kai-Ming Fu, MD, Weill Cornell, New York NY

11:49-11:53 am Pathology Specific, Pharmacologically Reversible Loss of Neuronal Function in Human Gliomas
Shawn Hervey-Jumper, MD, U of California San Francisco, San Francisco CA

11:53-11:57 am Modified Frailty Index to Predict Adverse Outcomes after Decompressive Hemicraniectomy (DHC) for Acute Ischemic Stroke (AIS)
Stephan Munich, MD, Rush University, Chicago IL

11:57-12:01 pm The Future of Virtual Reality and Artificial Intelligence in Neurosurgery Residency Training
Juan Ortega-Barnett, MD, Dell Medical School, Austin TX

12:01-12:05 pm Chronic Subdural Hematoma – Embolize or Evacuate? An Update on cSDH Management
Andrew Gard, MD, MD West One, Omaha NE

12:05-12:09 pm Against the Curve: Survival of the Private Practice Community Neurosurgeon
Stephen Johans, MD, Neurosurgery of St Louis, St Louis MO

12:09-12:13 pm Concerns, Perceptions, and Career Considerations of Female Medical Students Interested in Neurosurgery: A Qualitative Study
Nathan Nair, MD, Georgetown University, Washington DC

12:13-12:25 pm Discussion

12:25-12:30 pm **Closing Remarks**
Judy Huang, MD, President, NSA

TITLE: MAGNETOGENETICS ALLOW DEVICE-FREE REGULATED GENE THERAPY IN THE BRAIN AND PERIPHERAL NERVES

AUTHORS: SR Unda, AM Anoniazzi, RM Marongiu, LE Pomeranz, SA Stanley, JM Friedman, MG Kaplitt

PRESENTER: Michael Kaplitt, MD PhD

INTRODUCTION: Optogenetics allows control of neuronal activity using light-sensitive ion channels, but implanted light devices and other limitations makes translation into a human therapeutic challenging. Here we present magnetogenetics, a novel gene therapy approach for bidirectional control of neuronal function with magnetic fields that require no device implantation.

METHODS: A modified TRPV1 receptor, which normally responds to heat and pressure, fused to ferritin which binds cellular iron, was expressed in mouse brain and sciatic nerve. Magnetic fields were generated by proximity to an MRI or transcranial magnetic stimulation (TMS), with behavioral outputs correlated with fiber photometry and PET imaging of neuronal activity along with post-mortem histology.

RESULTS: AAV delivery of the excitatory magnetogenetic construct into striatal indirect pathway neurons resulted in freezing when exposed to either an MRI or to a clinical TMS device. Fiber photometry with the GCamp calcium indicator, as well as FDG-PET, confirmed neuronal activation in living animals. A modified inhibitory construct was then expressed in subthalamic projection neurons of parkinsonian mice, with magnetic fields inducing neuronal inhibition and resulting behavioral improvement. Magnetogenetic regulation of sciatic nerve has also been demonstrated with work in pain models ongoing.

CONCLUSION: Magnetogenetic gene therapy allows activation or inhibition of specific neuronal circuits with external magnetic fields, including clinical devices such as TMS, in both the brain and sciatic nerve. This provides both a device-free mechanism for probing circuits in animal models and provides a new opportunity for non-invasive regulation of neuronal function following gene therapy delivery in human disease.

TITLE: IL12 SECRETING CAR-T CELLS REPROGRAM THE TUMOR MICROENVIRONMENT AND IMPROVE EFFICACY AGAINST HETEROGENOUS TUMOR MODELS

AUTHORS: SH Shen, AA Mohan, KM Hotchkiss, SL Cook, AM Swartz, EM Moelker, KK Patel, SE Zaidi, CM Suryadevara, D Wilkinson, PE Fecci, L Sanchez-Perez, JH Sampson, AP Patel

PRESENTER: Anoop Patel, MD

INTRODUCTION: Antigen heterogeneity, including canonical glioblastoma (GBM) associated genes such as EGFRvIII, are a challenge for antigen directed cellular therapies such as CAR-T cells. We hypothesized that using cytokines such as Interleukin-12 (IL12) in combination with CAR-T cells may improve targeting of heterogeneous tumors by reprogramming the microenvironment and facilitating endogenous immune responses.

METHODS: Mice were injected with a 50/50 mix of CT2A or CT2A EGFRvIII+ cells to model tumor heterogeneity. EGFRvIII-specific third generation CAR-T cells engineered with or without single chain IL12 were transduced into murine T cells and administered intratumorally. Antitumor efficacy of CAR-T cells was assessed using survival, and single cell sequencing of tumors was used to study mechanisms of IL12 mediated CAR-T cell efficacy.

RESULTS: EGFRvIII CAR-Ts alone fail to cure heterogeneous tumors, but IL12 secreting CAR-Ts cure 60% of mice. EGFRvIII CAR-Ts secreting IL12 persisted longer in vivo compared to EGFRvIII CAR-Ts and could persist without prior lymphodepletion. This effect was mediated by recruitment of the endogenous CD8 T cell compartment and epitope spreading. Single cell sequencing determined that IL12 acts on microglia to increase antigen presentation pathways and contribute to epitope spreading.

CONCLUSIONS: EGFRvIII CAR-Ts engineered to secrete IL12 treat antigen heterogenous tumors by polarizing local APCs and recruiting endogenous T cells. IL12 secreting CAR-Ts are able to persist longer without needing lymphodepletion when compared to traditional EGFRvIII CAR-Ts. Using CAR-T cells that secrete IL12 represents a promising approach to counter tumor heterogeneity, offering therapeutic potential against GBM in clinical settings.

TITLE: THE INCIDENCE OF RECOUPMENT OF PAYMENTS BY COMMERCIAL INSURERS AFTER NEUROSURGICAL PROCEDURES

AUTHORS: LM Tumialán, M Pacult

Presenter: Luis Manuel Tumialán, MD

INTRODUCTION: Neurosurgery practices have recently identified an alarming trend in recoupments of payments after successful neurosurgical interventions. The need to have a greater understanding of the depth of the problem prompted a rigorous examination of one neurosurgical practice.

METHODS: An analysis of the accounts receivables for a 26-neurosurgeon private practice was reviewed for the years 2021, 2022 and 2023. The occurrence, the amount, the insurer and the procedures where a recoupment were extracted from subsequent payment to the practice were collected.

RESULTS: In 2021, insurance companies recouped $1.298 million (3.2% of total revenue). In 2022, that number increased to $1.4 million (3.6% of total revenue). So far in 2023, insurance companies have recouped $495,428. All told, over 2.5 years, insurance companies have recouped $3.225 million for procedures where a prior authorization was obtained and the procedure performed. The top three codes for recoupment: 22853 (interbody spacer), 22551 (ACDF), 22840 (non-segmental instrumentation). United Healthcare has the greatest number of recoupments, representing $1.739 million (54%) of total recoupments for this practice.

CONCLUSION: The practice of recoupment of payment after neurosurgical procedures needs to end. Increased awareness of the recoupment tactic used by commercial payers is imperative for all neurosurgery practices, whether academic, hospital employed or private practice. Examining the trends in other practice types will add to our understanding and lay the foundation for advocacy. Federal legislation to end the practice of recoupment needs to be part of the Washington Committee legislative agenda.

TITLE: REBUILDING A PEDIATRIC NEUROSURGERY PROGRAM THROUGH TRANSFORMATIONAL LEADERSHIP: A CASE STUDY

AUTHORS: A Klugh, A Salehi, G Lai,

PRESENTER: Arnett Klugh, III MD

INTRODUCTION: An in-depth exploration will be provided of the successful rebuilding of a now-vibrant pediatric neurosurgery program, a process which has required the implementation of transformational leadership principles. Initial and ongoing challenges faced will be covered, including receding scandal, Pandemic-related fiscal and workforce issues, low morale, high staff turnover, and stymied innovation. In parallel and resulting from these strategies, progress has been made towards significant improvements in patient care, staff satisfaction, and overall program performance. A series of practical insights and strategies will be outlined that can be applied by other leaders facing similar challenges in their healthcare settings.

METHODS: Critical transformational leadership strategies were employed to create a compelling vision and achieve buy-in, foster a culture of trust and collaboration, and inspire staff to exceed their own expectations.

RESULTS: The volume and complexity of neurosurgical cases increased substantially with a wide spectrum of care ushering in historical firsts in surgical techniques. Academic interest blossomed with basic science pediatric brain tumor research and clinical study engagement. The pediatric neurosurgery program grew in operational efficiency, sustainability and reputation.

CONCLUSION: This case study serves as a testament to the power of transformational leadership in driving significant change and improvement in healthcare.

TITLE: DIAGNOSTIC BIOPSY OF A MOTOR BRANCH OF THE FEMORAL NERVE TO THE QUADRICEPS MUSCLE: AN ALTERNATIVE FOR A PROXIMAL MOTOR NERVE BIOPSY.

AUTHORS: KH Ho, FA Khan, K Tanji, P Garcia, CJ Winfree

PRESENTER: Christopher J Winfree, MD

INTRODUCTION: Peripheral nerve biopsy is one diagnostic tool for unexplained cases of peripheral neuropathy, with the sural nerve often being the default choice for biopsy. In cases where motor nerve biopsy is desired, biopsy of the superficial peroneal nerve or the motor branch to the gracilis muscle have been described. However, biopsy site selection and clinical correlation is key, necessitating the selection of alternative sites in some cases. This report introduces a new surgical approach that combines femoral nerve motor branch and quadriceps muscle biopsies, expanding the options for biopsy site selection, especially for conditions affecting motor nerve fibers.

METHODS: A 45-year-old woman with suspected hereditary progressive neuromuscular weakness and uninformative medical and genetic workup underwent a biopsy of her left femoral nerve motor branch and adjacent quadriceps muscle. The procedure, conducted under general anesthesia, included intraoperative nerve stimulation to identify the appropriate branch. Intraoperative EEG also showed distinctive changes when stimulating either motor or sensory branches of the femoral nerve.

RESULTS: The pathology report indicated moderately severe myofiber atrophy and nonspecific myelin alterations. The biopsy ruled out axonal motor neuropathy as well as motor neuron disease.

CONCLUSION: This is the first report of biopsy of the femoral nerve motor branch, which is a technically straightforward option for motor nerve biopsy, especially in select cases where a proximal motor nerve is desired.

TITLE: ONCOLYTIC IMMUNOACTIVATION IS ASSOCIATED WITH SURVIVAL IN A GLIOBLASTOMA CLINICAL TRIAL

AUTHORS: EA Chiocca

PRESENTER: E Antonio Chiocca, MD, PhD

INTRODUCTION: Immunotherapy failures can be due to the highly suppressive tumor microenvironment characterizing aggressive forms of cancer, like recurrent glioblastoma (rGBM). Here, we report the results of a "first-in-human" phase 1 trial in 41 rGBM subjects, injected with CAN-3110, an oncolytic herpes virus (oHSV). Unlike other clinical oHSVs, CAN-3110 retains the viral neurovirulence ICP34.5 gene transcribed by a Nestin promoter, a protein over-expressed in GBM and other invasive tumors, but not in adult brain or healthy differentiated tissue4. These modifications confer CAN-3110 with preferential tumor replication.

METHODS: A 3+3, dose-escalation and dose expansion phase 1 clinical trial in hmans with recurrent GBM

RESULTS: No dose-limiting toxicities were encountered. Surprisingly, positive HSV1 serology was significantly associated with both improved survival and clearance of CAN-3110 from injected tumors. Survival after treatment, particularly in HSV1 seropositive subjects, significantly associated with a-changes in tumor/PBMC T cell counts and clonal diversity, b- peripheral expansion/contraction of specific T cell clonotypes, and c- tumor transcriptomic signatures of immune activation.

CONCLUSION: These results provide human validation that intralesional oHSV treatment enhances anticancer immune responses even in immunosuppressive tumor microenvironments, particularly in subjects with cognate serology to the injected virus. This provides a biologic rationale for use of this oncolytic modality in cancers that are otherwise unresponsive to immunotherapy (clinicaltrials.gov NCT03152318) (published in *Nature* (Ling et al, 2023).

TITLE: TARGETED RADIONUCLIDE THERAPIES (TRT) FOR BREAST CANCER LEPTOMENINGEAL DISEASE

AUTHORS: L Zhao, P Clark, Z Morris, M Dey

PRESENTER: Mahua Dey, MD

INTRODUCTION: Targeted radionuclide therapies (TRTs) are a form of radiation-based cancer therapy that employ a tumor-targeting agent to facilitate uptake of a radioactive isotope in tumor cells. Clinical studies have demonstrated that TRTs can improve survival by delivering radiation to all metastatic tumor sites without exceeding clinically acceptable toxicity limits. Alkylphosphocholine NM600 offers flexibility to chelate diverse therapeutically relevant radioisotopes (e.g. ^{177}Lu, ^{225}Ac) and demonstrates tumor-specific uptake and retention in >50 cancers including diverse murine tumor models as well as human tumors. Leptomeningeal disease (LMD) is a challenging form of cancer metastasis involving the dissemination of tumor cells via the cerebrospinal fluid (CSF).

METHODS: Direct injection of NM600 into the CSF space could provide highly selective delivery of high dose radiation directly to tumor cells in settings of LMD, when used to deliver radioisotope emitting very short-range radiation (e.g., ^{225}Ac, mean range 100 μm). We used ^{225}Ac-NM600 to test anti-cancer efficacy and toxicity profile breast cancer mouse model of LMD.

RESULTS: We found that ^{225}Ac is more effective at cancer cell killing compared to external beam radiation therapy. The cell death is due to double stranded DNA damage. Mice with breast cancer LMD tolerated the radiation well without significant toxicity. ^{225}Ac also modulates immune activation profile of the cancer cells and can be used as an immune modulating agent as well as cytotoxic agent.

CONCLUSION: In conclusion, we found that TRT can be safely administered in the setting of breast cancer LMD and may be an effective treatment modality with favorable toxicity profile.

TITLE: HEMANGIOBLASTOMA OF THE POSTERIOR CRANIAL FOSSA AND SPINAL CORD. SINGLE CENTER RETROSPECTIVE STUDY.

AUTHOR: C Vasquez, M Nagib

PRESENTER: Ciro Vasquez, MD

INTRODUCTION: Hemangioblastomas are rare tumors of the central nervous system, accounting for 1-2.5% of all intracranial tumors. They can be located on the cerebellum, brainstem, and spinal cord. The WHO classifies Hemangioblastomas as Grade I meningeal tumors of uncertain origin. They can present sporadically or in patients with von Hippel-Lindau (VHL) disease.

METHODS: A total of 33 patients with pathological diagnosis of hemangioblastomas were included in this study. Data was collected from hospital charts, radiological images, and pathology analysis from 2010 to 2023 from a single institution. Demographic data of patients included: presenting symptoms, morphology and location of tumor, surgical course, and outcomes.

RESULTS: From all 33 cases reviewed, 31 were adults and 2 were children with predominance in women (56%). The most common presenting symptoms were imbalance and headaches. Tumors more frequently occurred in the cerebellum (71%), followed by spinal cord (26%) and supratentorial space (3%). All patients underwent surgical resection with gross total resection achieved in 94% of the cases. The most common type of tumor was solid (60%) in appearance vs solid/cystic 40%. Outcome was favorable in 64% of cases, 24% fair, 3% poor and undeterminate in 9%.

CONCLUSION: Hemangioblastomas of the central nervous system are highly vascularized tumors thar should be resected en-block to minimize intraoperative blood loss and ease of operation. Prognosis and surgical outcomes are generally favorable.

TITLE: OUTCOMES OF RECURRENT GLIOBLASTOMA PATIENTS WITH RADIATION NECROSIS FOLLOWING GAMMATILE BRACHYTHERAPY IMPLANTATION

AUTHOR and PRESENTER: Jay McCracken, MD

INTRODUCTION: Implantation of collagen tile brachytherapy GammaTile (GT Medical Technologies Tempe, AZ) allows for targeting of radiation to residual malignancy following surgical resection of gross disease. Radiation necrosis (RN) can develop after radiotherapy or brachytherapy. We sought to determine outcomes in recurrent glioblastoma patients with RN after treatment with Gammatile. All patients were previously treated with surgical resection followed Stupp protocol chemoradiation. At recurrence, patients underwent repeat surgical resection and implantation of GammaTile. Subsequent MRIs were assessed for stability, presumed RN or progression. Symptomatic RN patients were treated with corticosteroids or bevacizumab.

METHODS: From December 2020 to February 2023, 19 patients were treated. Median time from initial radiation to GammaTile therapy was 270 days.

RESULTS: A total of 8 patients (42%) developed RN at a median time of 81 days from GammaTile. In RN patients vs those that did not develop RN, pathological tumor viability was lower (20% vs 50%, p=0.3), age was lower (54 vs 63, p=0.06), tumor volume was lower (10.8 cc vs 51.9 cc, p=0.02), time from initial surgery was longer (470 days vs 299 days, p=0.46), number of GammaTiles placed was lower (5 vs 8, p=0.045), rate of gross total resection (GTR) was higher (100% vs 64%, p=0.04), and MGMT methylation rate was higher (63% vs 11%, p=0.03). No patients in the RN group experienced radiographic progression (0% vs 45%, p=0.009) and 3 (38%) required bevacizumab therapy. Median overall survival from GammaTile surgery in the RN group was 325 days vs 188 days (p=0.03).

CONCLUSION: Our series demonstrates a significant survival benefit in patients who develop RN following GammaTile implantation after glioblastoma recurrence. RN developed in younger patients with smaller tumor volumes, lower pathological tumor viability, and higher rates of GTR and MGMT methylation status.

TITLE: **EPIDEMIOLOGY AND SURVIVAL OUTCOMES OF PATIENTS WITH BRAIN METASTASES: A NATIONAL POPULATION-BASED STUDY**

AUTHORS: J Rincon-Torroella, M Parker, K Jiang, J Materi, A Kalluri, T Azad, D Kamson, L Kleinberg, X Ye, C Bettegowda

PRESENTER: Jordina Rincon-Torroella, MD

INTRODUCTION: Brain metastases (BM) are the most common CNS tumors. We report the prevalence and survival of patients with synchronous (sBM) and metachronous BM (mBM) using population-based databases.

METHODS: We identified 1,872,057 patients with malignancies between 2015-2019 from the NCI SEER Program database and 11,497,663 patients with the 15 most common primary metastatic cancers to the brain between 2013-2023 from the TriNetX Research Network. SBM were identified within 2 months and mBM were identified >2 months after primary cancer diagnosis. Survival was evaluated with Kaplan-Meier curves and multivariate Cox regression.

RESULTS: In SEER, 35,986 (1.9%) patients had sBM. Of the 11,497,663 patients with primary cancer identified from TriNetX , 300,863 (2.6%) had BM, including 113,827 (37.8%) sBM and 187,036 (62.2%) mBM. BM most commonly arose from lung, breast, and melanoma. The average time to mBM was 1.8 (1.3-2.5) years. Patients with BM had significantly shorter survival. In both SEER and TriNetX, BM were associated with poorer survival than extracranial metastases only (SEER: HR: 1.40 [95%CI: 1.39 – 1.42], P<0.001; TriNetX: 38.75 vs 69.18 months, HR 1.840 [95% CI 1.821–1.859], $p < 0.0001$). Patients with sBM had significantly decreased median survival compared to mBM (11 vs. 37 months, HR 2.166 [95%CI 2.139-2.193], $p < 0.0001$). However, no survival advantage was observed from the time of BM diagnosis (11 vs. 12 months, HR 1.063 [95%CI 1.048-1.078], $p = 0.4111$).

CONCLUSION: Regardless of primary cancer origin or chronicity, BM represent a healthcare burden with tremendous mortality. These results can guide improved screening.

TITLE: AUGMENTED REALITY ENHANCED MIS TLIF: A TECHNICAL DESCRIPTION AND CASE SERIES

AUTHOR and PRESENTER: **Richard L. Price, MD, PhD**

INTRODUCTION: Augmented reality (AR) utilizes optical projections into the user's field of view to create a visual overlay in the visual field. Use of AR in spine surgery has primarily focused on pedicle screw placement. Here we show novel applications of AR to perform the entirety of a MIS TLIF (AR-MIS TLIF) ultimately improving efficiency and reducing radiation exposure for surgical teams.

METHODS: A retrospective review of 24 consecutive patients, where AR was used for pedicle screw placement, decortication of contralateral facets, placement of graft materials, facetectomy, and discectomy portions of the MIS TLIF were examined.

RESULTS: AR-MIS TLIF was performed on 24 patients with a total of 32 TLIF levels. Average operative time was 118 minutes per level. Blood loss averaged 60.4 ml per operation, or 47.9 ml per level fused. All 24 patients were ambulatory on POD 1. Eleven patients (45.8%) were discharged on POD 1 and five patients (20.8%) were discharged on POD 2. No patients experienced major surgical complications. There was a significant reduction ($p<0.01$) in fluoroscopy time with AR-MIS TLIF when compared to traditional MIS TLIF. All pedicle screws (n=112) and interbodies (n=32) were accurately positioned as verified by post-operative Xrays.

CONCLUSION: The use of AR allows for an efficient and precise MIS TLIF while reducing traditional reliance on fluoroscopy. AR navigation can be utilized with nearly all instrumentation and used to perform most surgical steps beyond pedicle screw placement, allowing for a precise and efficient procedure with minimal radiation exposure to the surgical team.

TITLE: INFLUENCE OF SEX ON FUNCTIONAL RECOVERY FOLLOWING TRAUMATIC SPINAL CORD INJURY

AUTHORS: B Benedict, S Javeed, JK Zhang, MI Kaleem, K Botterbush, S Yakdan, A Belzberg, S Tuffaha, SS Burks, AD Levi, EL Zager, AH Faraji, MA Mahan, R Midha, TJ Wilson, N Juknis, JK Greenberg, WZ Ray

PRESENTER: Wilson Zachary Ray, MD

INTRODUCTION: Sex differences may influence spinal cord injury (SCI) outcomes, however systematic analyses of these differences are lacking. We quantified sex effects on functional and neurological SCI recovery.

METHODS: Adult traumatic SCI patients enrolled in a SCI Model Systems center within 30 days of injury (1992-2016) were included (N=3912, 20% female). Outcomes were Functional Independence Measure (FIM) and individual items, ASIA Motor Index Score, and AIS grade improvement from baseline to 1 year. Multivariable regression models controlling for age, injury level, decompression/fusion surgery, baseline AIS grade, and baseline scores assessed sex impact.

RESULTS: Females were older, more educated, and had fewer sensory complete injuries. Males had higher 1-year FIM scores (B=3.2 points [1.9, 4.5]). Bladder control and transfers accounted for the greatest FIM differences. While unadjusted analyses showed higher 1-year ASIA scores (F:66, M:56, p=0.042) and greater score improvements for females (F:+10, M:+8, p=0.046), no sex effect was present after risk adjustment. A trend toward higher AIS improvement was seen for females (OR:1.28 [0.99, 1.66]), but when stratified, only AIS B injuries showed a significant effect (OR:1.88 [1.03, 3.55]).

CONCLUSIONS: Outcome differences exist, likely attributable to physiology and injury differences. Higher male FIM may reflect lower urinary incontinence and greater strength. Higher female AIS improvement rates could stem from less severe baseline injuries. No independent sex effect on motor recovery was found.

TITLE: MANAGEMENT OF ACUTE SPINAL TRAUMA IN PREGNANT PATIENTS: A SYSTEMATIC REVIEW OF THE LITERATURE

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PRESENTER: Merritt D. Kinon, MD

INTRODUCTION: Despite the high incidence of spine trauma globally, traumatic spinal cord injury (tSCI) during pregnancy is considered a rare medical emergency. These patients require special considerations during diagnosis and management to optimize outcomes for both mother and fetus; however, the literature on acute management of these patients is relatively sparse compared to that of mothers with pre-existing SCI. This systematic review aims to evaluate management strategies for tSCI during pregnancy in improving neurologic, obstetric, and neonatal outcomes.

METHODS: A systematic review was performed to identify patients who acquired tSCI during their pregnancy.

RESULTS: Data from 73 patients was extracted from 43 articles from 1955-2023. The mothers' average age was 26.1 ± 6.2 years old, and the average weeks gestational age (WGA) of the fetus at the time of injury was 21.1 ± 7.7 weeks. The thoracic spinal cord was the most common segment affected (41.1%) and had the greatest proportion of complete SCI (46.6%). The only positive predictor for neurologic recovery was ASIA grade at presentation; patients presenting with ASIA B or C SCI had a statistically greater likelihood of improvement than patients presenting with ASIA A SCI ($p = 0.0029$ and $p = 0.0048$, respectively). However, surgical management of the mother prior to delivery significantly decreased the incidence of adverse events in the fetus compared to conservative management (OR: 0.24, 95% CI: 0.065 to 0.90).

CONCLUSION: Favorable neurologic and obstetric outcomes for acute tSCI in pregnancy depend on timely and tailored strategies by the providing surgeon and obstetrician.

TITLE: DIRECT RETROGRADE MMA EMBOLIZATION THROUGH MINI CRANIOTOMY FOR SUBDURAL HEMATOMA EVACUATION: A TECHNICAL NOTE

AUTHOR and PRESENTER: Ben Waldau, MD

INTRODUCTION: Subacute and chronic subdural hematomas (SDH) are common neurosurgical problems with a high recurrence rate after evacuation. Middle meningeal artery (MMA) embolization has been shown to decrease the chance of hematoma recurrence. Currently, MMA embolization is performed through radial or femoral access. Here we introduce a novel surgical approach by performing direct retrograde catheterization and embolization of the MMA during a mini craniotomy for hematoma evacuation.

METHODS: A 76-year-old male on aspirin with multiple comorbidities including congestive heart failure and end stage renal disease presented with a 14mm right acute on chronic SDH. A calvarial groove of the MMA was localized over the center of the SDH with fluoroscopy in a radiolucent Mayfield.

RESULTS: A larger frontal branch of the MMA was identified in the surgical field after the craniotomy. The branch was catheterized with a Headway Duo microcatheter and a Synchro 2 soft microwire under direct visualization, and the catheter tip was advanced to the level of the sphenoid wing under roadmap guidance. After a super-selective angiogram of the right MMA had shown no anastomoses to the eye, the frontal branches of the MMA were successfully embolized with Onyx 18. Overall, the procedure took 100 minutes with a total time under anesthesia of 185 minutes. No periprocedural complications were encountered, and the patient recovered to his neurological baseline.

CONCLUSION: Direct retrograde MMA catheterization during mini craniotomy is a novel surgical procedure that allows for robust MMA embolization and improved workflow since two procedures can be combined into one.

TITLE: PATIENTS REPORT SUBSTANTIAL IMPROVEMENT AFTER SURGERY FOR GRADE II LUMBAR SPONDYLOLISTHESIS: A 2-YEAR ANALYSIS OF THE QUALITY OUTCOMES DATABASE (QOD)

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PRESENTER: Kai-Ming Fu, MD

INTRODUCTION: This study aims to assess the long-term patient reported outcomes (PROs) after the surgical management of grade II spondylolisthesis using the QOD database.

METHODS: This is a retrospective analysis of the multicenter, prospectively collected Quality Outcomes Database (QOD). Patients who underwent arthrodesis for grade II lumbar spondylolisthesis were included. Baseline characteristics and comorbidities were recorded. Pre-operative and 3-, 12-, and 24-month PROs including NRS Back Pain (NRS-BP), NRS Leg Pain (NRS-LP), Oswestry Disability Index (ODI), and EuroQol-5D (EQ-5D) scales along with post-operative patient satisfaction using the North American Spine Society (NASS) index were evaluated. Multivariable analysis to determine predictors of non-routine discharge was performed.

RESULTS: There were 400 patients that were eligible for comparative analysis that were categorized into two groups: <60 years (n=157) and ≥60 years (n=243). Older patients had a lower body mass index ($p<0.01$), higher rates of diabetes ($p<0.01$) and osteoarthritis ($p<0.01$). There were no baseline differences in PROs (ODI, EQ-5D, NRS leg pain, and back pain) among age categories. Older patients also had greater rates of non-routine discharge ($p<0.01$). Multivariable analysis revealed that patients with baseline ambulation dependence ($p<0.01$), and Medicare coverage ($p=0.01$) had significantly greater odds of non-routine discharge after adjusting for several variables. Regardless of age, significant improvements were seen for all patients at 2-year follow-up, with most patients achieving >87% overall satisfaction rates.

CONCLUSIONS: Most patients including elderly patients undergoing fusion for grade II lumbar spondylolisthesis report decreased pain and improved outcomes.

TITLE: PATHOLOGY SPECIFIC, PHARMACOLOGICALLY REVERSIBLE LOSS OF NEURONAL FUNCTION IN HUMAN GLIOMAS

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PRESENTER: Shawn Hervey-Jumper, MD

INTRODUCTION: Prior evidence has demonstrated that neuronal activity is preserved within glioma-infiltrated cortex and maintains the ability to engage in task specific computations albeit with information loss. These findings support a potential therapeutic target to rescue cognitive impairments seen in nearly all afflicted patients if neuronal activity can be recovered. We developed an in vivo human behavioral and electrophysiological model to assess neuronal population tuning responses within primary sensory cortex including the decodability of stimuli and task-related changes in population spiking.

METHODS: We placed high-density electrode arrays to record human local field potentials from gliomas. We next designed a static sensory detection threshold task, stimulating with a tachometer at two different face and hand sites while recording from cortical contacts over both tumor-infiltrated and normal appearing cortex.

RESULTS: In tumor-infiltrated cortex, the ability to decode the site of stimulation using the oscillatory power in both theta (4-8 Hz) and gamma (32-70 Hz) bands was reduced compared to normal appearing cortex. However, tumor-infiltrated cortex-maintained selectivity between hand and face stimulation. Targeted next-generation tumor sequencing uncovered novel molecular targets of glioma-neuronal integration. The degree of loss of selectivity correlated with WHO grade and pathology. WHO grade 4 tumors and oligodendrogliomas demonstrated the greatest loss of selectivity. Administration of GABA agonist rescued theta band selectivity and decodability.

CONCLUSION: These results suggest that loss of neuronal computations in glioma-infiltrated cortex is caused by loss of neuronal selectivity and is both tumor selective and pharmacologically reversible.

TITLE: MODIFIED FRAILTY INDEX TO PREDICT ADVERSE OUTCOMES AFTER DECOMPRESSIVE HEMICRANIECTOMY (DHC) FOR ACUTE ISCHEMIC STROKE (AIS)

AUTHORS: KC Joshi, N Pertsch, B Kolb, EM Ritz, RW Byrne, SA Munich

PRESENTER: Stephan Munich, MD

INTRODUCTION: The incidence of acute ischemic stroke (AIS) doubles with each decade after 55. Initial studies evaluating the efficacy of decompressive hemicraniectomy (DHC) excluded patients over 60 years due to the assumption that older patients faired worse. The concept of frailty aims classify patients according to a theory of "accumulating deficits," which may be independent of age.

METHODS: The NSQIP data set (2008-2018) was accessed for patients undergoing DHC for AIS, assigning a modified Frailty Index 11 (mFI-11) based on 11 preoperative clinical variables to assess the clinical outcomes of these patients.

RESULTS: 394 patients were identified (Table 1). There was a statistically significant increase in the rate of return to the operating room with increasing mFI-11 scores (Table 2). The discharge disposition was significantly different in patients with greater frailty - 5.7% of severely frail patients discharged to home versus 14.5% of robust patients. There were no statistically significant differences in rates of pneumonia, cardiac arrest, 30-day mortality and Clavien class 4 complications amongst the different frailty groups. Multivariate logistic regression analysis demonstrated that compared with age, gender, ASA class, and pre albumin levels, mFI was a better predictor of the development of pneumonia (OR 6.278, 95 % CI 1.8, 22.0, p=0.004) and return to operating room (OR 4.0, 95 % CI 1.2 ,13.4, p=0.02).

CONCLUSION: Higher mFI-11 scores were associated with an increased risk of return to the operating room discharge disposition other than home. Assessment of frailty may provide greater insight into the overall tolerance and outcome of patients to DHC after AIS.

TITLE: THE FUTURE OF VIRTUAL REALITY AND ARTIFICIAL INTELLIGENCE IN NEUROSURGERY RESIDENCY TRAINING

AUTHORS: J Ortega-Barnett

PRESENTER: Juan Ortega-Barnett, MD

INTRODUCTION: Currently most neurosurgery training programs are based on learning through apprenticeship and knowledge transfer. Most surgical skills are obtained through the daily grind of scrubbing in cases and occasional workshop practice on cadavers or spine and skull models. Yet science and learning theories have shown that in order to obtain expertise experience traditionally it is necessary to practice for many years through trial and error. However deliberate practice methods with AI and VR technology can shorten the time frame to develop expertise. A proposed method for deliberate practice in neurosurgery residency training is presented.

METHODS: A literature review on learning theories, curriculum development and applied artificial intelligence and virtual reality simulation in neurosurgery residency education is outlined. Using David Kern's six step model for curriculum development to implement the learning experience along with deliberate practice methods with interleaving concepts, randomization of learning skills, distributed learning, increasing the challenges, consolidation and routine timely feedback, applied through virtual reality simulation and artificial intelligence we can hone in on each learner creating a precision medical education.

RESULTS: 40 Pubmed articles on VR and AI in neurosurgery education and several texts on learning theories and curriculum development are reviewed establishing a background for a possible method in neurosurgery precision education.

CONCLUSION: This is a general review of the available technology that may be applied in the neurosurgical residency program curriculum. VR and AI In the pre-, intra-, and postoperative stages of neurosurgery, have the ability to enhance surgeons' skill sets. Further studies on education and training in neurosurgery with VR simulation and AI are needed.

TITLE: CHRONIC SUBDURAL HEMATOMA – EMBOLIZE OR EVACUATE? AN UPDATE ON CSDH MANAGEMENT

AUTHOR and PRESENTER: Andrew P Gard, MD

INTRODUCTION: Although the traditional management for chronic subdural hematoma (cSDH) involves surgical evacuation, endovascular embolization has demonstrated significant utility in the treatment of cSDH. A growing body of literature over the past decade demonstrates the safety and efficacy of middle meningeal artery (MMA) embolization for cSDH. As a surgical adjunct, MMA embolization decreases the recurrence rate of cSDH after surgical evacuation. Endovascular embolization has also been efficacious as a stand-alone therapy for cSDH in select cases. Recent randomized controlled trials have been undertaken to establish the transforming role of MMA in the modern management of cSDH.

METHODS: Literature review of endovascular management of cSDH

RESULTS: MMA embolization is effective in the treatment of cSDH both as a surgical adjunct (after surgical evacuation or as a surgical rescue for recurrent hematomas) and as a primary treatment alternative in select cases.

CONCLUSION: MMA embolization should be considered in the modern management of cSDH – both as a surgical adjunct as well as a stand-alone treatment.

TITLE: AGAINST THE CURVE: SURVIVAL OF THE PRIVATE PRACTICE COMMUNITY NEUROSURGEON

AUTHORS: S Johans

Presenter: Stephen Johans, MD

INTRODUCTION: Neurosurgery is done in many different settings including small and large town community hospitals and academic centers. The desire to keep high quality care, to provide convenient and cost effective care, to keep transparency and control of our group, and the desire to keep to our mission was the catalyst for a transformation for our Neurosurgery group. Our group of community, private practice Neurosurgeons decided to leave hospital employment, going against the trend in our area, to form a surgeon owned multi-specialty surgical group.

METHODS: A retrospective review of the transition of leaving a hospital employed Neurosurgery group to forming a surgeon owned multi-specialty surgical group from 2019 to present day.

RESULTS: Six Neurosurgeons left a hospital employed group to form a community private practice group. Neurosurgery of St. Louis is now a surgeon owned group that operates and covers call at 6 hospitals in St. Louis and Southern Illinois and at a Surgery Center. Neurosurgery of St. Louis has 8 Neurosurgeons and 1 Orthopedic Spine surgeon and has joined forces with 37 Urologists at Urology of St. Louis to form a Multi-specialty surgical group.

CONCLUSION: Our group is able to provide high quality, cost effective care, while also being very convenient for the patient with the multiple locations we have in the area. We believe forming alliances with hospital systems and other privately owned physician groups helps with the common goal of providing the best care for the patient.

TITLE: CONCERNS, PERCEPTIONS, AND CAREER CONSIDERATIONS OF FEMALE MEDICAL STUDENTS INTERESTED IN NEUROSURGERY: A QUALITATIVE STUDY

AUTHORS: G Wong, J Williams, K Smith, MN Nair

PRESENTER: Mani Nathan Nair, MD

INTRODUCTION: Neurosurgery exhibits notably lower representation of Black, Hispanic, and female surgeons compared to various other medical and surgical specialties. Existing research focuses on medical students' views on surgeons, factors influencing female medical students' preferences in surgical fields, and the perceived interests and concerns of students contemplating a career in neurosurgery. However, there is a significant gap in understanding the unique concerns and perspectives of female medical students interested in neurosurgery.

METHODS: Semi-structure interviews with female medical students were recruited from local medical schools in the DC area. Transcripts were analyzed thematically into codes.

RESULTS: Six female medical students from our home institution participated in total. We identified 13 themes related to concerns, perceptions, and career considerations of female students interested in neurosurgery: ambitious/ "gunner", diversity, global health, immediate impact, innovation/research, intense/competitive, mentorship, passionate, procedural/surgical aspect, research, residency length, salary, subject interest, and work-life balance.

CONCLUSION: Female medical students face distinct challenges and factors to consider when choosing a career in neurological surgery. It is imperative to enhance the diversity within the neurosurgical specialty and boost the representation of female neurosurgeons. Early interventions designed to tackle and alleviate their specific concerns are pivotal in achieving this goal.

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William F. Meacham
Arthur Morris
Frank Otenasek
William B. Patton
George E. Roulhac
Edward B. Schlesinger
I. Joshua Speigel
Charles E. Troland
Jack I. Woolf

RECENTLY DECEASED

R. Michael Scott – 8.2023
Willis Brown – 8.2023
Donlin Long – 9.2023
J. Paul Ferguson – 5.2023
Gary Hutchinson – 7.2023
Wolff Kirsch – 11.2023
John Neill – 2.2023
Julian Youmans – 11.2019
Leonard Cerullo – 1.2024

NSA Medal Recipients

William E. Hunt – 1998
William F. Collins – 1999
Charles A. Fager – 2000
Albert L. Rhoton, Jr. – 2001
John A. Jane – 2002
Charles B. Wilson -- 2003
Lyle A. French – 2004
Edward R. Laws – 2005
L. Nelson Hopkins – 2006
John C. VanGilder – 2007
Arthur L. Day – 2008
Donald P. Becker – 2009
Madjid Samii – 2010
Peter J. Jannetta – 2011
R. Michael Scott – 2012
Rodger Goodell – 2013
Arnold Menezes – 2014
Richard Fessler – 2015
H. Hunt Batjer – 2016
David Kline – 2017
Allan H. Friedman – 2018
Stephen Haines - 2019
Fredric Meyer – 2020
Robert Dempsey – 2021
Paul Nelson – 2022
Ralph G. Dacey, Jr. – 2023
David Piepgras - 2024

Location of Annual Meetings
The Neurosurgical Society of America

	Date	Place
	June, 1948 - Organizational Meeting.	The Palmer House, Chicago, Illinois
1.	November, 1948	The Ambassador East, Chicago, IL
2.	October, 1949	Le Chateau Frontenac, Quebec City, Quebec
3.	September, 1950	The Cloister, Sea Island, Georgia
4.	September, 1951	Sun Valley Lodge, Sun Valley, Idaho
5.	September, 1952	The Cloister, Sea Island, Georgia
6.	September, 1953	The Broadmoor, Colorado Springs, Colorado
7.	July, 1954	The Grand Hotel, Mackinac Island, Michigan
8.	March, 1955	Marc Del Monte Lodge, Pebble Beach, California
9.	January, 1956	Key Biscayne Hotel, Key Biscayne, Florida
10.	January, 1957	El Mirador Hotel, Palm Springs, California
11.	January, 1958	Key Biscayne Hotel, Key Biscayne, Florida
12.	April, 1959	The Homestead, Hot Springs, Virginia
13.	March, 1960	Del Monte Lodge, Pebble Beach, California
14.	March, 1961	Boca Raton Hotel and Club, Boca Raton, Florida
15.	March, 1962	Buena Vista Hotel, Biloxi, Mississippi
16.	June, 1963	London, England
17.	January, 1964	Litchfield Park, Arizona
18.	January, 1965	San Juan, Puerto Rico
19.	March, 1966	The Royal Orleans, New Orleans, Louisiana
20.	October, 1967	The Biltmore, New York, New York
21.	May, 1968	The Mark Hopkins, San Francisco, California
22.	May, 1969	Key Biscayne Hotel, Key Biscayne, Florida
23.	March, 1970	Ojai Valley Inn, Ojai Valley, California
24.	May, 1971	The Cloister, Sea Island, Georgia
25.	March, 1972	Del Monte Lodge, Pebble Beach, California
26.	June, 1973	Southampton Princess Hotel, Southampton, Bermuda
27.	May, 1974	Key Biscayne Hotel, Key Biscayne, Florida
28.	March, 1975	The Inn at Rancho Bernardo, San Diego, California
29.	March, 1976	Marco Beach Hotel, Marco Island, Florida
30.	May, 1977	Broadmoor Hotel, Colorado Springs, Colorado
31.	January, 1978	Acapulco Princess Hotel, Acapulco, Mexico
32.	May, 1979	Greenbrier, White Sulphur Springs, West Virginia
33.	March, 1980	Hyatt Hotel, Hilton Head Island, South Carolina
34.	March, 1981	The Lodge at Pebble Beach, Pebble Beach, California
35.	March, 1982	Marco Beach Hotel, Marco Island, Florida
36.	May 8-11, 1983	Marriott's Casa Marina Resort, Key West, Florida
37.	May 13-16, 1984	Hotel del Coronado, Coronado, California
38.	May 19-22, 1985	Kiawah Island Company, Kiawah Island, South Carolina
39.	April 2-5, 1986	Grand Hotel, Point Clear, Alabama
40.	May 10-13, 1987	Salishan Lodge, Gleneden Beach, Oregon
41.	April 5-9, 1988	The Homestead, Hot Springs, Virginia
42.	May 10-13, 1989	Marriott's Castle Harbour Resort, Tucker's Town, Bermuda
43.	April 8-11, 1990	The Inn at Spanish Bay, Pebble Beach, California
44.	May 15-18, 1991	San Destin Beach Hotel, San Destin, Florida
45.	June 14-17, 1992	Banff Springs Hotel, Banff, Alberta, Canada
46.	March 24-27, 1993	Boca Raton Resort & Club, Boca Raton, Florida
47.	May 22-25, 1994	The Inn at Semi-ah-Moo, Blaine, Washington
48.	June 4-7, 1995	The Cloister, Sea Island, Georgia
49.	May 4-8, 1996	The Ritz-Carlton, Laguna Niguel, California

50. March 30-April 5, 1997.....Langham Hilton, London & Robinson College, and University of Cambridge, Cambridge, England
51. May 13-17, 1998.....Le Chateau Frontenac, Quebec City, Quebec
52. March 28-31, 1999 .....The Scottsdale Princess, Scottsdale, Arizona
53. June 4-7, 2000.....…….The Sheraton Tamarron, Durango, Colorado
54. June 6-9, 2001.....The Ritz-Carlton, Amelia Island, Florida
55. April 21- 24, 2002..... Kiawah Island Resort, South Carolina
56. June 8-11, 2003.....Sunriver Resort, Oregon
57. June 6-9, 2004..... Eldorado Hotel, Santa Fe, New Mexico
58. June 5-8, 2005.....The Grand Floridian Resort and Spa, Orlando, Florida
59. June 4-7, 2006..... Ojai Valley Resort and Spa, Ojai, California
60. June 3-6, 2007..... The American Club, Kohler, Wisconsin
61. June 1-4, 2008..... The Fairmont Chateau, Whistler, British Columbia, Canada
62. June 7-10, 2009..... The Homestead, Hot Springs, Virginia
63. April 11-14, 2010..... The Inn at Spanish Bay, Pebble Beach, California
64. March 27-30, 2011 .....Mauna Lani Bay Hotel, Kohala Coast, Island of Hawaii
65. June 10-13, 2012..... The St. Regis Deer Crest Resort, Park City, Utah
66. April 7-10, 2013……..……..…… The Cloister, Sea Island, Georgia
67. June 8-11, 2014…… The Algonquin, St. Andrews-by-the-Sea, New Brunswick, Canada
68. April 12-15, 2015……..……..……. The Resort at Pelican Hill, Newport Coast, California
69. June 19-22, 2016……..…… Powerscourt Hotel Resort, Enniskerry Village, Wicklow Co., Ireland
70. April 2-5, 2017……..……Ponte Vedra Inn & Club, Ponte Vedra Beach, Florida
71. June 10-13, 2018.....Four Seasons Jackson Hole, Teton Village, Wyoming
72. June 16-19, 2019..... Fairmont Banff Springs, Banff, Alberta, Canada
73. June 14, 2020...……..…….Virtual
74. June 20-23, 2021…….Edgewood Resort, Lake Tahoe, Nevada
75. June 12-15, 2022…….Four Seasons Resort Maui at Wailea, Maui, Hawaii
76. June 19-21, 2023……Chatham Bars Inn, Cape Cod, Massachusetts
77. June 24-26, 2024……...….Penha Longa Resort, Lisbon, Portugal

Officers of The Neurosurgical Society of America

YEAR	PRESIDENT	PRESIDENT-ELECT	VICE-PRESIDENT	SECRETARY	TREASURER
1948	Arthur Morris		Frank Otenasek	Jack Woolf (Rec. Sec.) Edward Schlesinger (Cor. Sec.)	Joshua Speigel
1948-49	Arthur Morris		Frank Otenasek	Edward Schlesinger	I. Joshua Speigel
1949-50	Frank Otenasek		George Roulhac	C.D. Hawkes	I. Joshua Speigel
1950-51	George Roulhac		Joseph Dorsey	C.D. Hawkes	I. Joshua Speigel
1951-52	Joseph Dorsey		Lyle French	C.D. Hawkes	I. Joshua Speigel
1952-53	William Meacham		Harry Maxwell Kenneth E. Livingston	C.D. Hawkes	I. Joshua Speigel
1953-54	C.D. Hawkes		Carl J. Graf Charles Neill	Lester Mount	I. Joshua Speigel
1954-55	Everett F. Hurteau		Collin S. MacCarty George Ehni	Lester Mount	I. Joshua Speigel
1955-56	Charles E. Troland		Eben Alexander, Jr. Claude M. Bertrand	Lester Mount	I. Joshua Speigel
1956-57	I. Joshua Speigel		Lester Mount Robert Watson	Frank P. Smith	Bertram Selverstone
1957-58	Lyle A. French		Harvey Chenault Frank E. Nulsen	Frank P. Smith	Bertram Selverstone
1958-59	Charles L. Neill		Christian Keedy Raymond Thompson	Frank P. Smith	Bertram Selverstone
1959-60	Collin S. MacCarty		Thomas Holbrook Edward Schlesinger	Raymond Thompson	Bertram Selverstone
1960-61	Carl J. Graf		William Patton William Williamson	Raymond Thompson	Bertram Selverstone
1961-62	Lester Mount		John Adams Richard Schneider	Raymond Thompson	Bertram Selverstone
1962-63	Claude M. Bertrand		James C. Walker William F. Collins, Jr.	Courtland Davis, Jr.	Bertram Selverstone
1963-64	Kenneth Livingston	Raymond Thompson	Robert B. King	Courtland Davis, Jr.	Bertram Selverstone
1964-65	Raymond Thompson	Robert Wilson	Robert Weyand	Courtland Davis, Jr.	Thomas H. Mason
1965-66	Robert Watson	Bertram Selverstone	Ludwig Segerberg	Courtland Davis, Jr.	Thomas H. Mason
1966-67	Bertram Selverstone	John E. Adams	Frank P. Smith	Courtland Davis, Jr.	Thomas H. Mason
1967-68	John E. Adams	Frank P. Smith	Orlando J. Andy	Courtland Davis, Jr.	Thomas H. Mason
1968-69	Frank P. Smith	Courtland Davis, Jr.	W. Eugene Stern	William Collins, Jr.	Thomas H. Mason

YEAR	PRESIDENT	PRESIDENT-ELECT	VICE-PRESIDENT	SECRETARY	TREASURER
1969-70	Courtland Davis, Jr.	Edward Schlesinger	Thomas H. Mason	William Collins Jr.	Herbert Lourie
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1971-72	Frank E. Nulsen	Thomas H. Mason	John Shillito	William Collins, Jr.	Herbert Lourie
1972-73	Thomas H. Mason	William F. Collins, Jr.	Martin P. Sayers	Shelley N. Chou	Herbert Lourie
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1974-75	Robert S. Knighton	Charles A. Fager	Ross H. Miller	Shelley N. Chou	Robert D. Weyand
1975-76	Charles A. Fager	George Ehni	William E. Hunt	August W. Geise	Robert D. Weyand
1976-77	George Ehni	Shelley N. Chou	Hugh V. Rizzoli	August W. Geise	Lucien R. Hodges
1977-78	Shelley N. Chou	William E. Hunt	Herbert Lourie	August W. Geise	Lucien R. Hodges
1978-79	William E. Hunt	Eldon F. Foltz	Lee A. Christoferson	Jim L. Story	Lucien R. Hodges
1979-80	Eldon F. Foltz	John Meagher	David Kelly, Jr.	Jim L. Story	Lucien R. Hodges
1980-81	John Meagher	Herbert Lourie	Horace A. Norrell, Jr.	Jim L. Story	Lucien R. Hodges
1981-82	Herbert Lourie	August W. Geise	Peter Jannetta	Jim L. Story	Richard A. Olafson
1982-83	August W. Geise	Martin P. Sayers	Joseph Galicich	Donald P. Becker	Richard A. Olafson
1983-84	Martin P. Sayers	Lucien R. Hodges	Calvin B. Early	Donald P. Becker	Richard A. Olafson
1984-85	Lucien R. Hodges	Jim L. Story	W. Jost Michelsen	Donald P. Becker	Richard A. Olafson
1985-86	Jim L. Story	Richard A. Olafson	John C. VanGilder	Donald P. Becker	Phillip Williams, Jr.
1986-87	Richard A. Olafson	W. Jost Michelsen	Carole A. Miller	Russell L. Travis	Phillip Williams, Jr.
1987-88	W. Jost Michelsen	Melvin Shafron	Harry O. Cole	Russell L. Travis	Phillip Williams, Jr.
1988-89	Melvin Shafron	Carole A. Miller	Robert G. Selker	Russell L. Travis	J. Paul Ferguson
1989-90	Carole A. Miller	Robert G. Selker	Charles D'Angelo	Russell W. Hardy	J. Paul Ferguson
1990-91	Robert G. Selker	Russell L. Travis	Stanley M. Patterson	Russell W. Hardy	J. Paul Ferguson
1991-92	Russell L. Travis	W. Ray Jouett	Arnold H. Menezes	Russell W. Hardy	Richard C. Dewey
1992-93	W. Ray Jouett	Russell W. Hardy	Ralph T. Wicker	Troy M. Tippett	Richard C. Dewey
1993-94	Russell W. Hardy	J. Paul Ferguson	Richard G. Perrin	Troy M. Tippett	Richard C. Dewey
1994-95	J. Paul Ferguson	Donald P. Becker	Robert Goodkin	Troy M. Tippett	Harry O. Cole
1995-96	Donald P. Becker	Richard C. Dewey	R. L. Ferguson	Willis E. Brown, Jr.	Harry O. Cole
1996-97	Richard C. Dewey	Robert Goodkin	Allan H. Friedman	Willis E. Brown, Jr.	Harry O. Cole
1997-98	Robert Goodkin	John C. VanGilder	Philip H. Gutin	Willis E. Brown, Jr.	Edward C. Tarlov
1998-99	John C. VanGilder	Troy M. Tippett	Robert A. Ratcheson	Paul B. Nelson	Edward C. Tarlov
1999-00	Troy M. Tippett	Robert A. Ratcheson	John E. McGillicuddy	Paul B. Nelson	Edward C. Tarlov

YEAR	PRESIDENT	PRESIDENT-ELECT	VICE-PRESIDENT	SECRETARY	TREASURER
2000-01	Robert A. Ratcheson	Harry O. Cole	David G. Piepgras	Paul B. Nelson	Allan H. Friedman
2001-02	Harry O. Cole	Paul B. Nelson	Richard Morawetz	Joseph Piepmeier	Allan H. Friedman
2002-03	Paul B. Nelson	Willis E. Brown	Hal Hankinson	Joseph Piepmeier	Allan H. Friedman
2003-04	Willis E. Brown	Hal Hankinson	Edward C. Tarlov	Joseph Piepmeier	Richard G. Perrin
2004-05	Hal Hankinson	Edward C. Tarlov	Griffith R. Harsh III	Nicholas M. Barbaro	Richard G. Perrin
2005-06	Edward C. Tarlov	Allan H. Friedman	Stephen J. Haines	Nicholas M. Barbaro	Richard G. Perrin
2006-07	Allan H. Friedman	Joseph M. Piepmeier	Martin G. Luken III	Nicholas M. Barbaro	Moustapha Abou-Samra
2007-08	Joseph M. Piepmeier	Arnold H. Menezes	Phillip E. Williams, Jr.	John L. D. Atkinson	Moustapha Abou-Samra
2008-09	Arnold H. Menezes	Richard G. Perrin	Thomas Rodenhouse	John L. D. Atkinson	Moustapha Abou-Samra
2009-10	Richard G. Perrin	Nicholas M. Barbaro	H. Hunt Batjer	John L. D. Atkinson	Griffith R. Harsh, IV
2010-11	Nicholas M. Barbaro	Philip H. Gutin	Mitesh V. Shah	John L. D. Atkinson	Griffith R. Harsh, IV
2011-12	Philip H. Gutin	H. Hunt Batjer	Vincent C. Traynelis	John L. D. Atkinson	Griffith R. Harsh, IV
2012-13	H. Hunt Batjer	Stephen J. Haines	Robert E. Wharen, Jr.	John L.D. Atkinson	Richard W. Byrne
2013-14	Stephen J. Haines	Moustapha Abou-Samra	Martin G. Luken, III	Mitesh V. Shah	Richard W. Byrne
2014-15	Moustapha Abou-Samra	Griffith R Harsh IV	E. Sander Connolly, Jr.	Mitesh V. Shah	Richard W. Byrne
2015-16	Griffith R Harsh IV	John L. D. Atkinson	Iain Kalfas	Mitesh V. Shah	Paul J. Camarata
2016-17	John L. D. Atkinson	Richard W. Byrne	Christopher Wallace	Judy Huang	Paul J. Camarata
2017-18	Richard W. Byrne	Christopher Wallace	Gordon Deen	Judy Huang	Paul J. Camarata
2018-19	Christopher Wallace	E. Sander Connolly, Jr.	Eldan Eichbaum	Judy Huang	Guy McKhann
2019-20	E. Sander Connolly, Jr.	Mitesh V. Shah	Louis Kim	Matthew Smyth	Guy McKhann
2020-21	Mitesh V. Shah	Paul D. Camarata	Jeffrey Tomlin	Matthew Smyth	Guy McKhann
2021-22	Paul J. Camarata	Eldan Eichbaum	Matthew Howard	Matthew Smyth	Jeffrey Tomlin
2022-23	Eldan Eichbaum	Judy Huang	Bernard Bendok	Aviva Abosch	Jeffrey Tomlin
2023-24	Judy Huang	Guy McKhann	Gregory Zipfel	Aviva Abosch	Jeffrey Tomlin

Bylaws

Article I: Name and Organization

The Name of the Society shall be "The Neurosurgical Society of America."

The Society is a non-profit public benefit society and is not organized for the private gain of any person. It is organized for public educational and charitable purposes, operating exclusively within the meaning of Section 501(c)(3) of the Internal Revenue Code.

Notwithstanding any other provision in these articles, the Society shall not carry on any other activities not permitted to be carried on (a) by a society exempt from federal income tax under Section 501(c)(3) of the Internal Revenue Code or (b) by a society whose contributions are deductible under Section 170(c)(2) of the Internal Revenue Code.

No substantial part of the activities of this Society shall consist of carrying on propaganda, or otherwise attempting to influence legislation, and the Society shall not participate or intervene in any political campaign (including the publishing or distribution of statements) on behalf of any candidate for public office.

The property of this Society is irrevocably dedicated to educational and charitable purposes and no part of the net income or assets of this Society shall ever inure to the benefit of any director, officer or member thereof, or to the benefit of any private person. Upon dissolution of the Society, its assets remaining after payment, or provision for payment, of all debts and liabilities of this Society shall be distributed to a non-profit fund, foundation or society which is organized and operated exclusively for educational and charitable purposes and which has established its tax exempt status under Section 501(c)(3) of the Internal Revenue Code.

Article II: Objectives

The objectives of the Society shall be to enhance the advancement of the specialty of neurological surgery in America:

a. By furnishing a forum for intimate exchange of ideas and information among a group of representative neurosurgeons;
b. By fostering personal acquaintanceship among its members to make free and confident exchange of information possible;
c. By bringing young neurosurgeons of promise into a group where they can develop full expression of ideas before a cross section of American neurosurgery;
d. By sponsoring international meetings on a personal plane of critical but sympathetic discussion of progress in neurological surgery on this continent and abroad through further dissemination of new information in the field of neurological surgery;
e. By maintaining in its membership roll a balance between academic and community neurosurgeons to promote harmonious balance between teaching of neurosurgery and its general practice in American communities.

Article III: Membership

Section 1: Membership Categories

a. Active membership shall be formed from neurosurgeons who are certified by the American Board of Neurological Surgery or, in the case of residents of foreign countries, its equivalent in the opinion of the Executive Committee. The privilege of voting shall be reserved for Active members and Senior members. The privilege of holding executive office shall be reserved for Active members. The Active membership cap shall be 200.
b. Senior Membership: An Active member may choose to change status to Senior after 15 years of Active membership. Senior members shall have the privilege of voting, may serve on committees but are not eligible to hold executive office.
c. Associate membership may be accorded to those who are not neurosurgeons, but who are in a closely related field and whose contributions and attendance will be of benefit to the Society. Associate members may serve on committees but will not have the privilege of voting or the privilege of holding executive office. Associate membership shall have no more than 10 members at any given time.
d. Honorary membership may be accorded to certain individuals whom the Society wishes to honor, without reference to qualifications or age. Any member may propose an individual for Honorary membership to the executive committee. If approved by the Executive Committee, the candidate shall then be put forth for a vote at the annual Business Meeting where a ¾-majority vote is required for election.
e. Inactive membership status may be accorded only once per member, to Active members who are temporarily unable to meet attendance requirements of Active membership, due to illness, injury, or other extenuating circumstances. Inactive membership status may apply for up to three years, at a maximum, from date of approval. Application for Inactive membership status must be made as a written request to both the Secretary and the Chair of the Membership Committee. Inactive members may not vote, may not serve on Committees, and may not hold Executive Office. Inactive Members shall be exempt from Annual Meeting registration fees, and during their Inactive status shall be exempt from paying membership dues. However, upon reinstatement as an Active member, membership dues shall be paid in arrears, the amount to be determined by the Executive Committee at the time of reinstatement. At any time within the three-year window, the Inactive member may request return to Active membership, with a written request to both the Secretary and the Chair of the Membership Committee. If the Inactive Member has been unable to return to Active Membership by the end of the three-year window, their membership in the Society will terminate.

Section 2: Procedure of Application and Election to membership for Active and Associate Membership

a. A candidate must meet the qualifications for Active membership outlined in Article III, Section 1a.
b. Candidates for membership must have attended at least one meeting of the Society and must have presented a paper at the meeting before being proposed by a sponsor and must attend two more meetings before being elected to membership.
c. A candidate must be 49 years of age or younger when proposed for membership. Application for Active membership must be submitted prior to the applicant's 50th birthday.
d. An application form must be completed including a picture and a CV, and letters from a sponsor and two other members.
e. The membership Chair shall present the full application of candidate members to the Executive Committee at the Interim Meeting for approval.

f. The Secretary shall then circulate the candidates' names to the entire membership electronically 60 days before the Annual Meeting for an electronic vote. A lack of a response shall be counted as a Yes vote.
g. Electronic vote results are communicated to the Executive Committee and elected members are notified.
h. The member is then formally inducted at the annual business meeting.

Section 3: Procedure for handling Rejected applications:

The Executive Committee, before notification of rejected applicants, shall review all rejected applications. This Committee may request convening of the Membership Committee for review of such rejected applications.

Section 4: Process for Reapplying for membership

Individuals whose membership is terminated under provision of these Bylaws may apply to the Membership Committee for readmission. Such applications shall be considered in the light of other pending applications for membership in the Society. Applicants for readmission shall be exempt from the age requirement described in Article III, Section 2c.

Article IV: Annual Meeting Attendance

Section 1: Active Members

a. Every Active member of the Society is expected to attend every Annual Meeting.
b. The membership of any Active member who fails to attend any meeting may be terminated unless they submit an excuse acceptable to the Executive Committee within ninety days.

Section 2: Associate Members

a. Associate members shall attend Annual Meetings at least every three years.
b. Absence from three consecutive meetings, except for reasons acceptable to the Executive Committee, shall result in automatic termination of membership.

Section 3: Senior Members

Senior members are exempt from mandatory meeting attendance.

Section 4: Inactive Members

Inactive members are exempt from mandatory meeting attendance.

Article V: Executive Committee

Section 1: Makeup of the Executive Committee

The officers of the organization shall be a President, President-Elect, Vice-President, Secretary, Treasurer, and five Councilors. These ten individuals shall constitute the Executive Committee. The President-Elect and Vice-President shall be elected annually. The President-Elect shall assume the office of President at the conclusion of the following Annual Meeting after becoming President-Elect. Councilors shall be the three immediate Past-Presidents and two councilors elected from membership. One councilor shall be nominated annually on the basis of their interest and demonstrated service to the Neurosurgical Society of America. This councilor shall take office at the end of the Annual Meeting at which they are elected and serve for two years.

Section 2: Nomination of Officers

a. Potential nominees must meet criteria as outlined in membership definitions.
b. Nominations are solicited from the membership 120 days prior to the annual Business Meeting by the Chair of the nominating committee.
c. The nominating committee subsequently convenes to propose additional names.
d. A roster of nominees is circulated to the membership 30 days prior to the Annual Meeting.

Section 3: Election of Officers

Officers are elected by a majority vote at the business meeting of the Annual Meeting.

Section 4: Terms of Office

a. The President shall serve from the end of one Annual Meeting through the end of the subsequent Annual Meeting (defined as one meeting cycle).
b. The President-Elect shall serve one meeting cycle.
c. The Vice-President shall serve one meeting cycle.
d. The Secretary and the Treasurer shall serve for three meeting cycles. Their term of office must be staggered so that they do not expire in the same year.

Section 5: Duties of Officers

a. **President**: It shall be the duty of the President to preside at all meetings of the Society, to call the vote, and to see that rules are properly enforced in all deliberations of the Society. They shall be an ex-officio member of all committees. They shall assume office at the end of the Annual Meeting at which they are installed and shall continue in office until the end of the subsequent Annual Meeting. In the event of a vacancy in any office, it shall be the privilege of the President to appoint an interim officer.
b. **President-Elect:** The President-Elect shall preside in the absence of the President. The President-Elect shall succeed the President at the next Annual Meeting.
c. **Vice-President**: In the absence of the President and President-Elect, the Vice-President shall preside and assume the usual duties of the President. In the absence of the President, President-Elect, and Vice-President, the Secretary shall preside pro tem.

d. **Secretary**: It shall be the duty of the Secretary to keep a true record of the proceedings of the meetings, to preserve all books, papers and articles belonging to the Society, and to keep a register of the members. They shall send notice of all meetings to each member at the appropriate time and notify all members of committees of their appointments. They shall also act as a Secretary of the Executive Committee. At the end of each Annual Meeting the Secretary shall summarize the Society's activities during the year and along with the printed program for the meeting deposit these documents with the Archivist.
e. **Treasurer**: It shall be the duty of the Treasurer to collect all money due from the members, keep a correct record of such funds, and disburse funds for the ordinary expenses of the Society as well as other funds ordered by the Executive Committee.

Article VI: Committees

Section 1: Standing committees of the NSA

The standing committees of the Society shall consist of Executive, Nominating, Membership, Scientific Program, Auditing and Finance, Local Arrangements, Bylaws, Long Range Planning and Site Selection Committees.

a. **The Executive Committee**: It shall be the duty of the Executive Committee to oversee the functioning of the various officers and committees and insure the efficient running of the Society. It shall have the power to drop from the roll any member who has failed to pay their dues for more than two years, or who misses any meeting of the Society without adequate excuse, or who fails for any reason to maintain professional standards in their community. It shall set the dues structure for various classes of membership.
b. **The Nominating Committee** shall consist of five members: The two immediate Past-Presidents and three additional members appointed by the President for a one-year term shall also serve on this committee. The Past-Past-President shall serve as Chair. This committee shall have the responsibility of presenting candidates for office each year. Nominations from the floor before balloting at the Annual Business Meeting shall be accepted. The committee shall also have the responsibility of presenting to the President and Executive Committee nominations for the CNS and AANS annually. Final nominations for the CNS and AANS shall be chosen by majority vote of the Executive Committee.
c. **The Membership Committee** shall consist of four members and a Chair appointed by the President. Each member shall serve for a maximum of 5 years. It shall be the responsibility of this committee to receive applications and present eligible candidates to the membership electronically for a vote; a lack of response shall be counted as a Yes vote. It shall be the major responsibility of the Membership Committee to examine the individuals proposed for membership with a view of their consonance with the ideals and objectives of the organization, with these ideals including the goal of promoting diversity within the organization's membership. The term of office for Chair of this committee is limited to five years.
d. **The Scientific Program Committee** shall consist of three members appointed by the President to prepare for and serve at the time of the next Annual Meeting.
e. **The Auditing and Finance Committee** shall consist of a Chair and four members appointed by the President. Each member shall serve for a maximum of 5 years. The duties of the committee shall be to examine the books of the Treasurer and state their condition at the ensuing meeting, as well as to oversee the financial affairs to be sure that the Society is managing its assets and expenses in the best way possible. Committee members may not include any current member of the Executive Committee or the prior year's Treasurer.

f. **The Local Arrangements Committee** shall consist of a Chair and two members selected by the President, producing continuity in physical arrangements and permitting each committee member to be responsible for the arrangements with the hotel and the membership for their meeting.
g. **The Site Selection Committee** shall consist of three members appointed by the President, each serving a 5-year term in addition to the two immediate Past-Presidents. It is responsible for identifying future meeting sites and negotiating meeting site contracts. The President shall appoint the Chair for a term of five years.
h. **The NSA Medal Committee** shall consist of seven members appointed by the President to serve three-year terms. It shall be the responsibility of this committee to select an individual to be honored by the Neurosurgical Society of America with the NSA Medal, which is bestowed at the Annual Meeting. The President shall appoint the Chair for a term limit of three years.
i. **The NSA Bylaws Committee** shall consist of a Chair and four members chosen by the President to serve 3-year terms. This committee shall have the responsibility of proposing changes to the Bylaws in accordance with rules governing their amendment in these documents.
j. **The Long-Range Planning Committee** shall consist of a Chair and two members appointed by the President. Each member shall serve for a maximum of 5 years. The members of this committee shall advise the Executive Committee regarding long-range strategic planning and issues which can affect the vitality of the Society.

Section 2: Ad Hoc Committees

a. The President shall have the power to appoint ad hoc committees as required in the best interests of the Society.
b. These committees shall dissolve at the end of the President's term unless specifically renewed by the incoming President.

Article VII: Archivist

The Archivist shall maintain materials that create and preserve a historical record for the Society. The Archivist may attend the Executive Committee meeting but shall not have a vote. The President shall appoint an Archivist for a period of five years.

Article VIII: Meetings

Section 1: Annual Meeting: Meetings shall be held annually.

Section 2: Interim Meeting: An Interim Meeting is held annually in the President's hometown.

Section 3: Special Meeting: The President or any three members of the Executive Committee may call special meetings.

Article IX: Quorum

The membership present at any Annual executive session of an Annual Meeting or Special Meeting shall constitute a quorum for business.

Article X: Removal and emergency suspension of officers

Section 1: Removal

Any officer may be removed from office by a three-fourths vote of the general membership at a Special Meeting or at the Annual Meeting. Notice of a pending motion to remove an officer must be published to the general membership at least thirty days prior to the meeting at which the removal motion shall be discussed and acted upon. In the event of removal of the President, succession shall be in accordance with Article V, Sec 5. If an officer other than the President is removed under this Article, a replacement officer shall be appointed by the Executive Committee to fill out the term of the officer removed.

Section 2: Emergency Suspension

The Executive Committee, under conditions that it considers emergent and by majority vote, may suspend from office any officer of the Neurosurgical Society of America. Upon such suspension from office, the officer shall cease to be a member of the Executive Committee and shall immediately turn over to the Executive Committee any and all Neurosurgical Society of America records in their possession. The Executive Committee shall promptly notify the Neurosurgical Society of America membership of the emergency suspension and shall recommend removal of the suspended officer in accordance with Article X, Section 1.

Article XI: Bylaws Amendments

Section 1: Proposal of bylaws amendments

a. The Bylaws committee may propose bylaws amendments at the annual Business Meeting.
b. Members may propose bylaws amendments to the Chair of the bylaws committee.

Section 2: Adoption of bylaws amendments

a. Proposed Bylaws amendments shall be circulated to the membership electronically 60 days before the Annual Meeting.
b. Bylaws amendments shall be presented for discussion at the Annual Meeting.
c. Bylaws amendments that had not been circulated in advance of the Annual Meeting shall be voted on at the following Annual Meeting.
d. Bylaws amendments require a ¾-majority vote of those attending the Annual Meeting.

Article XII: Dues

The Executive Committee of the Society shall have the power to determine dues and assessments of all categories of membership on an annual basis.

Article XIII: Parliamentary Procedure

Section 1: Deliberations

"Sturgis Standard Code of Parliamentary Procedure" shall govern the deliberations of this Society.

Section 2: Order of Business

The order of procedure of the Executive Session of the Society shall be as follows:

a. The call to order
b. The reading of the minutes
c. Reports of officers and committees
d. Election of officers
e. Installation of new members
f. Unfinished business
g. New business

CORPORATE SUPPORTERS

The Neurosurgical Society of America would like to thank the following companies for their corporate sponsorship of the 77th Annual NSA Meeting