

**I AM CHAMPION**



**2011 PROGRAM BOOK**

**40<sup>TH</sup> ANNUAL MEETING OF THE AANS/CNS  
SECTION ON PEDIATRIC NEUROLOGICAL SURGERY**

**November 29 – December 2, 2011  
Hilton Austin Hotel, Austin, Texas**



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### Claim CME Credit the Easy Way

Again this year, attendees will self-report CME credit for the programs they attend by going online to MyAANS.org from any computer with Internet service. Please have your MyAANS.org username [e-mail address] and password handy during and after the meeting for convenient completion and submission.

Do not self-report CME credit for the optional pre-meeting ticketed event. By turning in your ticket onsite, credit will automatically be added to your record in MyAANS.org.

### Who Should Attend

The educational sessions will be directed towards pediatric neurological surgeons, residents, nurse clinicians and physician assistants and will be directly applicable to their practices.

## AANS/CNS Section on Pediatric Neurological Surgery November 29-December 2, 2011 Austin, Texas

### Continuing Medical Education Credit

This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of the AANS and the AANS/CNS Section on Pediatric Neurological Surgery. The AANS is accredited by the ACCME to provide continuing medical education for physicians.

The AANS designates this live educational activity for a maximum of 26 *AMA PRA Category 1 Credits™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

For the Mid-Level Practitioner's Seminar: This continuing nursing education activity was approved by the Illinois Nurses Association, an accredited approver by the American Nurses Credentialing Center's Commission on Accreditation.

### Joint Sponsorship Disclaimer

The material presented at the 2011 AANS/CNS Section on Pediatric Neurological Surgery Annual Meeting has been made available by the AANS/CNS Section on Pediatric Neurological Surgery and the AANS for educational purposes only. The material is not intended to represent the only, nor necessarily the best, method or procedure appropriate for medical situations discussed, but rather is intended to present an approach, view, statement or opinion of the faculty, which may be helpful to others who face similar situations.

Neither the content (whether written or oral) of any course, seminar or other presentation in the program, nor the use of specific product in conjunction therewith, nor the exhibition of any materials by any parties coincident with the program, should be construed as indicating endorsement or approval of the views presented, the products used or the materials exhibited by the AANS/CNS Section on Pediatric Neurological Surgery and jointly sponsored by the AANS, or its Committees, Commissions or Affiliates.

Neither the AANS nor the AANS/CNS Section on Pediatric Neurological Surgery makes any statements, representations or warranties (whether written or oral) regarding the Food and Drug Administration (FDA) status of any product used or referred to in conjunction with any course, seminar or other presentation being made available as part of the 2011 AANS/CNS Section on Pediatric Neurological Surgery Annual Meeting. Faculty members shall have sole responsibility to inform attendees of the FDA status of each product that is used in conjunction with any course, seminar or presentation and whether such use of the product is in compliance with FDA regulations.

### Annual Meeting Learning Objectives

Upon completion of the CME activity, participants should be able to:

1. Discuss updates on new therapies of pediatric neurosurgical disorders.
2. Discuss updates on clinical and translational research of congenital, traumatic, neoplastic and other pediatric neurosurgical conditions.
3. Explain new techniques in the surgical treatment of pediatric neurosurgical disorders.
4. Discuss challenging social and economic problems for pediatric neurosurgery.



## **FUTURE ANNUAL MEETING SITE**

**St. Louis**

**November 27-30, 2012**

## **PAST ANNUAL MEETING SITES**

<b>1972</b> Cincinnati	<b>1993</b> San Antonio
<b>1973</b> Columbus	<b>1994</b> St. Louis
<b>1974</b> Los Angeles	<b>1995</b> Pasadena
<b>1975</b> Philadelphia	<b>1996</b> Charleston
<b>1979</b> New York	<b>1997</b> New Orleans
<b>1980</b> New York	<b>1998</b> Indianapolis
<b>1981</b> Dallas	<b>1999</b> Atlanta
<b>1982</b> San Francisco	<b>2000</b> San Diego
<b>1983</b> Toronto	<b>2001</b> New York
<b>1984</b> Salt Lake City	<b>2002</b> Scottsdale
<b>1985</b> Houston	<b>2003</b> Salt Lake City
<b>1986</b> Pittsburgh	<b>2004</b> San Francisco
<b>1987</b> Chicago	<b>2005</b> Orlando
<b>1988</b> Scottsdale	<b>2006</b> Denver
<b>1989</b> District of Columbia	<b>2007</b> South Beach (Miami)
<b>1990</b> San Diego/ Pebble Beach	<b>2008</b> Spokane
<b>1991</b> Boston	<b>2009</b> Boston
<b>1992</b> Vancouver, BC	<b>2010</b> Cleveland
	<b>2011</b> Austin



# JOINT SECTION OF PEDIATRIC NEUROLOGICAL SURGERY OFFICERS AND COMMITTEES

## Pediatric Section Chairs

<b>1972-73</b> Robert L. McLaurin	<b>1991-93</b> R. Michael Scott
<b>1973-74</b> M. Peter Sayers	<b>1993-95</b> Arthur Marlin
<b>1974-75</b> Frank Anderson	<b>1995-97</b> Harold L. Rekate
<b>1975-76</b> Kenneth Shulman	<b>1997-99</b> Marion L. Walker
<b>1976-77</b> E. Bruce Hendrick	<b>1999-01</b> John P. Laurent
<b>1977-78</b> Frank Nulsen	<b>2001-03</b> Thomas G. Luerksen
<b>1978-79</b> Luis Schut	<b>2003-05</b> Andrew D. Parent
<b>1979-81</b> Fred J. Epstein	<b>2005-07</b> Rick Abbott
<b>1981-83</b> Joan L. Venes	<b>2007-09</b> Jeffrey H. Wisoff
<b>1983-85</b> Harold J. Hoffman	<b>2009-11</b> Ann-Christine Duhaime
<b>1985-87</b> William R. Cheek	<b>2011-13</b> Alan R. Cohen
<b>1987-89</b> David G. McLone	
<b>1989-91</b> Donald H. Reigel	

## Officers

Chair.....	Alan R. Cohen, MD (2011-2013)
Chair-Elect.....	Bruce A. Kaufman, MD (2011-2013)
Secretary.....	Sarah J. Gaskill, MD (2011-2013)
Treasurer.....	Mark R. Proctor, MD (2011-2013)
Immediate Past Chair.....	Ann-Christine Duhaime, MD (2011-2013)

## Members at Large

Corey Raffel, MD, PhD (2010-2012)  
Abhaya Vivek Kulkarni, MD (2010-2012)  
Mark Souwedaine, MD (2011-2013)  
Bermans J. Iskandar, MD (2011-2013)

## Standing Committees

### Nominating Committee

Ann-Christine Duhaime, MD, *Chair*  
Jeffrey H. Wisoff, MD  
Rick Abbott, MD

### Rules & Regulations Committee

Elizabeth Tyler-Kabara, MD, PhD, *Chair*  
John C. Wellons III, MD, *Chair-Elect*

### Membership Committee

David H. Harter, MD, *Chair*  
Robin M. Bowman, MD, *Vice-Chair*

### Education Committee

Mark D. Krieger, MD, *Chair*  
Gerald A. Grant, MD, *Vice-Chair*

### Pediatric Section Annual Meeting Subcommittee

Timothy M. George, MD, *Chair* (2011, Austin)  
Jeffrey R. Leonard, MD/Matthew D. Smyth, MD (2012, St. Louis)  
James Drake, MD/Jim Rutka, MD (2013, Toronto)  
Shenandoah Robinson, MD (2010, *Cleveland, Immediate Past-Meeting Chair*)  
Alan R. Cohen, MD, *Ex-Officio*  
Mark R. Proctor, MD, *Ex-Officio*

## Ad Hoc Committees

### Education Committee Subcommittees (ad hoc)

#### National Meeting Subcommittee

David I. Sandberg, MD, *Co-Chair* (2011-2013)  
Greg Olavarria, MD, *Co-Chair* (2011-2013)

### Communications Subcommittee

Ann M. Ritter, MD, *Chair*  
Richard C. E. Anderson, MD, *Web site*  
Jeffrey R. Leonard, MD  
Peter P. Sun, MD

### Training Subcommittee (Traveling Fellowships and Training)

Bermans J. Iskandar, MD, *Chair*  
Matthew D. Smyth, MD  
Sanjiv Bhatia, MD  
David I. Sandberg, MD

### International Education Subcommittee

Jogi Pattisipu, MD

### Examination Questions Committee

Corey Raffel, MD, PhD, *Chair*

### Lifetime Achievement Award

Ann-Christine Duhaime, MD

### Transition of Care Committee

Harold L. Rekate, MD, *Chair*

### Research Committee

John R. W. Kestle, MD, *Chair*  
Nalin Gupta, MD, PhD  
Ann-Christine Duhaime, MD

## Representatives and Liaisons

### **Liaison to the AANS Executive Committee**

Alan R. Cohen, MD

### **Liaison to the CNS Executive Committee**

Bruce A. Kaufman, MD

### **Liaison to the Washington Committee, AANS/CNS**

Ann-Christine Duhaime, MD

### **Liaison to the Washington Communications Committee on Public Relations**

Corey Raffel, MD, PhD

### **Pediatric Section Representatives on the Joint Guidelines Committee**

Ann Marie Flannery, MD, *Chair*

Sarah J. Gaskill, MD

Benjamin C. Warf, MD

Abhaya Vivek Kulkarni, MD

Jay K. Riva-Cambrin, MD

### **Liaison to Joint Section on Trauma**

Matthew D. Smyth, MD

### **Liaison with the American Board of Pediatric Neurological Surgery**

Tae Sung Park, MD

### **Liaison with the Accreditation Council of Pediatric Neurosurgery Fellowships**

Jeffrey P. Blount, MD

### **Liaison with ISPN**

Jogi Venkata Pattisapu, MD

### **Liaison with ASPN**

Rick Abbott, MD

### **Liaison with AAP Section of Neurological Surgery (SONS)**

Mark S. Dias, MD

### **Liaison to the Joint Council of State Neurosurgical Societies**

Catherine Anne Mazzola, MD

### **Liaison to the Coding and Reimbursement Committee**

David P. Gruber, MD

### **Liaison to the Devices and Technology Committee**

Shenandoah Robinson, MD

### **Liaison to the Young Neurosurgeons Committee**

Paul Klimo Jr., MD

### **Liaison to the Neuro-Critical Care Society**

Ashutosh Singhal, MD

### **Liaison to Quality/Outcomes Groups**

Liliana C. Goumnerova, MD



## KEYNOTE SPEAKERS

### 2011 Raimondi Lecture

**Mack Brown**

**Head Coach, University of Texas**

**Sports-related Concussive Brain Injuries: A Coach's Perspective**



Mack Brown is entering his 14th season as Head Coach of The University of Texas (UT) Longhorns in Austin, Texas. With a mark at Texas of 133-34 (.796), the 2008 Bobby Dodd National Coach of the Year and 2009 Big 12 Coach of the Year has elevated the Longhorns program to new heights. Brown has brought enthusiasm back to the program, while wowing recruits, supporters and alumni. His down-home wit and wisdom are energetic, thoughtful, engaging and enthusiastic. That passion has helped the Longhorns sign some of the nation's finest recruiting classes year in and year out, while raising enthusiasm and support for Texas football to an all-time high.

With all of the success on the field, the primary emphasis with Brown's squads has remained the same: maintaining a high level of achievement in the classroom and in the community. Eighty percent of Brown's players at North Carolina received their degrees. And more than a third of his players at Texas have regularly earned 3.0 grade point averages and achieved spots on the Big 12 Commissioner's and Athletics Director's honor rolls.

Brown has served on the NCAA Football Rules Committee and the NCAA Football Issues Committee. He has been chairman of the Football Coaches' Committee and a member of the Board of Directors of the College Football Association. A past member of the American Football Coaches Association's (AFCA) Ethics Committee, Brown also has served on the AFCA Public Relations Committee. He has been invited to coach in five postseason all star games, including the Japan Bowl, Hula Bowl (twice) and East-West Shrine Game (twice).

Brown and his wife, Sally, are active in Austin community affairs. They were instrumental in the opening of The Rise School of Austin, an early childhood education program that integrates children who have disabilities with their typically developing peers, and serve on its board of directors. Earlier this year, they were honored with the announcement of a new site to be named The Mack & Sally Brown Rise School of Austin. In April, the American Red Cross named Brown the 2011 Lady Bird Johnson Humanitarian Award Winner. In September of 2008, he and Sally were named Citizens of the Year for Caritas of Austin, which provides meals and aid for the homeless. Earlier that year, UT gave Brown The Mack Brown Distinguished Chair for Leadership in Global Affairs; the chair is part of the Robert S. Strauss Center for International Security and Law, a university-wide global affairs research center named for renowned lawyer and public servant, Ambassador Robert S. Strauss.

### Special Lecture

**Benjamin S. Carson Sr., MD**

**The Importance of Impacting the World Outside of Neurosurgery**



Benjamin S. Carson Sr., MD, is a full professor of neurosurgery, oncology, plastic surgery and pediatrics at The Johns Hopkins University School of Medicine. He has directed pediatric neurosurgery at The Johns Hopkins Children's Center for more than a quarter of a century. In May of 2008, he became the inaugural recipient of a professorship dedicated in his

name; he now is the Benjamin S. Carson Sr., MD, and Dr. Evelyn Spiro, RN, Professor of Pediatric Neurosurgery.

Dr. Carson performed the first and only successful separation of craniopagus (Siamese) twins joined at the back of the head in 1987, the first completely successful separation of type-2 vertical craniopagus twins in South Africa in 1997 and the first successful placement of an intrauterine shunt for a hydrocephalic twin. He is interested in all aspects of pediatric neurosurgery.

Dr. Carson is a member of the Alpha Omega Alpha Honor Medical Society and the Horatio Alger Society of Distinguished Americans. He sits on the boards of Kellogg Company, Costco Wholesale Corporation and the Academy of Achievement, and is an Emeritus Fellow of The Yale Corporation. In 2001, Dr. Carson was named one of the nation's 20 foremost physicians and scientists by CNN and *TIME* magazine; that year, during its 200th anniversary celebration, the Library of Congress also recognized him one of 89 "Living Legends." In 2004, he was appointed by President George W. Bush to serve on the President's Council on Bioethics. Dr. Carson also received the 2006 Spingarn Medal from the National Association for the Advancement of Colored People (NAACP). In 2008, President Bush presented Dr. Carson with the Ford's Theatre Lincoln Medal as well as the Presidential Medal of Freedom. That same year, he was recognized by *U.S. News & World Report* and Harvard's Center for Public Leadership as one of "America's Best Leaders." In 2009, TNT premiered a movie based on Dr. Carson's memoir entitled "Gifted Hands: The Ben Carson Story," which was nominated for and won several awards.

Dr. Carson is president and co-founder of the Carson Scholars Fund, which recognizes young people of all backgrounds for exceptional academic and humanitarian accomplishments; to date, the fund has given more than \$4.3 million dollars to some 4,300 scholars in 42 states as well as Washington, DC. In addition, Dr. Carson is Co-Founder of Angels of the OR under the auspices of The Baltimore Community Foundation, which assists neurosurgery patients with expenses not covered by insurance.

## AAP/Section on Neurological Surgeons (SONS) Speaker

**Francisco G. Cigarroa, MD**

**The Future of Pediatric Academic Medicine in a Changing World**



Francisco G. Cigarroa, MD, Chancellor of The University of Texas System, is a nationally renowned pediatric and transplant surgeon. A native of Laredo, Texas, he earned a bachelor's degree from Yale and received his medical degree from The University of Texas Southwestern Medical Center at Dallas.

During his 12 years of postgraduate training, Dr. Cigarroa was Chief Resident at Harvard's teaching hospital, Massachusetts General in Boston, and completed a fellowship at Johns Hopkins Hospital in Baltimore. In 1995, he joined the faculty of The University of Texas Health Science Center at San Antonio and, in October of 2000, was appointed its third president.

In February 2003, Dr. Cigarroa was appointed by President George W. Bush to serve as a member of the President's Committee on the National Medal of Science. In October of 2006, he was elected to membership in the prestigious Institute of Medicine of the National Academies. Dr. Cigarroa is a Fellow of the American College of Surgery. He also is a Diplomate of the American Board of Surgery, from which he received a certificate in pediatric surgery. He is a member of the Yale University Council and was most recently elected in June of 2010 to serve as an Alumni Fellow to The Yale Corporation.

## Franc Ingraham Award for Distinguished Service and Achievement

**R. Michael Scott, MD**



R. Michael Scott, MD, received his A.B. in English Literature from Williams College in Williamstown, MA, and his MD from Temple University in Philadelphia, the city in which he was born. (His father, Michael Scott, was Chairman of the Department of Neurosurgery at Temple University during that department's infancy.) After a surgical internship at Boston

City Hospital, a two-year research fellowship at the National Institute of Neurological Diseases and Stroke, and residency training in Neurosurgery at the Massachusetts General Hospital, Dr. Scott joined the faculty of Tufts University School of Medicine. From 1974 to 1987, he also was a member of the neurosurgical staff at the New England Medical Center (now called Tufts Medical Center), under the direction of Bennett M. Stein, MD, and William Shucart, MD.

In 1988, Dr. Scott joined the Neurosurgical Department of Children's Hospital Boston; he has directed the hospital's Pediatric Neurosurgical Fellowship Program since its inception in 1991. In 1992, he was named Professor of Surgery at Harvard Medical School. And in 2004, he was named Neurosurgeon-in-Chief at Children's Hospital Boston.

Dr. Scott is a Past-President of the American Society of Pediatric Neurosurgeons, a former Director of the American Association of Neurological Surgeons and a Past-Chairman of the Pediatric Section of the American Association of Neurological Surgeons. He was appointed to the Board of Directors of The American Board of Neurological Surgery in 1997 and was elected its Vice-Chairman in 2002, completing his term in 2003. In addition, Dr. Scott completed a ten-year term as Chairman of The American Board of Pediatric Neurological Surgery in 2009 and currently is a member of the Accreditation Council of Pediatric Neurosurgery Fellowships.

Dr. Scott's major clinical and research interests are pediatric cerebrovascular disease, brain tumors, and congenital malformations of the brain and spinal cord.

# PEDS





## RAIMONDI LECTURERS

1978	E. Bruce Hendrick	1995	Robert H. Pudenz
1979	Paul C. Bucy	1996	Samuel S. Flint
1980	Floyd Gilles	1997	M. Michael Cohen, Jr.
1981	Panel Discussion	1998	Robert A. Zimmerman
1982	Panel Discussion	1999	David B. Schurtleff
1983	Derek Harwood-Nash	2000	Steve Berman
1984	Anthony E. Gallo Jr.	2001	Alejandro Berenstein
1985	Frank Nulsen	2002	Volker K.H. Sonntag
1986	William F. Meacham	2003	Jon Huntsman
1987	Dale Johnson	2004	J. Michael Bishop
1988	Joseph J. Volpe	2005	James B. McClintock, PhD
1989	Martin Eichelberger	2006	Richard D. Lamm
1990	George R. Leopold	2007	Roberto C. Heros
1991	Judah Folkman	2008	Renée Jenkins
1992	Olof Flodmark	2009	Charles Stiles, PhD
1993	Maurice Albin	2010	Richard C. Karl
1994	Blaise F.D. Bourgeois	2011	Mack Brown

## MATSON MEMORIAL LECTURERS

1987	John Shillito	2001	Donald H. Reigel
1988	E. Bruce Hendrick	2002	David McLone
1989	Martin P. Sayers	2003	Robin P. Humphreys
1990	Roger Guillemin	2004	A. Leland Albright
1991	Robert L. McLaurin	2005	Joan L. Venes
1992	Joseph Murray	2006	James P. McAllister James M. Drake
1993	Eben Alexander, Jr.		Joseph R. Madsen
1994	Joseph Ransohoff		Edward H. Oldfield
1995	John Holter	2007	Harold L. Rekate
1996	None	2008	Marion L. Walker
1997	Maurice Choux	2009	John A. Jane, Sr.
1998	Luis Schut	2010	Jeffrey A. Golden
1999	Gary C. Schoenwolf	2011	Thomas G. Luerssen
2000	Postponed due to illness		

## FRANC INGRAHAM AWARD FOR DISTINGUISHED SERVICE AND ACHIEVEMENT RECIPIENTS

1988	E. Bruce Hendrick
2001	Luis Schut
2004	Fred J. Epstein
2007	Robin P. Humphreys
2009	David G. McLone
2010	Robert Alex Sanford
2011	R. Michael Scott



## KENNETH SHULMAN AWARD RECIPIENTS

- 1983 Kim Manwaring**  
Neonatal Post-Hemorrhagic Ventriculomegaly: Management with Pulsed Lumbar Cisternostomy
- 1984 Arno Fried**  
A Laboratory Model of Shunt-Dependent Hydrocephalus
- 1985 Ann-Christine Duhaime**  
The Shaken Baby Syndrome
- 1986 Robert E. Breeze**  
Formation in Acute Ventriculitis
- 1987 Marc R. Delbigio**  
Shunt-Induced Reversal of Periventricular Pathology in Experimental Hydrocephalus
- 1988 Scott Falci**  
Rear Seat-Lap Belts. Are They Really “Safe” for Children?
- 1989 James M. Herman**  
Tethered Cord as a Cause of Scoliosis in Children with a Myelomeningocele
- 1990 Christopher D. Heffner**  
Basilar Pons Attracts its Cortical Innervation by Chemotropic Induction of Collateral Branch Formation
- 1991 P. David Adelson**  
Reorganization of the Cortical-Tectal Pathway Following Neonatal Cerebral Hemispherectomy in Cats
- 1992 David Frim**  
Effects of Biologically Delivered Neurotrophins in Animal Models of Neural Degeneration
- 1993 Monica C. Wehby**  
Metabolic Demonstration of Retained CNS Function in the Rabbit Model of Infantile Hydrocephalus
- 1994 Ellen Shaver**  
Experimental Acute Subdural Hematoma in Infant Piglets
- 1995 Seyed M. Emadian**  
Correlation of Chromosome 17p Loss with Clinical Outcome in Patients with Primitive Neuroectodermal Tumors
- 1996 John Park**  
Platelet Derived Growth Factor Induces Differentiation of Neuroepithelial Stem Cells into Neurons
- 1997 Michael J. Drewek**  
Quantitative Analysis of the Toxicity of Human Amniotic Fluid to Rat Fetal Spinal Cord Cultures
- 1998 Adrianna Ranger**  
Implantation of Medulloblastoma Cells into Collagen Type I Gels: Invasiveness, Enzymatic Characterization, and the Impact of Surgical Excision and Radiation
- 1999 Susan Durham**  
The Surprisingly Sturdy Infant Brain: Why is it More Resistant to Focal Injury?
- 2000 Ketan R. Bulsara**  
Novel Findings in the Development of the Normal and Tethered Filum Terminale
- 2001 David I. Sandberg**  
Convection Enhanced Delivery into the Rat Brain Stem: A Potential Delivery for the Treatment of Diffuse Pontine Gliomas
- 2002 David Cory Adamson**  
Mechanisms of Reclosure in 2 Surgical Models of Myelomeningocele Implications for Fetal Surgery
- 2003 Joshua E. Medow**  
Posture Independent Piston Valve: A Practical Solution to Maintaining Stable Intracranial Pressure in Shunted Hydrocephalus
- 2004 Joshua E. Medow**  
The Permeable Proximal Catheter Project: A Novel Approach to Preventing Shunt Obstruction
- 2005 David Cory Adamson**  
Digital Karotyping Identifies a Novel Retinoblastoma Oncogene
- 2006 Elias B. Rizk**  
Folate Receptor Function is Essential in CNS Recovery after Injury: Evidence in Knockout Mice
- 2007 Jeffrey P. Greenfield**  
A Stem Cell Based Infiltrative Model of Pontine Glioma
- 2008 Toba Niazi**  
Medulloblastoma Growth Enhancement by HGF/SF Expression in Cerebellar Neural Progenitor Cells is Suppressed by Systemic Antibody Treatment
- 2009 Symeon Missios**  
Cell Proliferation and Neuronal Migration after Closed Head Injury in the Immature Piglet
- 2010 Amanda Muhs Saratsis**  
Proteomic Analysis of Cerebral Spinal Fluid From Children with Brainstem Glioma

## HYDROCEPHALUS ASSOCIATION AWARD RECIPIENTS

- 1989 Eric Altschuler**  
Management of Persistent Ventriculomegaly Due to Altered Brain Compliance
- 1990 Shalom Michowiz**  
High Energy Phosphate Metabolism in Neonatal Hydrocephalus
- 1991 Nesher G. Asner**  
Venous Sinus Occlusion and Ventriculomegaly in Craniectomized Rabbits
- 1992 Marcia da Silva**  
Reversal of High Energy Phosphate Metabolism Changes in Experimental Hydrocephalus after CSF Shunting
- 1993 Charles Bondurant**  
The Epidemiology of Cerebrospinal Fluid Shunting
- 1994 Monica C. Wehby-Grant**  
The Rabbit Model for Infantile Hydrocephalus: Regional Differences in the Cortical Metabolic Response to Hydrocephalus and Shunting
- 1995 Richard J. Fox**  
Cerebrospinal Fluid Absorptive Site of the Parasagittal Dura: A Cadaveric Study
- 1996 Martha J. Johnson**  
Reactive Astrocytosis in a New Model of Obstructive Hydrocephalus
- 1997 No Prize Awarded**
- 1998 Daniel Lieberman**  
In Vetro Detection of Fluid Flow in Ventriculoperitoneal Shunts (VPS) Using Contrast Enhanced Ultrasound
- 1999 Kimberly Bingaman**  
Hydrocephalus Induces the Proliferation of Cells in the Subventricular Zone
- 2000 No Prize Awarded**
- 2001 Jake Timothy**  
Treatment of Hydrocephalus Using a Choroid Plexus Specific Immunotoxin: An In Vitro Study
- 2002 Joshua E. Medow**  
Quick Brain MRI vs. CT Scan for Evaluating Shunted Hydrocephalus
- 2002 Jonathan Miller**  
Abberant Neuronal Development in Hydrocephalus
- 2003 Martin U. Schuhmann**  
Serum and CSF C-Reactive Protein in Shunt Infection Management
- 2004 Jeffrey Pugh**  
Can the Skull Diploic Space Be Utilized for Absorption of Cerebrospinal Fluid? and  
**Jay K. Riva-Cambrin**  
Pediatric Posterior Fossa Tumors: Pre-Operative Predictors of Chronic Hydrocephalus
- 2005 Jeffrey P. Greenfield**  
Intraoperative Assessment of Third Ventriculostomy Success
- 2006 Kurtis I. Auguste**  
Greatly Impaired Migration of Aquaporin-4 Deficient Astroglial Cells After Implantation into Mouse Brain
- 2007 No Prize Awarded**
- 2008 Ellen L. Air**  
A Longitudinal Comparison of Pre- and Postoperative DTI parameters in Young Hydrocephalic Children
- 2009 Christopher Janson**  
Immortalization and Functional Characterization of Rat Arachnoid Cells
- 2010 Ramin Eskandari**  
Effects of Early and Late Reservoir Treatment in Experimental Neonatal Hydrocephalus

MEETING ROOM FLOOR PLAN — HILTON AUSTIN HOTEL

FOURTH FLOOR



SIXTH FLOOR

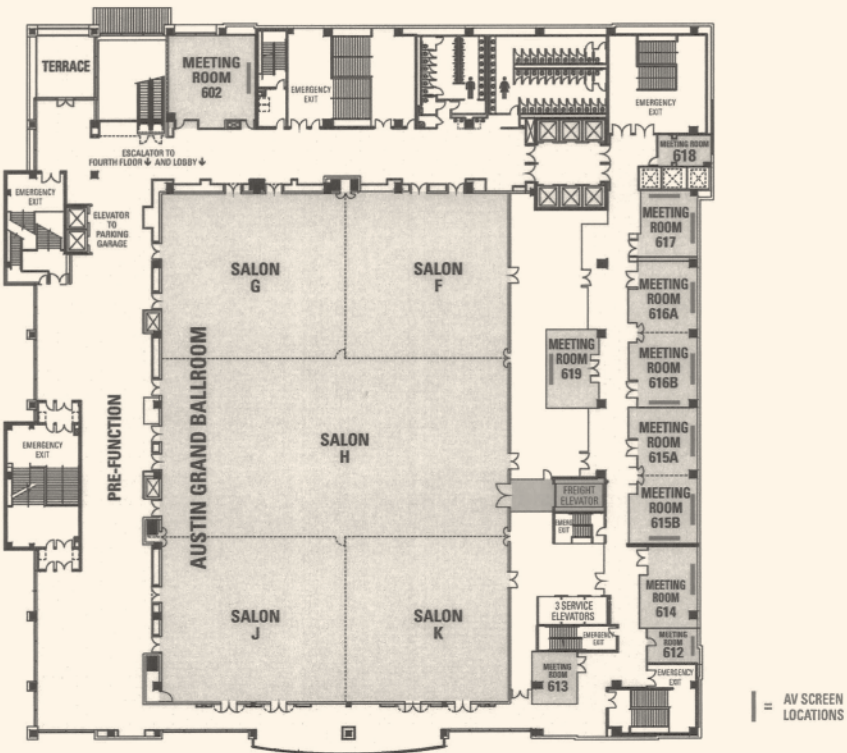
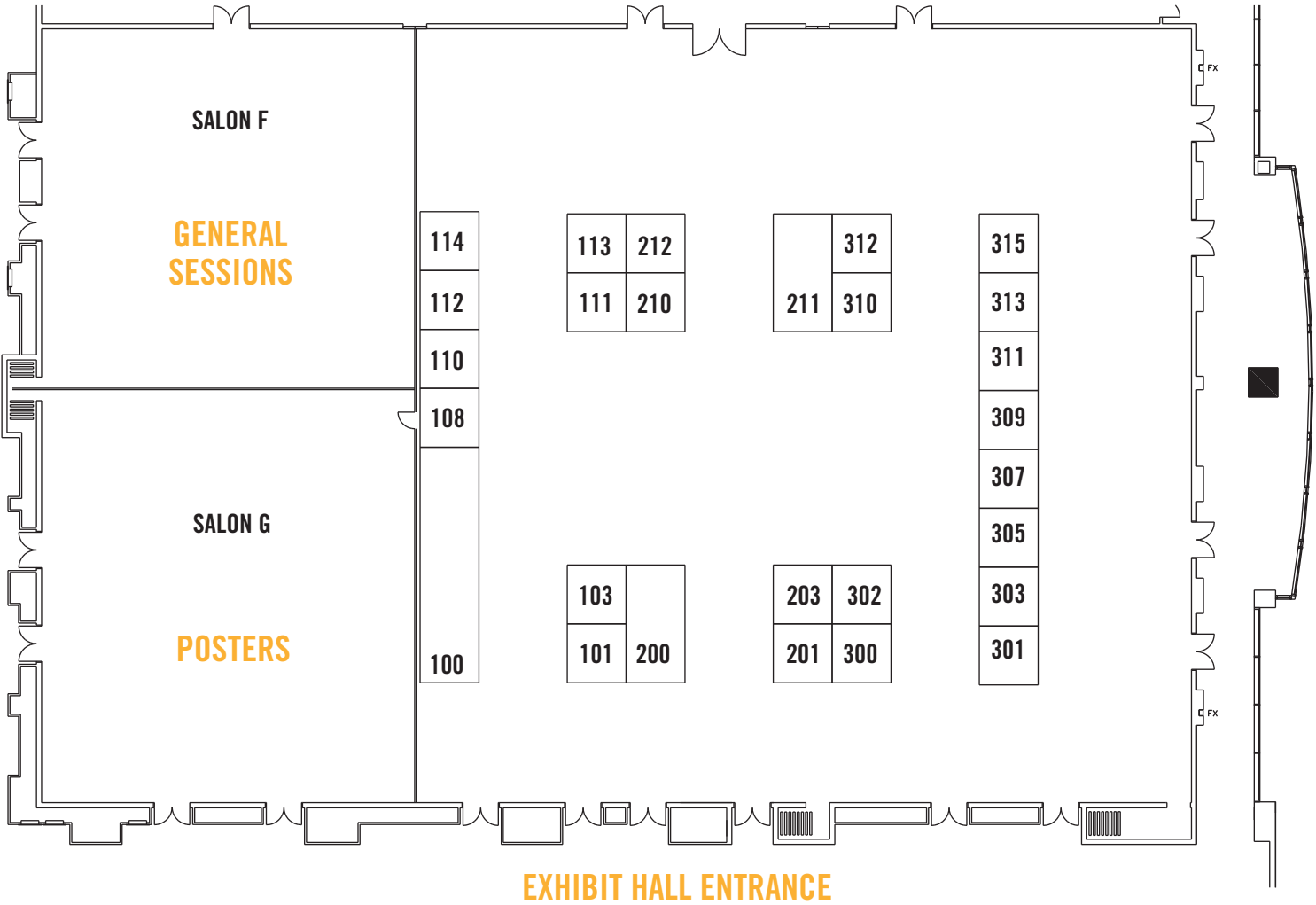




EXHIBIT HALL FLOOR PLAN



# EXHIBITOR LISTING

as November 1, 2011

**The AANS/CNS Section on Pediatric Neurological Surgery gratefully recognizes the support of the following exhibitors.**

## **Aesculap Inc.**

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Center Valley, PA 18034-8218  
Phone: (610) 984-9206  
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www.aesculapusa.com  
Booth: 101

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Fax: (978) 326-1399  
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Fax: (708) 409-1619  
www.brainlab.com  
Booth: 315

## **Children's Medical Center Dallas**

Attn: Human Resources  
1935 Medical District Drive  
Dallas, TX 75235  
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Fax: (214) 456-1081  
www.childrens.com  
Booth: 212

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Raynham, MA 02767  
Phone: (508) 880-8100  
Fax: (508) 977-6471  
www.codman.com  
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Fax: (801) 924-4951  
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Fax: (678) 896-4203  
www.ecolab.com  
Booth: 210

## **Hydrocephalus Association**

Ste. 705  
870 Market St.  
San Francisco, CA 94102  
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Fax: (415) 732-7040  
www.hydroassoc.org  
Booth: 110

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Canada  
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Fax: (204) 480-7071  
www.imris.com  
Booth: 103

## **Integra**

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Plainsboro, NJ 08536  
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Fax: (609) 799-3297  
www.integralife.com  
Booth: 111

## **KARL STORZ Endoscopy-America, Inc.**

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El Segundo, CA 90245  
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Fax: (424) 218-8537  
www.ksea.com  
Booth: 307

## **KLS—Martin , LP**

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Jacksonville, FL 32245  
Phone: (904) 641-7746  
Fax: (904) 641-7378  
www.klsmartin.com  
Booth: 203

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Buffalo Grove, IL 60089  
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Fax: (847) 405-2075  
www.leica-microsystems.com  
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Fax: (210) 643-1745  
www.lww.com  
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710 Medtronic Pkwy.  
Minneapolis, MN 55432  
Phone: (763) 514-4000  
Fax: (763) 505-0450  
www.medtronic.com  
Booth: 100

## **National Research Council of Canada and Genomics and Health Initiative Project on Surgical Oncology**

75 boul de Mortagne  
Boucherville, Quebec, J4B6Y4  
Canada  
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Fax: (450) 641-5106  
www.neurotouch@ca  
Booth: 312

## **NICO Corp.**

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9190 Priority Way West Dr.  
Indianapolis, IN 46240  
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Fax: (317) 682-0305  
www.niconeuro.com  
Booth: 300

## **Orthomerica Products Inc.**

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6333 N Orange Blossom Trl.  
Orlando, FL 32810  
Phone: (800) 446-6770  
Fax: (407) 290-2419  
www.orthomerica.com  
Booth: 309

## **Pro Med Instruments, Inc.**

Ste. 101  
4529 SE 16th Pl.  
Cape Coral, FL 33904  
Phone: (239) 369-2310  
Fax: (239) 369-2370  
www.headrest.de  
Booth: 301

## **RosmanSearch, Inc.**

# 250  
30799 Pinetree Rd  
Pepper Pike, OH 44124  
Phone: (216) 287-2302  
Fax: (216) 803-6672  
www.rosmansearch.com  
Booth: 201

## **Scott & White Healthcare System-Neurosciences Institute**

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Temple, TX 76508  
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Fax: (254) 724-5680  
www.sw.org  
Booth: 313

## **Sophysa USA, Inc.**

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Crown Point, IN 46307  
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Fax: (219) 663-7741  
www.sophysa.com  
Booth: 113

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Fax: (269) 324-5482  
www.stryker.com  
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Houston, TX 77054-4185  
Phone: (713) 275-2063  
Fax: (713) 741-0122  
www.visualaseinc.com  
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## EDUCATIONAL GRANTS

The AANS/CNS Section on Pediatric Neurological Surgery wishes to thank the following companies for their generous support of this year's Annual Meeting.

### **Diamond Support Level**

Medtronic  
Codman, a Johnson and Johnson company  
Integra Foundation

### **Emerald Support Level**

KLS Martin Group

### **Sapphire Support Level**

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## PROGRAM-AT-A-GLANCE

	TIME	EVENT	LOCATION
<b>TUESDAY</b> November 29	6:45 AM–7:00 PM	Registration	Salon G Prefunction
	8:00 AM–2:45 PM	Mid-Level Practitioner's Seminar	Salon B
	3:00–5:00 PM	The Essentials of Coding Pediatric Neurosurgery Procedures	Salon B
	6:30–8:00 PM	Opening Reception	Salon GHJ Prefunction
<b>WEDNESDAY</b> November 30	6:45 AM–5:00 PM	Registration	Salon G Prefunction
	7:15–8:00 AM	Continental Breakfast in Exhibit Hall	Salon HJK
	7:15 AM–5:30 PM	Exhibits Open Poster Viewing	Salon HJK Salon G
	8:00 AM–12:00 PM	Scientific Sessions	Salon FG
	10:25–10:40 AM	Beverage Break in Exhibit Hall	Salon HJK
	12:00–1:00 PM	Lunch in Exhibit Hall	Salon HJK
	1:00–4:30 PM	Scientific Sessions	Salon FG
	2:55–3:15 PM	Beverage Break in Exhibit Hall	Salon HJK
	4:30–5:30 PM	Wine & Cheese Reception in Exhibit Hall	Salon HJK
<b>THURSDAY</b> December 1	6:45 AM–4:00 PM	Registration	Salon G Prefunction
	6:45 AM–3:30 PM	Exhibits Open Poster Viewing	Salon HJK Salon G
	6:45–7:30 AM	Resident/Fellows Meet the Leadership Breakfast	Meeting Room 404
	6:45–7:30 AM	Continental Breakfast in Exhibit Hall	Salon HJK
	7:30 AM–12:00 PM	Scientific Sessions	Salon FG
	9:15–9:35 AM	Beverage Break in Exhibit Hall	Salon HJK
	12:00–1:00 PM	Lunch in Exhibit Hall	Salon HJK
	1:00–4:30 PM	Scientific Sessions	Salon FG
	2:30–2:50 PM	Beverage Break in Exhibit Hall	Salon HJK
	6:30–10:00 PM	Evening with Jimmie Vaughan	The Stage on Sixth
<b>FRIDAY</b> December 2	6:45–11:00 AM	Registration	Salon G Prefunction
	6:45–7:30 AM	Continental Breakfast in Exhibit Hall	Salon HJK
	6:45–11:00 AM	Exhibits Open Poster Viewing	Salon HJK Salon G
	7:30 AM–12:00 PM	Scientific Sessions	Salon FG
	10:35–10:50 AM	Beverage Break in Exhibit Hall	Salon HJK

**NOTE:** All dates, times and room locations are subject to change.

## PROGRAM DESCRIPTIONS

The open scientific sessions provide participants exposure to the latest in research and groundbreaking information available on neurosurgical topics. This year's meeting will feature Panel Debates that take a look at controversial topics, and are discussed by selected experts.

### Mid-Level Practitioner's Seminar

We are excited to be providing an informative Mid-Level Practitioner's Seminar focusing on the challenges in patient care and healthcare delivery. The seminar will be held on Tuesday, November 29 from 8:00 AM–2:45 PM. This year's course will include a variety of topics presented by a number of invited speakers. A continental breakfast and boxed lunch are included with registration. The liaison for nursing contact hours is Nicole Higginbotham, APRN, MSN, CPNP-AC.

### Learning Objectives:

Upon complete of this activity, participants should be able to:

#### The Impact of Quality Improvement: A Discussion of Pitfalls, Protocols and Policies to Improve Quality and Safety

1. Discuss why policies and protocols are important in improving QA
2. Identify some common mistakes when forming and implementing QA policies/procedures
3. Identify examples of QA initiatives

#### Providing Postoperative Medical Care to the ICU Patient

1. Recognize common postoperative complications following surgical intervention involving areas of endocrine function
2. Discuss the management of postoperative neuro-endocrine dysfunction, including DI
3. Discuss the importance of adequate postoperative nutrition
4. Identify when to initiate supportive nutrition therapy
5. Discuss the relationship between nutrition and healing

#### Understanding the Pediatric Ophthalmologic Assessment

1. Review the ophthalmologic assessment of the pediatric patient
2. Identify normal variations in the ophthalmologic exam
3. Recognize abnormal ophthalmologic findings
4. Review management of the patient with abnormal ophthalmologic findings

#### How to Recognize and Diagnose Abnormal Scans

1. Recognize the presence of abnormal radiologic findings on CTs and MRIs
2. List three abnormal radiologic findings
3. List two differential diagnoses for an abnormal radiologic finding
4. Review common neuroradiologic terminology

#### An Update on Pediatric Concussions and Sports

1. Discuss the diagnosis of concussion
2. Identify current methods for evaluating concussion severity
3. Review treatment modalities for concussions
4. Discuss return-to-play guidelines

#### Uncommonly Seen Pediatric Brain Tumors

1. Review common tumors found in pediatric patients
2. List unusual and rare tumors seen in pediatric patients
3. Discuss differential diagnoses of pediatric brain tumors

#### Surgical Epilepsy Indications, Treatments and Outcomes

1. Describe the available surgical evaluation and treatment options for epilepsy syndromes in children
2. Describe expected outcomes of common surgical treatments for epilepsy
3. Review postoperative management of patients with epilepsy

#### The Nuances of How to Perform Non-Operative Neurosurgical Procedures

1. List important considerations in performing LPs in patients with idiopathic intracranial hypertension
2. Discuss complications and problem solving techniques when performing ventriculo-peritoneal shunt patency flow studies
3. Discuss common problems with bedside management of external ventricular drains
4. Review techniques for adjusting programmable ventriculo-peritoneal shunt valves
5. Describe how to perform halo vest application, vagal nerve stimulator adjustment, baclofen pump interrogation and refilling

#### Managing Difficult and Controversial Conditions: Chiari Malformations, Slit Ventricle Syndrome, Pseudotumor Cerebri (IIH) and Arachnoid Cysts

1. Discuss the pathophysiology of slit ventricle syndrome
2. Review the diagnosis of slit ventricle syndrome
3. Describe treatment options for slit ventricle syndrome
4. Discuss the pathophysiology of idiopathic intracranial hypertension
5. Review the diagnosis of idiopathic intracranial hypertension
6. Describe the treatment options for idiopathic intracranial hypertension

#### Surgical Treatment for Spasticity & Movement Disorders

1. Identify indications for rhizotomy, baclofen pump insertion and DBS
2. Discuss postoperative management following rhizotomy
3. Discuss postoperative management of baclofen pumps

#### When to Treat Spinal Dysraphisms

1. Recognize when to refer patient for fetal surgery
2. Explain the diagnosis and treatment of spinal dysraphisms leading to tethered cord syndrome

#### Inspiring Community Service

1. Discuss how community service aides in healthcare delivery

### **The Essentials of Coding Pediatric Neurosurgery Procedures**

Immediately following the Mid-level Practitioner's Seminar, a 2-hour special coding course, directed toward pediatric neurosurgery and looking toward the future with an ICD-10 overview, will be offered. *All medical registrants are invited to attend.*

#### **Learning Objectives:**

Upon complete of this activity, participants should be able to:

### **The Essentials of Coding Pediatric Neurosurgery Procedures**

1. Apply correct CPT coding concepts to at least two common pediatric neurosurgical services
2. Discuss the differences between ICD-9-CM and ICD-10-CM diagnosis codes

#### **Exhibit Viewing**

Vendors and their exhibitors afford meeting participants an excellent opportunity to view highly specialized equipment and observe first hand demonstrations of the latest technology available in pediatric neurosurgery.

### **Poster Sessions**

The Poster Sessions are a very important part of our scientific program and include presentations of novel concepts, technical advances, and interesting clinical cases performed and documented by leaders in pediatric neurosurgery. Attendees will have multiple opportunities over the course of the meeting to view posters and interact with the attending author. Those times are during beverage breaks, breakfasts, lunches, and the Wine and Cheese Reception.

### **Opening Reception**

The opening reception will take place on Tuesday, November 29 from 6:30-8:00 PM at Hilton Austin Hotel in the Salon GHJ Prefunction area outside of the Austin Grand Ballroom on the 6th floor. Enjoy spending the evening with friends and colleagues over a wonderful assortment of hors d'oeuvres and an open bar. All registered attendees and registered guests/spouses receive one complimentary ticket to this event.

### **AN EVENING WITH JIMMIE VAUGHAN**

Join us for the final night, when we will take to The Stage on 6th, located on Austin's Famous 6th Street, for a special evening of music with Grammy Award Winning, Texas blues artist Jimmie Vaughan. He will entertain the group with his music as attendees relax and enjoy the evening with colleagues. Enjoy cocktails, dinner and a special evening of music. This event is not to be missed! The fee, an incredible bargain, includes cocktails, dinner and priceless entertainment. Medical Attendees: \$50; Spouse/Guest: \$50. The venue is a short walk from the hotel.





## PROGRAM SCHEDULE

### Tuesday, November 29

6:45 AM-7:00 PM

#### **Registration**

Salon G Prefunction

7:00-10:30 AM

#### **ABPNS Board Meeting**

Meeting Room 404

8:00 AM-2:45 PM

#### **Mid-Level Practitioner's Seminar**

Salon B

10:30 AM-12:30 PM

#### **ABPNS Examination**

Meeting Room 406

12:00-4:30 PM

#### **AANS/CNS Section on Pediatric Neurological Surgery Executive Committee Meeting**

Meeting Room 400/402

3:00-5:00 PM

#### **The Essentials of Coding Pediatric Neurosurgery Procedures**

Salon B

4:00-6:00 PM

#### **Speaker Ready Room**

Meeting Room 602

4:30-6:00 PM

#### **AANS/CNS Section on Pediatric Neurological Surgery Education Committee Meeting**

Meeting Room 404

6:30-8:00 PM

#### **Opening Reception**

Salon GHJ Prefunction

### Mid-Level Practitioner's Seminar

8:00-8:05 AM

#### **Welcome and Introductions**

8:05-8:30 AM

#### **The Impact of Quality Improvement: A Discussion of Pitfalls, Protocols and Policies to Improve Quality and Safety**

John C. Wellons III, MD

8:30-9:00 AM

#### **Providing Postoperative Medical Care to the ICU Patient**

Renee Higginson, MD

9:00-9:20 AM

#### **Understanding the Pediatric Ophthalmologic Assessment**

Melinda Rainey, MD

9:20-9:45 AM

#### **How to Recognize and Diagnose Abnormal Scans**

Christopher Richards, MD

9:45-9:50 AM

#### **Discussion and Wrap-up**

9:50-10:05 AM

#### **Break**

10:05-10:35 AM

#### **An Update on Pediatric Concussions and Sports**

Theodore Spinks, MD

10:35-11:05 AM

#### **Uncommonly Seen Pediatric Brain Tumors**

John Honeycutt, MD

11:05-11:30 AM

#### **Surgical Epilepsy Indications, Treatments and Outcomes**

Dave Clarke, MD

11:30-11:55 AM

#### **The Nuances of How to Perform Non-operative Neurosurgical Procedures**

Lucy Rochetti, PA-C

11:55 AM-12:00 PM

#### **Discussion and Morning Wrap-up**

12:00-1:00 PM

#### **Lunch and Networking**

1:00-1:25 PM

#### **Managing Difficult and Controversial Conditions: Chiari Malformations, Slit Ventricle Syndrome, Pseudotumor Cerebri (IIH) and Arachnoid Cysts**

Angela Price, MD

1:25-1:50 PM

#### **Surgical Treatment for Spasticity & Movement Disorders**

Patricia Aronin, MD, MS

1:50-2:15 PM

#### **When to Treat Spinal Dysraphisms**

Nicole Higginbotham, APRN and Morganna Kuehn, APRN

2:15-2:40 PM

#### **Inspiring Community Service**

Chris Dammert, MBA

2:40-2:45 PM

#### **Discussion and Afternoon Wrap-up/Evaluations**

2:45-3:00 PM

#### **Break**

3:00-5:00 PM

#### **The Essentials of Coding Pediatric Neurosurgery Procedures**

Kim Pollock, RN, MBA, CPC

## Wednesday, November 30

6:45 AM-5:00 PM

### Registration

Salon G Prefunction

7:00 AM-4:00 PM

### Speaker Ready Room

Meeting Room 602

7:00-8:00 AM

### SONS Executive Committee Meeting

Meeting Room 404

7:15-8:00 AM

### Continental Breakfast in Exhibit Hall

8:00-8:05 AM

### Welcome and Opening Remarks

Alan R. Cohen, MD, FACS

8:05-8:45 AM

### Raimondi Lecture

Mack Brown

Head Coach, University of Texas

Sports-related Concussive Brain Injuries: A Coach's Perspective

8:45-10:05 AM

### Scientific Session I-Trauma

Moderators:

James E. Baumgartner, MD

Julian J. Lin, MD

#### 1. Early Cranioplasty Reduces the Risk of Bone Resorption After Decompressive Craniectomy in Children

Mark Peter Piedra, MD; Eric Thompson, MD; Nathan Selden, MD, PhD, FACS, FAAP; Daniel Guillaume, MD, MSc (Portland, OR)

#### 2. School Function After Pediatric TBI: Item Generation and Item Reduction for a New Measure

Shobhan H. Vachhrajani, MD; Dorcas Beaton, BScOT, MSc, PhD; Maureen Dennis, PhD; Peter Rumney, MD, FRCPC; Abhaya Kulkarni, MD, PhD, FRCSC (Toronto, Canada)

#### 3. Incidence of Seizures on Continuous EEG Acutely Following Traumatic Brain Injury in Children

Brent Randle O'Neill, MD; Daniel Arndt; Andrew White; Kelly Knupp; Michael Handler, MD (Aurora, CO)

#### 4. Preliminary Experience with Rapid-Sequence Magnetic Resonance Imaging for Evaluation of Pediatric Cervical Spine Trauma

Daniel James Guillaume, MD, FAANS; Jeffrey Pollock, MD; Louis Riccelli, MD; James Anderson, MD; Dianna Bardo, MD (Portland, OR)

#### 5. Management of Pediatric Isolated Skull Fractures in a Level 1 Trauma Center

George Al Shamy, MD; James Muns, MD; Andrew Jea, MD; Thomas Leursson, MD; Daniel Curry, MD; Robert Bollo, MD; Robert Dauser, MD; William Whitehead, MD, MPH (Houston, TX)

#### 6. A National Analysis of Pediatric Injuries Related to Child Restraint Seats: Are Children at Higher Risk for Injury Outside the Vehicle Than Inside?

Ashutosh Singhal, MD, FAANS, FRCSC; Edi Desapriya (Vancouver, Canada)

#### 7. Pediatric Sports-Related Concussion Produces Cerebral Blood Flow Alterations without Structural or Metabolic Brain Injury

Todd A. Maugans, MD; Kim Cecil, PhD; James Leach, MD; Chad Farley, MD (Cincinnati, OH)

#### 8. The Rotterdam Score May Be Useful to Predict Outcome in Children with Moderate Traumatic Brain Injury

Krista Keachie, MD; Kiarash Shahlaie, MD, PhD; Marike Zwienenberg-Lee, MD (Sacramento, CA)

10:05-10:25 AM

#### Panel Debate: What is the Role of the Pediatric Neurosurgeon in Sports-Related Concussion Management?

Moderator: Thomas Luerksen, MD

Panelists:

Ann Christine Duhaime, MD

Mark D. Krieger, MD

10:25-10:40 AM

#### Beverage Break in Exhibit Hall

10:40 AM-12:00 PM

### Scientific Session II—Neoplasm

Moderators:

Gerald A. Grant, MD

David I. Sandberg, MD

#### 9. Genetic Analysis of Pediatric Brainstem Glioma Using Cerebrospinal Fluid

Amanda Muhs Saratsis, MD; Sridevi Yadavelli, MD, PhD; Suresh Magge, MD; Javad Nazarian, PhD (Arlington, VA)

#### 10. Treatment of Medulloblastoma with Measles Virus Encoding the Na-I Symporter Gene Prolongs Survival

Corey Raffel, MD, PhD, FAANS; Brian Hutzen; Christopher Pierson, MD; Adam Studebaker, PhD (Columbus, OH)

#### 11. Multi-Drug Targeted Therapy in a Genetically Accurate Diffuse Intrinsic Pontine Glioma Model

Lauren Elana Rotman; Zhiping Zhou, MD, PhD; Mark Souweidane, MD (Cleveland Heights, OH)

#### 12. Risk Analysis of Cerebellopontine Angle Ependymomas

Frederick A. Boop, MD, FAANS, FACS; Scott Wait, MD; R. Sanford, MD; Paul Klimo, MD; Tom Merchant, DO; David Ellison, MD (Memphis, TN)

## PROGRAM SCHEDULE

### 13. A Systematic Review of Clinical Outcomes for Pediatric Craniopharyngioma Following Surgical Treatment

Aaron John Clark, MD; Tene Cage, MD; Derick Aranda, MD; Andrew Parsa, MD, PhD; Kurtis Auguste, MD; Nalin Gupta, MD, PhD (San Francisco, CA)

### 14. Outcome and Prognostic Features in Paediatric Pineoblastomas: Analysis of Cases from the SEER Database.

Jothy Kandasamy, MBBS, BSc; Senthil Selvanathan; Salah Hammouche; Heidi Salminen; Michael Jenkinson (Liverpool, United Kingdom)

### 15. Bone Marrow-Derived Cells in the Transition of low-grade to High Grade Glioma

Prajwal Rajappa, MD; William Cobb, MD, PhD; Yujie Huang, PhD; David Lyden, MD, PhD; Jeffrey Greenfield, MD, PhD (New York, NY)

### 16. Gross-Total Resection Correlates with Long-Term Survival in Pediatric Patients with Glioblastoma

Tong Yang, MD; Nancy Temkin; Samuel Browd; Jeffrey G. Ojemann; Richard G. Ellenbogen (Seattle, WA)

12:00-1:00 PM

#### Lunch in Exhibit Hall

1:00-1:45 PM

#### SONS/AAP Lecture

Francisco G. Cigarroa, MD  
The Future of Pediatric Academic Medicine in a Changing World

1:45-2:55 PM

#### Scientific Session III—Functional, Spasticity

Moderators:

John Harrel Honeycutt, MD  
Angela V. Price, MD

### 17. Pediatric Deep Brain Stimulator Surgical Complications

John Harrel Honeycutt, MD, FAANS; Fernando Acosta, MD; Warren Marks, MD (Fort Worth, TX)

### 18. Human Embryonic-Derived Neural Stem Cell Treatment Promotes Oligodendrogenesis and Myelination in a Cerebral Palsy Model

Tenille Smith; Sahar Rosenblum, BS; Nancy Wang, BS; Sam Lawrence, BS; Kendrick Wang, BS; Angela Auriat, PhD; Hannes Vogel, MD; Raphael Guzman, MD (Reno, NV)

### 19. Selective Dorsal Rhizotomy for Treating Spasticity in Children with Atypical Diagnoses

Nathan Joseph Ranalli, MD; T.S. Park, MD (Saint Louis, MO)

### 20. Effects of Lumbar Selective Dorsal Rhizotomy on the Upper Extremities in Children with Spasticity

Paul Gigante, MD; Elizabeth Fontana; Richard Anderson (New York, NY)

### 21. Predictors and Outcomes of Surgical Intervention for Birth-Related Brachial Plexus Palsy

Laura A. Allen; Nicole Safiano; Michael Falola, MD, MPH; Camille Broome, MPH; Chevis Shannon, MBA, MPH, DrPH; John Wellons III, MD (Mountain Brk, AL)

### 22. Functional Connectivity: Evaluation in Pediatric Brain Tumor Patients with and without Epilepsy

David Frederick Bauer, MD; Andrew Poliakov, PhD; Paritosh Khanna, MD; Gisele Ishak, MD; Edward Novotny, MD; Seth Friedman, MD; Dennis Shaw, MD; Samuel Browd, MD, PhD; Richard Ellenbogen, MD; Jeffrey Ojemann, MD (Seattle, WA)

### 23. Spinal Cord Fiber Tractography and Surgical Decision-Making: A New Tool's Role

Scott Daniel Wait, MD; Asim Choudhri, MD; Berkeley Bate, MD; Frederick Boop, MD (Phoenix, AZ)

2:55-3:15 PM

#### Beverage Break in Exhibit Hall

3:15-4:25 PM

#### Scientific Session IV—Hydrocephalus

Moderators:

David M. Frim, MD  
Cormac O. Maher, MD

### 24. Climate Drives Hydrocephalus in East Africa

Steven J. Schiff, MD, PhD, FAANS; Sylvia Ranjeva; Tim Sauer, PhD; Benjamin Warf, MD (University Park, PA)

### 25. Impact of an Institutional Shunt Protocol on the Incidence of Ventricular Reservoir Infection in Preterm Infants

Dean A. Hertzler, MD; Heather Spader, MD; John Kestle, MD; Jay Riva Cambrin, MD (Salt Lake City, UT)

### 26. Current CSF Tapping Criteria Do Not Reduce Neurological Deficits in Chronic Experimental Neonatal Hydrocephalus

Ramin Eskandari, MD; Melissa Packer, BS; Kelley Deren Lloyd, MS; Osama Abdullah, MS; James (Pat) McAllister, PhD (Salt Lake City, UT)

### 27. Cerebrospinal Fluid Movement as Influenced by Respiration Using a Magnetic Resonance Spin Labeling Technique

J. Gordon McComb, MD, FAANS; Shinya Yamada, MD, PhD; Mitsue Miyazaki, PhD; Yuichi Yamashita, RT; Masao Nakahashi, BS; Seiko Shimizu, BS, RT; Ikuo Aoki, AS; Yukuo Morohashi, RT (Los Angeles, CA)

### 28. Outcome of CSF Shunting in Children within a North American Multicenter Collaborative: Results from the Hydrocephalus Clinical Research Network (HCRN) Compared to Historical Controls

Abhaya Vivek Kulkarni, MD, FAANS, FRCS; Jay Riva Cambrin; Samuel Browd; James Drake; John Kestle; David Limbrick; Tamara Simon; Mandeep Tamber; John Wellons III; William Whitehead (Toronto, Canada)



## 29. Which Ventricular Measure Is More Predictive of CSF Diversion in Premature Neonates with Grade III/IV Intraventricular Hemorrhage?

Christina Mieko Sayama, MD; Jay Riva Cambrin, MD; John Kestle, MD, MSc; Joanna Beachy, MD, PhD; Richard Holubkov, PhD (Salt Lake City, UT)

## 30. Application of Diffusion Tensor Tractography in Pediatric Optic Glioma

Robert Lober, MD, PhD; Raphael Guzman, MD; Michael Edwards, MD; Kristen Yeom, MD (Stanford, CA)

4:30-5:30 PM

## Wine & Cheese Reception

Exhibit Hall

## Thursday, December 1

6:45 AM-4:00 PM

## Registration

Salon G Prefunction

6:45-7:30 AM

## Continental Breakfast in Exhibit Hall

6:45-7:30 AM

## Meet the Leadership Breakfast for Residents/Fellows

Meeting Room 404

7:30-9:00 AM

## Scientific Session V—Craniofacial

Moderators:

David F. Jimenez, MD

Matthew D. Smyth, MD

## 31. Endoscopic Strip Craniectomy for Unilateral Coronal Synostosis: Superior Ophthalmologic Results Than Fronto-Orbital Advancement

Ning Lin, MD; Gary Rogers, MD, JD, MBA, MPH; John Meara, MD, MBA, FRACS; Mark Proctor, MD; Linda Dagi (Boston, MA)

## 32. Craniosynostosis: Developing Parameters for Diagnosis, Treatment, and Management

Mark R. Proctor, MD, FAANS; Stephen Warren, MD; Robert Keating, MD; Karin Muraszko, MD; Jeffrey Blount, MD; Herbert Fuchs, MD, PhD; Ann Marie Flannery, MD; John Jane Sr., MD, PhD; Joseph McCarthy, MD (Boston, MA)

## 33. Use of Underplating Techniques for Fronto-Orbital Reconstruction in Craniosynostosis

Jennifer Gentry Savage, MD; Micam Tullous, MD; Patricia Mancuso, MD (San Antonio, TX)

## 34. Bioabsorbable Fixation Systems in the Treatment of Pediatric Skull Deformities: Good Outcomes and Low Morbidity

Melanie Hayden, MD, MAS; Joslyn Iman Woodard; Robert Arrigo, BS; Herman Lorenz, MD; Stephen Schendel, MD; Michael Edwards, MD; Raphael Guzman, MD (Menlo Park, CA)

## 35. Low Dose Craniofacial CT/Rapid Access MRI Protocol in Craniosynostosis Patients: Decreased Radiation Exposure and Cost Savings

Raymond Harshbarger, MD; Patrick Combs MD; David Leake, MD; Tim George, MD (Austin, TX)

## 36. Subtotal Calvarial Remodelling for the Correction of Scaphocephaly: Aesthetic Outcomes and Pilot Study on Cerebral Perfusion.

Jothy Kandasamy, MBBS, BSc; Paul Sillifant; Ajay Sinha; David Richardson; Laura Parkes; Burn Sasha; Christian Duncan (Liverpool, England)

## 37. Non-Endoscopic, Minimally Invasive Calvarial Vault Remodeling Without Postoperative Helmets For Sagittal Synostosis

Ian Mutchnick, MD (Cincinnati, OH); Todd A. Maugans, MD

## 38. Combined Chiari Decompression and Posterior Cranial Vault Remodeling for Cerebellar Tonsillar Herniation Associated with Craniosynostosis

David John Sacco, MD, FAANS (Dallas, TX)

## 39. Open and Endoscopic Surgical Excision of Calvarial Dermoid and Epidermoid Cysts

Luigi Bassani, MD; Tracey Ma, BA; Omar Tanweer, MD; John Engler, MD; Robert Elliott, MD; David Harter, MD; Jeffrey Wisoff, MD

9:00-9:15 AM

## Franc Ingraham Award for Distinguished Service and Achievement

Awardee: R. Michael Scott, MD

9:15-9:35 AM

## Beverage Break in Exhibit Hall

Award Reception for R. Michael Scott, MD

9:35-10:00 AM

## Panel Debate: Is Fetal Surgery the New Standard of Care for Myelomeningocele?

Moderator:

Alan R. Cohen, MD

Panelists:

Mark S. Dias, MD,

Michael Hillel Handler, MD

10:00-11:20 AM

## Scientific Session VI—Congenital Anomalies

Moderators:

Arthur J. DiPatri Jr., MD

Sean M. Lew, MD

## 40. Natural History of Scoliosis in Patients with Chiari I Malformation

Jennifer Mae Strahle, MD; Joseph Kapurch; Hugh J.L. Garton; Karin M. Muraszko; Cormac O. Maher (Ann Arbor, MI)

## 41. Intracranial Meningocele in the Pediatric Population

Subash Lohani, MD; Diana Rodriguez, MD; Hart Lidov, MD; R. Michael Scott, MD; Mark Proctor, MD (Boston, MA)

## PROGRAM SCHEDULE

### 42. Infections of the Spinal Subdural Space in Children: A Series of Cases and Review of All Published Reports. A Multi-National Collaborative Effort

Adam Lance Sandler, MD; Dominic Thompson, MBBS, BSc, FRCS; James Goodrich, MD, PhD; Lawrence Daniels III, MD; Arundhati Biswas, MD; Mostafa El Khashab, MD, PhD; Farideh Nejat, MD; Jasper van Aalst, MD; Erwin Cornips, MD; Sandeep Monhindra, MD; Rahul Gupta; Reza Yassari, MD, MS; Rick Abbott, MD (Bronx, NY)

### 43. The Importance of Evaluating for and Ruling Out a Chiari Malformation in All Patients with Scoliosis

Keyne K. Johnson, MD (Orlando, FL)

### 44. Decompression of Chiari I Malformation without Dural Patch Graft

Heather Stevens Spader, MD; Gerald Boxerman, MD; David Mandelbaum, MD; Craig Eberson, MD; Jeff Rogg, MD; Petra Klinge, MD (Providence, RI)

### 45. Closed Neural Tube Defects in Children with Multisystem Malformations and Caudal Regression Syndrome

Yasser Jeelani, MD; Gina Mosich, BS; Jenny Souster, MD; Alexander Tuchman, MD; Caleb Standafer, BA; Mark Krieger, MD; J. Gordon McComb, MD (Los Angeles, CA)

### 46. Regression of Symptomatic Hydrosyringomyelia After Non-Dural Opening For Chiari I Malformations

Elizabeth J. Fontana, MD; Neil Feldstein, MD; Richard Anderson, MD (New York, NY)

### 47. A Sustainable Sheep Colony of NTD for Testing of Novel Therapies

Timothy M. George, MD, FAANS; Yohannes Asfaw, DVM (Austin, TX)

11:20 AM-12:00 PM

#### Special Lecture

Benjamin Solomon Carson, MD

The Importance of Impacting the World Outside of Neurosurgery

12:00-1:00 PM

#### Lunch in Exhibit Hall

1:00-2:30 PM

#### Scientific Session VII—Neoplasms

Moderators:

Peter P. Sun, MD

Michael Vassilyadi, MD

### 48. Meta-Analysis of Treatment Outcomes of Pediatric Intracranial and Spinal Ependymomas

Tene A. Cage, MD; Aaron Clark, MD; Derick Aranda; Nalin Gupta, MD, PhD; Kurtis Auguste, MD (San Francisco, CA)

### 49. Predicting the Clinical Behavior of Pilocytic Astrocytomas in Children: Utility of Magnetic Resonance Spectroscopy

Ryan Casserly; Yasser Jeelani, MD; Brian Lee, MD, PhD; Caleb Standafer, BA; J. McComb, MD; Stefan Bluml, PhD; Mark Krieger, MD (Los Angeles, CA)

### 50. Weight Profile in Children Following Endoscopic Endonasal Approach to Craniopharyngioma

Kimberly Anne Foster, MD; Maria Koutourousiou; Matthew Tormenti; Nii Addo; Selma Witchel, MD; Carl Snyderman; Paul Gardner; Elizabeth Tyler-Kabara (Pittsburgh, PA)

### 51. Brainstem Tumors in Children and Adolescents, a 30 Year Institutional Experience

Magda E. Garzon Tarazona, MD; Ofelia Cruz Martínez, MD, PhD; Marionna Suñol, MD; Antonio Guillén, MD, PhD; Jaume Mora, MD, PhD (Barcelona, Spain)

### 52. Age-Dependant Anatomic Variation in Pediatric Endonasal Endoscopic Skull Base Surgery

Jeffrey Peter Greenfield, MD, PhD; Prajwal Rajappa, MD; Theodore Schwartz, MD; George Chater-Cure, MD; Felipe Perez, MD; Linda Heier, MD (New York, NY)

### 53. Differences in VEGF Expression Correlate with Degree of Enhancement in Medulloblastoma

Shawn Level Hervey-Jumper, MD; Douglas Quint, MD; Patricia Robertson, MD; Cormac Maher, MD; Karin Muraszko, MD; Hugh Garton, MD, MPH (Ann Arbor, MI)

### 54. Angioarchitectural Determinants of Hemorrhagic Presentation in Children with Arteriovenous Malformations

Michael John Ellis, MD; Derek Armstrong, MD; Shobhan Vachhrajani, MD, FRCPC; Abhaya Kulkarni, MD, PhD; Peter Dirks, MD, PhD; James Drake, MD, MBBCH, Msc; Edward Smith, MD; R. Scott, MD; Darren Orbach, MD, PhD (Toronto, Canada)

### 55. Follow-Up Imaging of Surgically Treated Pediatric Arteriovenous Malformations

Shih-Shan Lang, MD; Joanna Ekstrom; Philip Storm, MD (Philadelphia, PA)

### 56. Postoperative Seizure Outcome in Children with Supratentorial Tumors

Courtenay Pettigrew; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BA; J. Gordon McComb, MD (Philadelphia, PA)

2:30-2:50 PM

#### Beverage Break in Exhibit Hall

2:50-4:30 PM

#### Scientific Session VIII—Epilepsy

Moderators:

Mark Robert Lee, MD

Curtis J. Rozzelle, MD

### 57. Chemotherapy Administration Directly into the Fourth Ventricle in a Non Human Primate Model

David I. Sandberg, MD, FAANS; M. Melissa Peet, MA; Mark Johnson, MS; Phaedra Cole, DVM; Tulay Koru Sengul, PhD; Ali Luqman, MD (Miami, FL)

## 58. Epilepsy Surgery Using 3-Tesla Intra-Operative MRI and Neuronavigation: The Montreal Children's Hospital Experience

Roy William Roland Dudley, MD; Jeffrey Atkinson, MD; Jose Montes, MD; Jean-Pierre Farmer, MD (Montreal, Canada)

## 59. MEG Contributes in the Surgical Management of Lesional Epilepsy

Jeffrey P. Blount, MD, FAAP, FAANS; Cody Smith, BS; Benjamin Ditty, MD; Curtis Rozzelle, MD (Birmingham, AL)

## 60. Seizure Outcome After Anatomic and Functional Hemispherectomies in Pediatric Epilepsy Patients

Tsulee Chen, MD; Peter Madsen; Phillip Storm; Gregory Heuer (Philadelphia, PA)

## 61. Invasive Intracranial Monitoring and Resective Surgery for Insular Epilepsy in Children

Louis Crevier, MD; Alain Bouthillier, MD; Philippe Major, MD; Dang Nguyen, MD; Lionel Carmant, MD (Montreal, Canada)

## 62. Pediatric Experience with Insular Epilepsy Surgery

Sanjiv Bhatia, MD, FACS, FAANS; Ngoc Le, MD; John Ragheb, MD; Prasanna Jayakar, MD, PhD; Trevor Resnick, MD; Ian Miller, MD; Michael Duchowny, MD (Miami, FL)

## 63. Effectiveness of Vagal Nerve Simulators for Pediatric Epilepsy Patients

Ann Marie Flannery, MD, FACS, FAANS; Richard Bucholz, MD (Frontenac, MO)

## 64. Post-Hemispherectomy Hydrocephalus in Children: Results of a Comprehensive, Multi-Institutional Review

Anne E. Matthews, PA-C; Adam Hartman; Yong D. Park; Anup D. Patel; Sean M. Lew (Milwaukee, WI)

## 65. Bilateral High Grade Intraventricular Hemorrhage is Associated with Male Sex, Younger Gestational Age and Lower Birth Weight, But Not Other Perinatal Factors

Ashley Grosvenor Tian, MD; Raphael G. Guzman; Susan R. Hintz; Ronald S. Cohen; Michael S.B. Edwards (Stanford, CA)

## 66. Continuous Irrigation for Neuroendoscopy: A Modification of the Biomedicus Centrifugal Pump

Brandon Rocque, MD; Jordan Henry, RN, BSN; Taryn Bragg, MD; Bermans Iskandar, MD (Madison, WI)

4:30-5:00 PM

## Annual Business Meeting

5:00-5:30 PM

## Sons Meeting

6:30-10:00 PM

## Evening with Jimmie Vaughan

The Stage on 6th

See page 17 for further information.

## Friday December 2

6:45-11:00 AM

## Registration

Salon G Prefunction

6:45-7:30 AM

## Continental Breakfast in Exhibit Hall

7:30-9:00 AM

## Scientific Session IX—Spine/General Neurosurgery

Moderators:

Theodore James Spinks, MD

Bradley E. Weprin, MD

## 67. Outcomes of Instrumented Fusion in the Pediatric Cervical Spine

Steven W. Hwang, MD; Loyola Gressot; William Whitehead; Daniel Curry; Robert Bollo; Thomas Luerssen; Andrew Jea (Boston, MA)

## 68. Prognostic Factors in Management of Primary Spinal Cord Astrocytoma in Children

Elizabeth Goodman; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BA; J. McComb, MD (Philadelphia, PA)

## 69. Degenerative Changes in Adolescent Spines: A Comparison of Motocross Racers and Age-Matched Controls

David John Daniels, MD; Michelle Clarke, MD; Ross Puffer, BS; Fredric Meyer, MD; Nicholas Wetjen, MD (Rochester, MN)

## 70. Retrospective Review of the Incidence of Facial Palsy in Treatment of Posterior Fossa Pediatric Tumors

Norianne M. Pimentel; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BS; J. McComb, MD (Monterey Park, CA)

## 71. The Impact of Direct Vertebral Body Derotation on the Lumbar Prominence in Lenke 5c Curves

Steven W. Hwang, MD; Ornella Dubaz; Alex Rothkrug; Jeffrey Kimball; Amer Samdani (Boston, MA)

## 72. Surgical Treatment of Intractable Post-Traumatic Epilepsy in Children

Nathan Joseph Ranalli, MD; Usman Akhtar, BA; David Limbrick, MD, PhD; T.S. Park, MD; Matthew Smyth, MD (Saint Louis, MO)

## 73. Shorter Stay and Similar Complication Rate with Limited Laminotomy for Selective Dorsal Rhizotomy; A Comparison Study

Sara Foppe, BS; Chevis Shannon, MBA, MPH, DrPH; Michael Falola, MD, MPH; John Wellons III, MD; Walter Oakes, MD (Birmingham, AL)

## 74. Excitotoxic Injury Causes NG-2 Cell Proliferation and Stress: Pathway to Neoplastic Glial Transformation?

David M. Frim, MD, FACS, FAANS; David Wright, PhD (Chicago, IL)

## 75. Use of Shared Medical Appointment Clinics for Common Pediatric Neurosurgical Conditions

Ann-Christine Duhaime, MD, FAANS; Sharon Haire, RN, MSN, PNP (Boston, MA)



## PROGRAM SCHEDULE

9:00-9:15 AM

### Research Awards

9:15-10:35 AM

### Scientific Session X—Vascular

Moderators:

Bermans J. Iskandar, MD

Mark D. Krieger, MD

#### 76. Treatment Trends and Overall Outcomes in Pediatric Arteriovenous Malformations

Melanie Hayden, MD, MAS; Robert Arrigo, BS; Maxwell Boakye, MD; Michael Edwards, MD; Raphael Guzman, MD (Stanford, CA)

#### 77. Progression of Moyamoya Arteriopathy Discovered in Asymptomatic Pediatric Syndromic Populations

Lissa Catherine Baird, MD; Ning Lin, MD; Kimberly Kopecky, BS; R. Scott, MD; Edward Smith, MD (Boston, MA)

#### 78. Cerebral Angiography in the Infant Population: Procedure Related Morbidity

Caitlin Elizabeth Hoffman, MD; Mark Souweidane, MD; Y. Pierre Gobin, MD; Lauren Rotman, BA; Alejandro Santillan, MD (New York, NY)

#### 79. Non-Invasive Autoregulation Monitoring with Near-Infrared Spectroscopy (NIRS) During Surgical Revascularization for Moyamoya Disease

Edward S. Ahn, MD; Lori Jordan, MD, PhD; Abby Larson, BS; Jessica Jamrogowicz, BS; Jennifer Lee, MD (Baltimore, MD)

#### 80. Increased Risk of Hemorrhage in Pediatric Patients with Arteriovenous Malformations and Associated Aneurysms: A Trend

Kevin Z. J. Chao, MD; Arjun Pendharkar; Raphael Guzman; Michael Edwards (Stanford, CA)

#### 81. Peritoneal Catheter Exchange Using a Modified Seldinger Technique

Jennifer Gentry Savage, MD; Micam Tullous, MD; Patricia Mancuso, MD; Kimberly Terry, MD (San Antonio, TX)

#### 82. CSF Pulsations in Shunt Systems: Implications for Overdrainage and New Valve Design

Wendell Lake, MD; David Hsu, MD; Taryn Bragg, MD; Bermans Iskandar, MD (Fitchburg, WI)

#### 83. Does Optic Nerve Sheath Diameter on MRI Decrease with Improved Pediatric Hydrocephalus?

Ashutosh Singhal, MD, FRCSC, FAANS; Michael Yang, HBSc, MBiotech; D. Douglas Cochrane, MD, FRCSC (Vancouver, Canada)

10:35-10:50 AM

### Beverage Break in Exhibit Hall

10:50 AM-12:00 PM

### Scientific Session XI General Neurosurgery/Quality/Outcomes

Moderators:

Patricia A. Aronin, MD, MS

Mark S. Dias, MD

#### 84. Generation of Normative Pediatric Skull Models for Use in Cranio-Orbital Remodeling Procedures

Nikoo Saber, PhD; John Phillips, MD; Thomas Looi, MSc, MBA; Peter Kim, MD, PhD; James Drake, MD, PhD (Toronto, Canada)

#### 85. Conflict of Interest in Pediatric Neurosurgery Research-Comparing Company Data to Surgeon Disclosure

Patrick J. McDonald, MD, FRCSC; Emma Schon; Michael Ellis, MD; Colin Kazina, MD (Winnipeg, Canada)

#### 86. Trainees' Perceptions of Benefits of, and Barriers to, a Career in Pediatric Neurosurgery

Mark S. Dias, MD, FAANS; Susan Durham, MD, MS, FAAP; Jeffrey Sussman, BA (Hershey, PA)

#### 87. Neurosurgical Complications of Left Ventricular Assist Devices in Children

Rory Mayer; Steve Hwang; Gaddum Reddy; William Whitehead; Daniel Curry; Thomas Luerssen; David Morales; Andrew Jea (Houston, TX)

#### 88. A Standardized Perioperative Care Protocol to Reduce Neurosurgical Infections-One Institution's Experience

Patricia A. Aronin, MD, MS, FAANS; Sarmistha Hauger (Austin, TX)

#### 89. When Pressure of the Uterine Cervix Meets Intracranial Pressure: A Scientific Approach to Prenatal Counseling

Hector E. James, MD, FAANS; Teresa MacGregor, MSN, CPNP; Philipp Aldana, MD (Jacksonville, FL)

#### 90. Pupil Findings and Survival in Pediatric Patients Undergoing Decompressive Craniectomy

Julian J. Lin, MD; Arnima Bhasin; Michail Vasilakis, MD; Lynne Lyle, RN (Peoria, IL)

12:00 PM

Closing Remarks

Timothy M. George, MD

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David M. Frim, MD, FACS  
Magda E. Garzon Tarazona, MD  
Timothy M. George, MD \*  
Paul Gigante, MD  
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Daniel James Guillaume, MD  
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Raymond Harshbarger, MD  
Melanie G. Hayden, MD  
Dean A. Hertzler, MD  
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Michael Vassilyadi, MD  
Scott Daniel Wait, MD  
Bradley E. Weprin, MD  
James West  
Sara Anne Wilkins  
Tong Yang, MD

\*Planning Committee Member

## ORAL ABSTRACTS

### 1. Early Cranioplasty Reduces the Risk of Bone Resorption After Decompressive Craniectomy in Children

Mark Peter Piedra, MD; Eric Thompson, MD; Nathan Selden, MD, PhD, FACS, FAAP; Daniel Guillaume, MD, MSc (Portland, OR)

**Introduction:** Appropriate timing of cranioplasty after decompressive craniectomy is not known. Bone resorption rates as high as 50 percent are reported. We hypothesized that early cranioplasty would reduce rates of infection, hydrocephalus, and bone resorption.

**Methods:** Between 1996 and 2010 we identified 59 patients younger than 18 years who underwent autologous cranioplasty after decompressive craniectomy for increased intracranial pressure secondary to trauma, vascular or infectious etiology at our institution. Patients were separated into early (within 6 weeks of craniectomy) and late cohorts. We compared rates of infection, hydrocephalus, and bone resorption.

**Results:** There were 27 early and 32 late cranioplasty patients. There was no significant difference in age, sex, reason for decompression, unilateral versus bilateral, presence of shunt, or use of surgical drains between the two cohorts. Rates of infection were not significantly different between the cohorts (7.7 percent early; 6.3 percent late,  $p < 1$ ), nor were rates of developing hydrocephalus (3.8 percent early; 3.1 percent late,  $p < 1$ ). There was a significant difference in rates of bone resorption between early and late cohorts (15 percent versus 44 percent respectively,  $p=0.0232$ ) yielding a relative risk of bone resorption in late versus early cranioplasty of 2.95 (95 percent confidence interval 1.10 to 7.92).

**Conclusion:** We identified an increased risk of bone resorption in delaying cranioplasty more than six weeks, but no difference in rates of infection or hydrocephalus. Based on these data, we recommend performing cranioplasty as soon as clinically feasible to reduce the risk of bone resorption.

### 2. School Function After Pediatric TBI: Item Generation and Item Reduction for a New Measure

Shobhan H. Vachhrajani, MD; Dorcas Beaton, BScOT, MSc, PhD; Maureen Dennis, PhD; Peter Rumney, MD, FRCPC; Abhaya Kulkarni, MD, PhD, FRCSC (Toronto, Canada)

**Introduction:** Pediatric traumatic brain injury (TBI) poses significant challenges for children as they attempt to reintegrate into school settings. A concept of school function previously was developed using grounded theory, and we now describe the next steps (item generation and reduction) toward the development of a questionnaire to measure school functioning after TBI.

**Methods:** Transcripts from seven focus groups of teachers and rehabilitation professionals were reviewed to identify concept specific observable behaviours and traits; these were converted into questionnaire items. Each item was placed into a putative domain of school function. Using a Delphi approach, 12 focus group participants were asked to rate the criticalness of each item and the ease of its observation in the school environment.

**Results:** Initial transcript review identified 208 potential items, placed in the domains of academic competence, cognitive function, psychosocial competence and physical function. Redundant items were eliminated, and 168 items then were subjected to the Delphi process. Of these, 54 items were deemed critical to measuring school function by greater than 8/12 participants. Another 41 items were considered potentially important. In total, 95 items comprise the prototype school functioning questionnaire.

**Conclusion:** We have constructed a prototype questionnaire that measures school function in children after TBI using a combined qualitative and clinimetric approach. Field testing with teachers of afflicted children will psychometrically validate the concept and will further refine and reduce the number of items. The benefits of using such a disease and context specific instrument will be immeasurable for this vulnerable population.

### 3. Incidence of Seizures on Continuous EEG Acutely Following Traumatic Brain Injury in Children

Brent Randle O'Neill, MD; Daniel Arndt; Andrew White; Kelly Knupp; Michael Handler (Aurora, CO)

**Introduction:** Traumatic brain injury (TBI) causes death and disability in the pediatric age group and seizures may cause diagnostic confusion or add additional metabolic burden. The incidence of EEG confirmed seizures and of subclinical seizures following traumatic brain injury in children is not well known.

**Methods:** Over a two-year period we obtained continuous EEG for 48 hours on all patients with severe TBI, and all other TBI patients with suspected seizure activity.

**Results:** 44 patients were enrolled, 21 had abusive head trauma (AHT) and 22 accidental traumas. The mean age for the AHT group was 7.3 months and for the accidental group was 9.3 years. For the AHT group, 62 percent (13 of 21) had seizures during EEG, monitoring, nine with only subclinical seizures and 4 with both clinical and subclinical seizures. 14 percent (3/22) of the accidental group had seizures ( $p=0.0036$ ), two with only subclinical seizures and one with only clinical seizures. When the analysis is limited to patients with an initial Glasgow Coma Score (GCS) of 8 or less, 67 percent (6/9) of AHT cases had seizures compared to 10 percent (2/20) of accidental cases ( $p=0.0050$ ).

**Conclusion:** Continuous EEG identifies a significant number of seizures in the acute period following TBI, many of them sub clinical. Victims of abusive head trauma are particularly prone to seizures. Continuous EEG monitoring allows earlier appropriate intervention in these patients, and may mitigate secondary damage resulting in improved outcomes.

### 4. Preliminary Experience with Rapid-Sequence Magnetic Resonance Imaging for Evaluation of Pediatric Cervical Spine Trauma

Daniel James Guillaume, MD, FAANS; Jeffrey Pollock, MD; Louis Riccelli, MD; James Anderson, MD; Dianna Bardo, MD (Portland, OR)

**Introduction:** Evaluation and clearance of the pediatric cervical spine following trauma can be challenging. Computed tomography does not reveal ligamentous, spinal cord, or other soft tissue injuries and may expose patients to unnecessary radiation. Although magnetic resonance imaging (MRI) can detect soft-tissue injuries, it often requires sedation in infants and young children do to long acquisition times. The purpose of this prospective study was to evaluate the utility of rapid-sequence cervical spine MRI in children suffering blunt trauma.

**Methods:** After Institutional Review Board approval, quick spine sequences (single shot T2 FSE and rapid STIR) in sagittal and axial planes were added to our standard cervical spine MRI trauma protocol. Nineteen children with neck pain following trauma were examined. Images were reviewed by 4 blinded reviewers (3 neuroradiologists and 1 neurosurgeon), who graded images based on diagnostic certainty on a 3 point scale: "1" being non-diagnostic, "2" being diagnostic for presence or absence of injury and "3" being equally diagnostic as standard MRI.

**Results:** Image quality was rated as "2" or "3" by all reviewers in 16 of 19 cases ( $p<0.05$ ). Only 6 of 28 sequences were rated as non-diagnostic by at least one reader ( $p<0.05$ ). The average acquisition time was 2 minutes 37 seconds (range 1:00 to 3:00 minutes, SD 0.02).

**Conclusion:** This preliminary study suggests use of a rapid-sequence cervical spine MR protocol is feasible in the majority of non-sedated children, exam time is short with minimal effect upon the scheduled MR patients, and diagnostic certainty is excellent.



## ORAL ABSTRACTS

### 5. Management of Pediatric Isolated Skull Fractures in a Level 1 Trauma Center

George Al Shamy, MD; James Muns, MD; Andrew Jea, MD; Thomas Leursson, MD; Daniel Curry, MD; Robert Bollo, MD; Robert Dauser, MD; William Whitehead, MD, MPH (Houston, TX)

**Introduction:** Ever since the “talk and die” syndrome has been described, practitioners have been observing patients with mild head injury (GCS 14-15) in the hospital for fear of clinical deterioration. The management of children with isolated skull fractures post trauma has been variable with some groups proposing discharge after brief observation in the emergency room. We sought to report our experience in a busy Level 1 trauma center.

**Methods:** A retrospective review was conducted for pediatric patients with linear non depressed skull fractures presenting to our institution from 2007-2011. Inclusion criteria included: GCS of 15, patients presenting within 24 hours with no intracranial findings on CT scans or evidence of non accidental trauma.

**Results:** Two hundred and eight patients met the inclusion criteria of which 194 pts were admitted for overnight observation. Twenty-five patients had loss of consciousness. Forty-three patients had at least one episode of vomiting and only 2 pts had a seizure disorder. Ninety-seven percent of patients were discharged the next morning. None of the 208 patients needed any neurosurgical intervention.

**Conclusion:** Patients with isolated skull fractures and normal GCS can be discharged safely from the ER especially if they have a reliable support system. This has the potential to limit patient's costs.

### 6. A National Analysis of Pediatric Injuries Related to Child Restraint Seats: Are Children at Higher Risk for Injury Outside the Vehicle Than Inside?

Ashutosh Singhal, MD, FAANS, FRCSC; Edi Desapriya (Vancouver, Canada)

**Introduction:** The widespread use of Child Restraint Seats (CRS) has been effective in decreasing mortality and morbidity associated with Motor Vehicle Collisions (MVC). However, anecdotes suggest the use of CRS has been accompanied by an increase in infant falls from hand held carrier/car seats. The current study explores the frequency of CRS related injuries both inside and outside of motor vehicles.

**Methods:** The Canadian Hospital Injury Reporting and Prevention Program (CHIRPP) is a Canada wide prospective emergency department surveillance program. A review was conducted in children under 1 year of age, of the cause and location of injuries related to CRS use from 1995-2007.

**Results:** There were 4,131 injuries involving CRS, and a remarkable 66.7 percent of these occurred outside the vehicle. The most common factor in non MVC related injuries was improper use of restraints while carrying the infant in the carrier/seat. Head injuries comprised the largest proportion of the non MVC injuries, with almost 1,500 injuries. The odds ratio for head injury was 42.7 ( $p < 0.0001$ ), a statistically significant finding suggesting that an infant in a CRS is far more likely to sustain a head injury outside the vehicle than in an actual MVC.

**Conclusion:** This national study suggests that an unintended by product of the widespread use of CRS is injury related to falls out of the CRS. This represents a previously unreported public health issue affecting a substantial number of children. Education of the public regarding this issue, and promoting the proper use of CRS, will likely prevent many of these types of injuries.

### 7. Pediatric Sports-Related Concussion Produces Cerebral Blood Flow Alterations without Structural or Metabolic Brain Injury

Todd A. Maugans, MD; Kim Cecil, PhD; James Leach, MD; Chad Farley, MD (Cincinnati, OH)

**Introduction:** The pathophysiology of sports related concussion (SRC) is incompletely understood, especially in children. Human adult and experimental animal investigations have identified structural axonal injuries, decreases in the neuronal metabolite N acetyl aspartate (NAA) and reduced cerebral blood flow (CBF) following SRC and minor traumatic brain injury. This investigation explores these possibilities following pediatric SRC.

**Methods:** We evaluated 12 children, age 11-15 years, who had sustained SRC using ImpACT testing, T1 weighted MRI, diffusion tensor imaging (DTI), spectroscopy (1H MRS) and phase-contrast angiography at less than 72 hours, 14 days and 30 days or greater post concussion. A similar number of age- and sex-matched controls were evaluated at a single time point.

**Results:** ImpACT results confirmed statistically significant differences in initial total symptom score (TSS) and reaction time (RT) between the SRC and control groups, resolving by 14 days for TSS and 30 days for RT. No evidence of structural injury was found on qualitative review of MRI. No decreases in NAA or elevation of lactic acid were detected by 1H MRS. Statistically significant alterations in CBF were documented in the SRC group, with reduction in CBF predominating (38 vs 48ml/100 g/min,  $P = 0.027$ ). Improvement toward control values occurred in only 27 percent of the participants at 14 days and 64 percent at more than 30 days following SRC.

**Conclusion:** Differing from adults, pediatric SRC is primarily a physiologic injury, affecting CBF significantly without evidence of measurable structural, metabolic neuronal or axonal injury. CBF recovery is unpredictable and frequently protracted.

### 8. The Rotterdam Score May Be Useful to Predict Outcome in Children with Moderate Traumatic Brain Injury

Krista Keachie, MD; Kiarash Shahlaie, MD, PhD; Marika Zwiennenberg-Lee, MD (Sacramento, CA)

**Introduction:** Early predictors of outcome following adult traumatic brain injury (TBI) include the Glasgow Coma Score (GCS), hypoxia, hypotension, and initial head CT characteristics. TBI prognosis in the pediatric population is less well understood. Using numerous demographic, clinical and radiographic variables, we seek to determine which variables are valuable in predicting outcome in pediatric TBI patients and if using the Rotterdam Score (RS), a CT classification system for TBI, may improve outcome prediction compared to GCS alone.

**Methods:** Clinically relevant data were collected prospectively from October 2008 until December 2010 in all TBI patients up to 16 years of age who presented to a Level 1 trauma center. Analysis included 111 patients with moderate and severe TBI. Thirty-one separate demographic, clinical and radiographic variables were analyzed as potential prognostic factors in TBI. Outcomes were assessed with 3- and 6-month Glasgow Outcome Score and extended Glasgow Outcome Score, which were then dichotomized to favorable or unfavorable.

**Results:** In patients with moderate TBI, a RS less than 2 was associated with a favorable outcome whereas a RS 3 or greater was associated with an unfavorable outcome ( $P < 0.06$ ). In patients with severe TBI, the RS did not have additional predictive value.

**Conclusion:** In pediatric patients with moderate TBI, the RS may be useful in predicting outcome following TBI. Analysis of additional risk factors will be needed to determine if RS can aid in early prognostication of outcome, either as an independent predictor or in combination with other risk factors.

## 9. Genetic Analysis of Pediatric Brainstem Glioma Using Cerebrospinal Fluid

Amanda Muhs Saratsis, MD; Sridevi Yadavelli, MD, PhD; Suresh Magge, MD; Javad Nazarian, PhD (Arlington, VA)

**Introduction:** Diffuse intrinsic pontine glioma (DIPG) is a leading cause of brain tumor death in children due to lack of effective therapy. Genetic analysis of DIPG has been limited due to the lack of readily available tumor tissue for molecular study. Molecular analysis of cerebrospinal fluid (CSF) could provide information on chromosomal abnormalities in DIPG.

**Methods:** CSF samples were submitted for MS/MS proteomic analysis using LTQ Orbitrap XL. Isolated peptides identified using the Sequest algorithm in the Bioworks browser against the Uniprot database were submitted to quantitative analysis using ProteoIQ. Relative protein expression was used to extrapolate potential regions of chromosomal amplification and deletion.

**Results:** Quantitative proteomic analysis revealed 309 proteins detected in DIPG CSF specimens but absent in controls. 76 percent correlated to regions of known genomic amplification in pediatric brainstem glioma. 1q and 17q were chromosomal regions with the greatest amplification. Forty-six proteins detected in all controls were absent in DIPG CSF specimens. Of these, 58 percent mapped to known genomic deletion sites for brainstem glioma, with X, 5p and 17p the most common abnormal regions. These findings correlate with existing data in the literature on genetic abnormalities of brainstem glioma.

**Conclusion:** Cerebrospinal fluid from children with DIPG is more readily available than tumor tissue. Proteomic analysis can reveal potential regions of genomic change in brainstem glioma that correlate with existing data in the literature, and can provide insight to pathways of brainstem gliomagenesis. Further genetic analysis of CSF and tumor tissue is currently underway.

## 10. Treatment of Medulloblastoma with Measles Virus Encoding the Na-I Symporter Gene Prolongs Survival

Corey Raffel, MD, PhD, FAANS; Brian Hutzen; Christopher Pierson, MD; Adam Studebaker, PhD (Columbus, OH)

**Introduction:** We are pursuing the potential of an oncolytic measles virus encoding the sodium iodide symporter gene (MV NIS) as a treatment for medulloblastoma. Besides its oncolytic activity, MV NIS can deliver targeted radiotherapy to the tumor.

**Methods:** MV NIS efficacy was evaluated in medulloblastoma cell lines in vitro. Athymic nude mice were injected with medulloblastoma cells in the caudate putamen. Ten days later, the mice were treated with MV NIS, then given a dose of 131I 24, 48 or 72 hours later. Tumor progression and 131I uptake were monitored. Mice were sacrificed; their brains were examined for the presence of tumor.

**Results:** In vitro studies showed MV NIS infected, replicated in, and killed all human medulloblastoma cell lines evaluated. Radioiodine was concentrated in infected cells. MV NIS treatment of localized, intracerebral medulloblastoma, both by itself and in combination with 131I, extended survival times (p < 0.0001). Mice given 131I were found to concentrate radioiodine at the site of their tumor implantations. In addition, mice that were given 131I either 24 or 48 hours, but not 72 hours, after MV NIS treatment exhibited a survival advantage over mice given MV NIS alone (p < 0.05).

**Conclusion:** MV NIS is a potentially useful agent in the treatment of medulloblastoma. The ability of MV NIS to induce medulloblastoma tumor cells to concentrate 131I may have clinical significance for radioimaging and targeted radiotherapeutic applications. Further investigation of MV NIS for eventual use in a medulloblastoma clinical trial is underway.

## 11. Multi-Drug Targeted Therapy in a Genetically Accurate Diffuse Intrinsic Pontine Glioma Model

Lauren Elana Rotman; Zhiping Zhou, MD, PhD; Mark Souweidane, MD (Cleveland Heights, OH)

**Introduction:** Recent molecular characterization has revealed that platelet derived growth factor receptor (PDGFR), a receptor tyrosine kinase, is overexpressed and activated in the majority of DIPG cases. Systemic administration of a PDGFR inhibitor (imatinib) has been shown to have minimal efficacy in treating DIPG. We hypothesize that complex signaling mechanisms, such as cross activation of signals downstream to PDGFR (e.g. AKT), may be responsible for imatinib's lack of efficacy. If true, a multi-drug targeted approach, inhibiting both PDGFR and its downstream signals, would be more effective in improving outcomes of patients with DIPG.

**Methods:** Brainstem glioma (BSG) cells were grown from a PDGF B driven mouse DIPG model. Experimental therapies were performed by inhibiting PDGFR alone (with imatinib or dasatinib), AKT alone (with perifosine) or combined PDGFR and AKT inhibition. Efficacy was assessed through quantification of cell survival.

**Results:** In comparison to drug-free controls, 23.2 percent of BSG cells survived with imatinib treatment while 8.7 percent of cells survived with combined imatinib and perifosine treatment (p=0.013). Compared to controls 10.1 percent of cells survived with dasatinib treatment while 5.1 percent of cells survived with combined dasatinib and perifosine treatment (p=0.008). Single therapy with perifosine showed 29.7 percent cell survival when compared to controls.

**Conclusion:** Co-inhibition of PDGFR and AKT signaling produced higher cytotoxicity against BSG cells, which supports our hypothesis that redundant signaling may be a major reason for imatinib's low efficacy in clinical trials. The use of a multi-targeted approach in treating PDGF driven DIPG provides a novel direction for the development of therapies for pediatric brain tumors.

## 12. Risk Analysis of Cerebellopontine Angle Ependymomas

Frederick A. Boop, MD, FACS, FAANS; Scott Wait, MD; R. Sanford, MD; Paul Klimo, MD; Tom Merchant, DO; David Ellison, MD (Memphis, TN)

**Introduction:** The authors have recently proposed a novel risk stratification of ependymomas based upon extent of resection, cell density/mitotic activity, and status of chromosome 1q. Cerebellopontine angle ependymomas (CPAE) have historically been one of the more difficult to treat but it has remained unclear if this is related to difficulty with resection or intrinsic tumor biology. This study is an attempt to answer that question.

**Methods:** From a cohort of 119 posterior fossa ependymomas, 23 CPAE, defined as having 3 of 4 of the following features: majority of the tumor in the CPA, rotation of the brain stem by tumor, encasement of cranial nerves and vessels, extension of tumor through the foramen of Lushka into the 4th ventricle, were analyzed using our novel stratification protocol. All children underwent maximal resection followed by 59.4 Gy focal irradiation. The authors reviewed clinical, radiographic, pathological and outcome data comparing CPAE to 4th ventricle ependymomas.

**Results:** CPAE have a poorer outcome than 4th ventricle ependymomas (p=0.013). This appears unrelated to differences in pathological features (cell density/mitotic count) or to 1q status.

**Conclusion:** Based upon risk stratification, it appears that children with CPAE are at increased risk for recurrence. The authors will present molecular analysis and risk stratification of this subgroup in relation to other posterior fossa ependymomas and to extent of surgical resection.

### 13. A Systematic Review of Clinical Outcomes for Pediatric Craniopharyngioma Following Surgical Treatment

Aaron John Clark, MD; Tene Cage, MD; Derick Aranda, MD; Andrew Parsa, MD, PhD; Kurtis Auguste, MD; Nalin Gupta, MD, PhD (San Francisco, CA)

**Objective:** Craniopharyngiomas are benign tumors but their close anatomic relationship with critical neurologic, endocrine, and vascular structures makes gross total resection with minimal morbidity difficult to achieve. Currently, there is controversy regarding the extent, timing, and modality of treatment for pediatric craniopharyngioma.

**Materials and Methods:** We performed a systematic review of the published literature on pediatric craniopharyngioma to determine patterns of clinical practice and reported outcomes using standard treatment strategies. This yielded 109 studies which contained data describing extent of resection for a total of 531 patients. Differences in outcome were examined based upon extent of resection and choice of radiation treatment.

**Results:** Gross total resection (GTR) was associated with increased rates of new endocrine dysfunction (OR 5.4,  $p < 0.001$ ), pan hypopituitarism (OR 7.8,  $p = 0.006$ ), and new neurologic deficits (OR 9.9,  $p = 0.03$ ) compared to biopsy procedures. GTR was associated with increased rates of diabetes insipidus (OR 7.7,  $p = 0.05$ ) compared to subtotal resection (STR) and radiotherapy (STR+XRT). The addition of XRT to STR was associated with increased rates of pan hypopituitarism (OR 9.9,  $p = 0.01$ ) but otherwise similar rates of morbidities.

**Conclusion:** Although subject to the limitations of a literature review, this report suggests that GTR is associated with increased rates of endocrinopathies compared to STR+XRT and should be considered when planning goals of surgery.

### 14. Outcome and Prognostic Features in Paediatric Pineoblastomas: Analysis of Cases from the SEER Database

Jothy Kandasamy, MBBS, BSc; Senthil Selvanathan; Salah Hammouche; Heidi Salminen; Michael Jenkinson (Liverpool, United Kingdom)

**Introduction:** Paediatric pineoblastomas are rare central nervous system tumours. Patient and treatment factors associated with outcome are poorly defined and limited to small retrospective case series and single case reports. Using the Surveillance, Epidemiology, and End Results (SEER) cancer registry, we investigated clinicopathological factors associated with outcome in paediatric pineoblastomas.

**Methods:** Paediatric patients (<16 years old) with pineoblastomas diagnosed between 1990 -2007 were identified from the SEER database. Kaplan-Meier survival analysis and Cox models were used to examine the effect of variables on overall survival. The variables analysed included patient's age at diagnosis, gender, race, tumour location, uni-focal or multi-focal tumour, tumour size, surgical resection and the use of adjuvant radiotherapy.

**Results:** Seventy-eight patients were identified, with a median age at diagnosis of 6.3 years. Sixty-three patients (80.8 percent) underwent surgery and thirty-nine patients (50 percent) received adjuvant radiotherapy. Thirty-nine patients (50 percent) had both surgery and radiotherapy. The median overall survival was 76 months. On univariate analysis, older age at diagnosis emerged as the only important predictor of overall survival.

**Conclusion:** This study represents the largest analysis of paediatric pineoblastomas to date. Clinically relevant prognostic factor was older age at diagnosis. Surgery and adjuvant radiotherapy did not influence overall survival.

### 15. Bone Marrow-Derived Cells in the Transition of Low-Grade to High-Grade Glioma

Prajwal Rajappa, MD; William Cobb, MD, PhD; Yujie Huang, PhD; David Lyden, MD, PhD; Jeffrey Greenfield, MD, PhD (New York, NY)

**Introduction:** Low-grade astrocytomas are well-differentiated tumors without neovascularization. Patient survival is largely dependent on avoiding transition to high-grade malignancy. A key event in this transition is the angiogenic switch providing an environment capable of vascular proliferation. Factors involved in the angiogenic switch have been a recent target of interest for glioma therapy. Bone marrow derived cells (BMDC) participate in the progression of cancer by breaking down normal structures, promoting vasculogenesis and invasiveness, providing an environment capable of promoting tumor growth. We investigated the role of BMDC in the transition of low-grade to high-grade gliomas.

**Methods:** A PDGF-driven murine glioma model was used to follow BMDC in the periphery and the brain. Flow cytometry was used to quantify BMDC and immunofluorescence was used to localize BMDC within the tumor environment.

**Results:** These animals form low-grade tumors at 4 weeks and transition to high-grade tumors by 6 weeks. The number of BMDC in the peripheral blood and within the tumor directly correlates with tumor grade. BMDCs congregate near blood vessels and the invasive front. When cranially shielded animals receive lethal dose radiation, the onset of tumor growth and high-grade progression is delayed by 4 weeks suggesting that the intact immune system participates in malignant transformation. Animals with bone marrow deficient in VEGFR2 or treated with jak inhibitors, that block BMDC mobilization, delay high-grade progression.

**Conclusion:** BMDC correlate with tumor grade and appear to play a role in malignant progression of gliomas. More studies are required to fully delineate the role of BMDC in this process.

### 16. Gross-Total Resection Correlates with Long Term Survival in Pediatric Patients with Glioblastoma

Tong Yang, MD; Nancy Temkin; Samuel Browd; Jeffrey G. Ojemann; Richard G. Ellenbogen (Seattle, WA)

**Introduction:** Glioblastoma is a rare central nervous system neoplasm in the pediatric patients. Few studies focused exclusively on this disease in this population. Available literature suggests that this disease behaves differently between pediatric and adult patients. We studied patients younger than 18 years of age, carrying the diagnosis of non-brainstem glioblastoma, their clinical characteristics and clinical factors associated with clinical outcome.

**Methods:** Thirty-nine pediatric patients with the diagnosis of non brainstem glioblastoma, who were treated in our institution from 1982 to 2011, were identified and studied.

**Results:** All patients underwent surgical intervention. Eighteen patients (46 percent) had gross total resection (GTR). Fourteen (36 percent) had subtotal resection (STR) and seven (18 percent) had biopsy. After surgery, all but two patients received radiation therapy (94.9 percent). All but three patients (92.3 percent) received chemotherapy (various agents depending on the institutional protocols established at the time of treatment). follow-up duration ranges from 0.5 month to 186 months. The median overall survival (OS) is 18.7 months (95 percent Confidence Interval (CI) 15.6 21.8 months). The survival rate at 1, 2 and 5 years is 63.2 percent, 44.8 percent and 20.0 percent, respectively. The mean OS for patients with GTR is 45.1 months (95 percent CI 1.8 88.4 months), 8.7 11.5 months for patients with STR or BX only.

**Conclusion:** Gross total resection correlates with long-term survival in our population of pediatric patients with non-brainstem glioblastoma.

## 17. Pediatric Deep Brain Stimulator Surgical Complications

John Harrel Honeycutt, MD, FAANS; Fernando Acosta, MD; Warren Marks, MD (Fort Worth, TX)

**Introduction:** Although deep brain stimulation (DBS) has become commonplace for treatment of adult movement disorders, little data is available about DBS treatment of childhood movement disorders. We present surgical complications in children 18 years old and younger undergoing DBS placement in our institution.

**Methods:** We conducted a retrospective analysis of all children 18 years old and younger undergoing DBS surgery from September 2007 to September 2011 at Cook Children's Medical Center. All patients enrolled for DBS surgery undergo a rigorous consent process approved by our institutional review board in accordance with the current United States FDA Humanitarian Device Exemption status of this device for dystonia.

**Results:** Fifty-three surgeries to implant electrodes with awake microelectrode recording (105 lead placements) were performed. Four infections required removal of DBS hardware (7.5 percent), with 3 of the 4 patients reimplanted successfully. Four patients (7.5 percent) suffered ischemia to the caudate nucleus during DBS implantation. Two were asymptomatic and 2 had transient hemiparesis that resolved within one month. A seizure in a known epilepsy patient during electrode implantation necessitated intraoperative sedatives and phosphenytoin. Three patients required electrode revision due to poor treatment response attributed to suboptimal placement. Finally, fractures or disconnection of electrode wires entailed revision in three (5.7 percent) patients.

**Conclusion:** Pediatric DBS affords another viable treatment option that movement disorder teams can offer to these challenging patients. Although the overall complication rate for this group of children was 33 percent, most complications were transient or easily treated. This information enables families to learn about risks associated with DBS placement.

## 18. Human Embryonic-Derived Neural Stem Cell Treatment Promotes Oligodendrogenesis and Myelination in a Cerebral Palsy Model

Tenille Smith; Sahar Rosenblum, BS; Nancy Wang, BS; Sam Lawrence, BS; Kendrick Wang, BS; Angela Auriat, PhD; Hannes Vogel, MD; Raphael Guzman, MD (Reno, NV)

**Introduction:** Cerebral palsy (CP) is the most common cause of motor disability in children. One important cause of CP, neonatal hypoxia ischemia induces oligodendrocyte apoptosis and impairs normal myelination. No CP treatment targets myelination making regenerative medicine a promising research frontier.

**Methods:** Neonatal Wistar rats underwent CCA ligation then placement in 8 percent O<sub>2</sub> at 37° C on post natal day 7(P7). Following P9 MRI, immunosuppressed pups received intra arterial transplant of 500k fLuc/eGFP transduced human embryonic derived neural stem cells (NSCs) or saline on P10. BrdU was injected intraperitoneally from P11 P18. In vivo bioluminescence images (BLI) were obtained from P11 P20. Immunohistochemistry was used to evaluate myelination (LFB, MBP) and oligodendrogenesis (BrdU/Olig2) 3, 10, and 30 days(d) after treatment. Brain and NSC mRNA was evaluated using RT qPCR. Luminex assay quantified NSC protein secretion.

**Results:** BLI demonstrated NSC homing to the ischemic hemisphere 1-7 days after transplant (p=0.001). Nestin+ NSCs localized to corpus callosum initially and migrated into external capsule and corona radiata 30 d after transplant. NSC treated pups had significantly more BrdU+ (p=0.020) and BrdU+/Olig2+(p<0.05) cells in the corpus callosum than controls 30 d after treatment. LFB and MBP staining demonstrated greater myelination 10 and 30 d after NSC treatment in corpus callosum (p=0.022, p<0.05) and striatum (p=0.017, p=0.001). Stat3 (2.82) and IL 6 (1.48) mRNA was upregulated in the brains of NSC treated pups. Proteomic and mRNA data confirm NSC expression of VEGF (17.9pg/mL, 4.35) and CXCL1 (3.6pg/mL, 10.27).

**Conclusion:** Intra-arterial transplant results in NSC engraftment into white matter tracts, increased oligodendrocyte proliferation, and improved myelination. NSC derived proteins may drive distinct changes in gene expression in the brain that activate endogenous self repair mechanisms, including oligodendrogenesis.

## 19. Selective Dorsal Rhizotomy for Treating Spasticity in Children with Atypical Diagnoses

Nathan Joseph Ranalli, MD; T.S. Park, MD (Saint Louis, MO)

**Introduction:** Selective dorsal rhizotomy (SDR) is a well studied procedure proven to reduce spasticity and facilitate motor performance in cerebral palsy (CP) patients with spastic diplegia. There is a paucity of literature on the application of SDR for spasticity in children with congenital brain malformations or neurological conditions that began after the first month of life. The goal of this study was to report on the use of SDR for spasticity in children with diagnoses of traumatic brain injury (TBI), stroke and neuronal migration disorders.

**Methods:** A retrospective review was performed of all patients who underwent SDR at the author's institution from January 2005 to April 2011 for spasticity secondary to atypical diagnoses. Data including patient characteristics, preoperative performance status, surgical details and postoperative outcomes were collected and compared.

**Results:** Twenty children (mean age 7 years 2 months) with spasticity due to atypical diagnoses underwent SDR performed by the same surgeon during a 6 year period. Fifteen of 20 patients were born at full term and 11 different diagnoses were identified (schizencephaly and TBI were the most common) with radiographic documentation in 19 cases. Study patients were followed up for 4-69 months and all experienced postoperative improvement in ambulation and notable reduction in tone as measured by the modified Ashworth scale.

**Conclusion:** SDR proved to be effective in treating spasticity in children with atypical diagnoses. SDR should be considered as a therapeutic option in appropriately selected children with lower extremity spasticity due to TBI, strokes and congenital brain malformations.

## 20. Effects of Lumbar Selective Dorsal Rhizotomy on the Upper Extremities in Children with Spasticity

Paul Gigante, MD; Elizabeth Fontan; Richard Anderson, MD (New York, NY)

**Introduction:** Randomized clinical trials have established selective dorsal rhizotomy (SDR) reduces lower extremity tone and improves functional outcome in children with spastic diparesis. The effects of SDR on upper extremity function, however, are not well characterized.

**Methods:** We retrospectively reviewed 40 children that underwent SDR at Columbia University/Morgan Stanley Children's Hospital from 2007-2010. Sixteen had upper extremity spasticity and were included in this study. All underwent pre- and post-operative testing measuring tone (modified Ashworth scale), range of motion (ROM), and gross motor function. follow-up was performed between six months and two years postoperatively (mean=9.5 months).

**Results:** In the upper extremities, 13 of 16 (81 percent) patients had improvements of at least one Ashworth point in two or more independent motor groups, and 8 of 16 (50 percent) had improved ROM of <15 degrees in at least one joint. Mean Ashworth scores for all upper extremity muscle groups trended toward improvement but did not reach statistical significance (1.72 vs. 1.85; p = 0.63). In comparison, there was a statistically significant improvement in mean Ashworth scores for lower extremity muscle groups including hip flexion (p = 0.001), hip extension (p = 0.005), knee flexion (p = 0.037), knee extension (p = 0.016), dorsiflexion (p = 0.007), and plantarflexion (p = 0.006).

**Conclusion:** In addition to improvements in lower extremity tone/function, SDR has some beneficial effects on upper extremities. These improvements, however, seem less predictable and powerful than lower extremity improvements. Current studies are focused on which preoperative factors are associated with improved upper extremity function after SDR.



## 21. Predictors and Outcomes of Surgical Intervention for Birth-Related Brachial Plexus Palsy

Laura A. Allen; Nicole Safiano; Michael Falola, MD, MPH; Camille Broome, MPH; Chevis Shannon, MBA, MPH, DrPH; John Wellons III, MD (Mountain Brk, AL)

**Introduction:** Risk factors for birth related brachial plexus palsy (BRBPP) have been well reported, but few studies address risk factors specific for children requiring surgical intervention. The intention of this study was to identify maternal, infant, and socioeconomic status (SES) risk factors and examine functional outcomes at a single center between 1999 and 2010.

**Methods:** A retrospective chart review was conducted to determine the nature of injury, type of procedure, and functional outcomes. Two hundred and eight infants were identified with BRBPP that presented for neurosurgical care as infants. Of those, 36 (17 percent) received neurosurgical intervention and had at least 9 months follow-up. Descriptive statistics and exploratory analysis were performed using SAS9.2.

**Results:** Patients undergoing surgery were more likely to have a history of grade II or III macrosomia (<4500 g) compared to those who did not undergo surgery ( $p=0.002$ ). Gender, race, insurance status, income markers, maternal age, gestational diabetes, shoulder dystocia, and use of vacuum/forceps at birth, were not different between the two groups. Of those undergoing surgery, 18 procedures were done to improve shoulder function and 35 procedures were done to improve elbow flexion. Of those with adequate initial and post-operative Mallet Scores, 9/14 (64 percent) improved in shoulder abduction and 13/20 (65 percent) improved in hand to mouth function ( $p=NS$ ).

**Conclusion:** Of the maternal, infant, and SES factors, only grade II or III macrosomia was associated with operative over non operative BRBPP. Surgical intervention appears to improve functional outcomes, but the natural history of unimproved non-operated infants in this population is unknown and challenging to analyze.

## 22. Functional Connectivity: Evaluation in Pediatric Brain Tumor Patients with and without Epilepsy

David Frederick Bauer, MD; Andrew Poliakov, PhD; Paritosh Khanna, MD; Gisele Ishak, MD; Edward Novotny, MD; Seth Friedman, MD; Dennis Shaw, MD; Samuel Browd, MD, PhD; Richard Ellenbogen, MD; Jeffrey Ojemann, MD (Seattle, WA)

**Introduction:** Functional connectivity MRI (fcMRI) is a way to evaluate cortical networks across different modalities such as motor, sensory, vision, and the default network using functional Magnetic Resonance Imaging. fcMRI relies on imaging the slow oscillation that occurs between connected regions about every 60 seconds. This oscillation can be seen at rest or with light anesthesia. We plan to evaluate these pathways in pediatric patients with brain tumors.

**Methods:** Patients were randomly selected from our tumor database. Inclusion criteria included age less than 18, history of brain tumor resection, and complete fcMRI data. Imaging was performed on a 3T Siemens Trio system. Data was acquired over approximately six minutes as part of a clinical imaging protocol.

**Results:** Fourteen patients were included in the study, eight female and six male. Tumor types include ganglioglioma (5), PXA (2), JPA (2), ependymoma (1), AA (1), GBM (2) and PNET (1). Seven patients had tumor associated epilepsy, and seven patients did not. In the patients with epilepsy, all had decreased or absent functional connectivity. The default network was diminished or absent in the patients affected by epilepsy. In the patients without epilepsy, functional connectivity was displaced but not decreased or absent. Motor and the default network were most likely displaced in patients without epilepsy.

**Conclusion:** fcMRI is a novel technique that may prove useful in presurgical planning by giving us insight into how tumors disrupt function. Functional connectivity was relatively preserved in the patients without epilepsy, but was disrupted or absent in the patients with epilepsy.

## 23. Spinal Cord Fiber Tractography and Surgical Decision Making: A New Tool's Role

Scott Daniel Wait, MD; Asim Choudhri, MD; Berkeley Bate, MD; Frederick Boop, MD (Phoenix, AZ)

**Introduction:** MRI diffusion tensor fiber tracking identifies white matter tracts in the brain. Recently, this technique has been applied to spinal cord pathology. The cord size, adjacent bone, and predominantly parallel direction of fiber tracts add imaging difficulty. We hypothesized that use of spinal cord tractography techniques assists in surgical planning and counseling.

**Methods:** Three patients with spinal cord pathology (2 intra axial tumors, 1 set of lumbosacral fused pyopagus twins) were evaluated with preoperative spinal cord tractography. Post processing was performed using manufacturer provided software, as well as the diffusion toolkit/tractvis software package. Intramedullary tumors were resected using a standard laminoplasty/midline myelotomy approach. The pyopagus twins were surgically divided and the neural tubes reconstructed.

**Results:** Two intramedullary tumors expanded the cord+/-cervicomedullary junction. Scanning was performed awake in a 14yo and under GETA in a 4yo. MRI on the pyopagus twins was performed under GETA. Spinal cord tractography was technically successful during all initial attempts and allowed preoperative identification of the motor tracts. In the case of pyopagus twins the motor tracts were crossed (twin A thoracic motor tracts terminated in twin B conus). In each case the anatomy of the motor tracts was used to counsel the patients/parents prior to surgery and specifically aided in surgical planning for the twin separation.

**Conclusion:** MRI software now permits visualization of the spinal cord pathways, even in young infants. This has proven useful in pre-operative planning and counseling for children with congenital and neoplastic abnormalities.

## 24. Climate Drives Hydrocephalus in East Africa

Steven J. Schiff, MD, PhD, FAANS; Sylvia Ranjeva; Tim Sauer, PhD; Benjamin Warf, MD (University Park, PA)

**Introduction:** Hydrocephalus occurs with estimates in sub-Saharan Africa of over 100,000 cases per year. The majority of infant hydrocephalus cases in East Africa appears to be postinfectious, related to preceding neonatal infections, and is thus preventable if the microbial origins and routes of infection can be characterized. Here we show that climate is an important factor in driving the infections that lead to postinfectious hydrocephalus.

**Methods:** In Uganda, almost all cases of infant hydrocephalus are treated at a single specialty hospital, where previous findings suggested seasonality in the microorganism spectrum from infants with postinfectious hydrocephalus (J Neurosurg Peds 7:73-87, 2011). The birthdates and dates of the infection and the operative intervention were determined for 696 consecutive children with postinfectious hydrocephalus treated over 5 years from 2001-2005. The address of each patient was associated with one of the 77 districts within Uganda. Satellite rainfall data were extracted for the same time period, and data from the 0.1o x 0.1o rainfall grid was averaged over each geographic district for each month. We performed a spatiotemporal analysis to determine whether the rainfall patterns were related to case data.

**Results:** Months with the greatest numbers of infections were associated with intermediate levels of rainfall. Four infection onset peaks straddled the twice yearly rainy seasons ( $p < 0.01$ ).

**Conclusion:** Given prior microbial analysis, these findings point to environmental factors as important with respect to preventing the newborn infections that lead to postinfectious hydrocephalus. Satellite climate data can reveal novel relationships between atmospheric dynamics and postinfectious neurosurgical diseases.

## 25. Impact of an Institutional Shunt Protocol on the Incidence of Ventricular Reservoir Infection in Preterm Infants

Dean A. Hertzler, MD; Heather Spader, MD; John Kestle, MD; Jay Riva Cambrin, MD (Salt Lake City, UT)

**Introduction:** Intraventricular hemorrhage in premature infants commonly leads to progressive ventricular dilatation and the need for ventricular reservoir placement. Prior research by Kestle et al demonstrated that implementation of a standardized protocol across the Hydrocephalus Clinical Research Network (HCRN) decreased infection rates in shunt surgery. Our study aims to ascertain if this protocol has had a parallel effect of diminishing the infection rate of ventricular reservoirs at our institution.

**Methods:** We conducted a retrospective cohort review of consecutive neonates with ventricular reservoirs inserted at Primary Children's Medical Center from June 2003 to June 2011. Medical records were reviewed for infection (culture proven or eroded hardware at 90 days), gestational age, weight, age at surgery, intrathecal antibiotics, revision, hemorrhage, return to OR, death and surgeon. Confounding factors such as sepsis, NEC, history of meningitis and number scrubbed were also analyzed and recorded.

**Results:** The sample's overall infection rate was 10.5 percent (11/105). Our institution used a pilot protocol in 2006-2007 and then the full HCRN protocol in 2007-2011. We found that the pre-protocol infection rate was 14.7 percent, 12.2 percent on the pilot protocol, and 5.4 percent using the HCRN protocol ( $p = 0.2$ ). Intrathecal antibiotics (a critical step in both protocols) were not associated with infection. Sepsis was not associated with infection, however, previous meningitis had a strong association ( $p < 0.001$ ).

**Conclusion:** At our institution, implementation of a standardized shunt protocol also decreased reservoir infections. While this was not statistically significant with our small sample size, we feel the clinical significance mandates further study.

## 26. Current CSF Tapping Criteria Do Not Reduce Neurological Deficits in Chronic Experimental Neonatal Hydrocephalus

Ramin Eskandari, MD; Melissa Packer, BS; Kelley Deren-Lloyd, MS; Osama Abdullah, MS; James (Pat) McAllister, PhD (Salt Lake City, UT)

**Introduction:** Without pathophysiological data guiding timing of neurosurgical intervention, premature neonates with hydrocephalus often receive delayed cerebrospinal fluid (CSF) drainage while awaiting maturation of other organ systems. Thus, we tested whether delaying CSF drainage would be associated with more cerebral damage.

**Methods:** Hydrocephalus was induced in 15-day old felines by intracisternal kaolin injections. Ventricular reservoirs were placed 7-8 (early,  $n=6$ ) or 15-16 (late,  $n=3$ ) days post-kaolin (dpk). Daily neurological assessments were performed until sacrifice 12 weeks post-reservoir (wpr). Reservoir taps were performed based exclusively on neurological deficit scores (NDS). Ventriculomegaly and white matter integrity were evaluated before reservoir placement and every 3 wpr with T2-weighted MRI and diffusion tensor imaging (DTI). Ventricular percentage (VP, ratio of ventricular volume to total intracranial volume) was calculated for all MRIs. Histology and immunocytochemistry were performed at 12-wpr.

**Results:** Ventriculomegaly remained moderate until 3-wpr in early animals, whereas late animals started with appreciably larger ventricles. Tapping failed to prevent progressive ventriculomegaly in either reservoir group; in both, ventricular volumes accelerated to severe levels at 9- and 12-wpr ( $<60\text{cm}^3$ ). NDS correlated with VP through 12-wpr ( $R^2=0.65$ ) in early group, but only up to 3-wpr ( $R^2=0.51$ ) in late treated animals. Internal capsule damage evaluated by DTI correlated strongly with ventricular percentage at 3-wpr ( $R^2=0.75$ ) in early treated but not in late-treated animals. Demyelination and apoptosis within the internal capsule were equally prominent in both treatment groups.

**Conclusion:** These results suggest a very short window of opportunity to prevent progressive ventriculomegaly, neurological deficits and irreversible damage.

## 27. Cerebrospinal Fluid Movement as Influenced by Respiration Using a Magnetic Resonance Spin Labeling Technique

J. Gordon McComb, MD, FAANS; Shinya Yamada, MD, PhD; Mitsue Miyazaki, PhD; Yuichi Yamashita, RT; Masao Nakahashi, BS; Seiko Shimizu, BS, RT; Ikuo Aoki, AS; Yukuo Morohashi, RT (Los Angeles, CA)

**Introduction:** Magnetic Resonance Imaging Cardiac gated phase contrast (PC) cine techniques have non-invasively shown the effect of the cardiac pulse on cerebrospinal fluid (CSF) movement. However, little is known about the effect of respiration on CSF movement.

**Methods:** To investigate the effect of respiration on CSF movement, we have developed a respiration-gated spin labeling balanced steady-state free precession (bSSFP) cine method. A respiration-gated non-contrast MRI spin labeling, time-spatial labeling inversion pulse (time-SLIP) with bSSFP cine was used to observe CSF movement in both the intracranial and intraspinal compartments in response to respirations in nine normal volunteers.

**Results:** CSF moved cephalad during inhalation and caudal during exhalation to a degree many times that noted with cardiac pulsation. Approximately 6 mL of CSF moved with each breath in the prepontine area. During breath-holding, a minimal amount of cephalad and caudal excursion of CSF was observed.

**Conclusion:** The time-SLIP bSSFP cine technique non-invasively allows visualization of CSF movement associated with respiration to a degree not previously reported.

## 28. Outcome of CSF Shunting in Children within a North American Multicenter Collaborative: Results from the Hydrocephalus Clinical Research Network (HCRN) Compared to Historical Controls

Abhaya Vivek Kulkarni, MD, FAANS, FRCS; Jay Riva Cambrin; Samuel Browd; James Drake; John Kestle; David Limbrick; Tamara Simon; Mandeep Tamber; John Wellons III; William Whitehead (Toronto, Canada)

**Introduction:** The HCRN, comprised of 7 North American pediatric neurosurgical centers, provides a unique multicenter assessment of the current outcomes of CSF shunting in unselected patients. We present the initial results in this cohort and compare it to historical data from prospective multicenter trials performed in the 1990s.

**Methods:** Analysis was restricted to patients with newly diagnosed hydrocephalus undergoing shunting for the first time. Detailed peri-operative data were collected prospectively and stored centrally from all HCRN centers between 2007 and 2010 by trained research coordinators. Historical control data was obtained from the Shunt Design Trial (1993-1995) and Endoscopic Shunt Insertion Trial (1996-1999). The primary outcome was time to first shunt failure using Cox regression survival analysis.

**Results:** The HCRN cohort ( $N=758$ ) was older than the historical cohort ( $N=720$ ) (mean age 2.5 years versus 1.6 years,  $p < 0.001$ ). The distribution of etiologies differed ( $p < 0.001$ , chi square), with more tumors and less myelomeningoceles in the HCRN cohort. The shunt survival estimates for the HCRN versus historical cohort were, respectively: 72 percent versus 62 percent (at 1 year), 64 percent versus 53 percent (2 years), and 60 percent versus 44 percent (3 years). The hazard ratio (HR) for shunt failure significantly favored the HCRN cohort, even after adjusting the model for the prognostic effects of age and etiology (adjusted HR=0.68, 95 percent confidence interval 0.57-0.82).

**Conclusion:** Our results provide high-quality data on the current outcome of shunting in general pediatric neurosurgery practice. Initial results suggest that these outcomes have improved compared to the 1990s, although some confounding effects remain unresolved.

### 29. Which Ventricular Measure is More Predictive of CSF Diversion in Premature Neonates with Grade III/IV Intraventricular Hemorrhage?

Christina Miekko Sayama, MD; Jay Riva Cambrin, MD; John Kestle, MD, MSc; Joanna Beachy, MD, PhD; Richard Holubkov, PhD (Salt Lake City, UT)

**Introduction:** Hydrocephalus develops in 35 percent of premature low-birth-weight infants with intraventricular hemorrhage (IVH) and is usually treated with a shunt/reservoir. To predict the need for shunt/reservoir placement in these babies, we assessed several radiologic parameters. The goal of this study was to determine whether the fronto occipital horn ratio (FOR), ventricular index (VI), biparietal diameter (BPD), or thalamo occipital distance (TOD) is the best predictor of the need for CSF diversion.

**Methods:** The above measures were recorded from CT/ultrasound imaging for a retrospective cohort of seventy-five preterm neonates with Grade III/IV IVH at Primary Children's Medical Center between 2003 and 2010.

**Results:** Prior to treatment decision, the mean FOR for those getting CSF diversion was 0.662 versus 0.465 for those without CSF diversion ( $p < 0.0001$ ). Similarly, the mean VI for those getting CSF diversion was 22.16 versus 16.31 for those without CSF diversion ( $p < 0.0001$ ) and the mean TOD was 3.87 versus 2.53 ( $p < 0.0001$ ). The mean BPD prior to treatment decision for those getting CSF diversion was 7.34 versus 6.95 for those without CSF diversion ( $p = 0.07$ ). The slope of measurements plotted over time indicated that FOR, VI and TOD change were predictive of treatment, but BPD change was not.

**Conclusion:** Overall, the three ventricular measurements (FOR, VI, and TOD) appear to predict CSF diversion, whereas BPD (which reflects head circumference) does not. These results imply that ventricular measurements should be used rather than OFC in future hydrocephalus studies.

### 30. Application of Diffusion Tensor Tractography in Pediatric Optic Glioma

Robert Lober, MD, PhD; Raphael Guzman, MD; Michael Edwards, MD; Kristen Yeom, MD (Stanford, CA)

**Introduction:** Magnetic resonance imaging (MRI) is commonly used in diagnosis and surveillance for optic pathway glioma (OPG). We investigated the role of diffusion tensor (DT) tractography in assessing the location of visual pathway fibers in the presence of tumor.

**Methods:** Data of ten children with OPG were acquired using a 3T MRI GRAPPA DT-EPI sequence (25 isotropic directions with b 1000s/mm<sup>2</sup>, slice thickness 3 mm). Fiber tractography was performed with seed regions placed within the optic chiasm and bilateral nerves on a coronal plane, including the tumor and surrounding normal-appearing tissue. Tracking was performed with a curvature threshold 30 degrees.

**Results:** OPG involved optic nerves (n=8) and/or optic chiasm (n=16). Of the 8 optic nerve lesions, fibers stopped abruptly at the tumor in 3 cases, diverged around it in 1 case, and traversed the tumor in 4 cases. Of the 16 chiasmatic lesions, fibers were untraceable in 2 cases, diverged around the tumor in 4 cases, and either entered or completely traversed the tumor in 10 cases. For each patient, DT tractography provided additional information about visual fiber arrangement in relationship to the tumor that was not evident by conventional MRI methods.

**Conclusion:** Optic pathway tractography is feasible in patients with OPG and provides new information about the arrangement of visual fibers in relationship to tumors that could be incorporated into surgical navigation for tumor biopsy or debulking.

### 31. Endoscopic Strip Craniectomy for Unilateral Coronal Synostosis: Superior Ophthalmologic Results Than Fronto-Orbital Advancement

Ning Lin, MD; Gary Rogers, MD, JD, MBA, MPH; John Meara, MD, MBA, FRACS; Mark Proctor, MD; Linda Dagi (Boston, MA)

**Introduction:** Unilateral coronal synostosis (UCS), known best for characteristic ipsilateral frontal plagiocephaly, is also associated with deformities of the facial structures and orbits. Strabismus and ocular torsion resulting from retro-positioning and rotation of the extra-ocular muscles generally persists and/or progresses despite fronto-orbital advancement (FOA) surgery. Endoscopic strip craniectomy (ESC) has been described as an alternative treatment for UCS in children under 3-6 months. In this abstract we describe the ophthalmologic outcome in children with UCS treated at our institution either by ESC or FOA.

**Methods:** Records of pediatric patients with UCS treated between 2004 and 2010 were retrospectively reviewed. Only patients with full early and late ophthalmologic evaluations were included. All surgeries were performed by the senior neurosurgeon, and incidence and severity of ophthalmologic abnormalities were assessed by the senior author.

**Results:** Of 43 children eligible for inclusion, 21 underwent endoscopic strip craniectomy and 22 had fronto-orbital advancement. Early evaluation demonstrated no difference in severity of strabismus or astigmatism between the two groups. The mean follow-up period was 23.5 months and 21.5 months for the ESC and FOA groups, respectively. Children treated with FOA were associated with more severe strabismus and higher incidence of amblyopia in delayed post-operative examination than those treated with ESC ( $p < 0.0001$ ). Strabismus surgery was required for 2/21 (9.5 percent) in the ESC group and 9/22 (40.9 percent) in the FOA group during the follow-up period (OR= 6.29).

**Conclusion:** Endoscopic strip craniectomy for UCS is associated with superior ophthalmologic results and marked reduction in subsequent need for eye surgery than fronto-orbital advancement.

### 32. Craniosynostosis: Developing Parameters for Diagnosis, Treatment, and Management

Mark R. Proctor, MD, FAANS; Stephen Warren, MD; Robert Keating, MD; Karin Muraszko, MD; Jeffrey Blount, MD, FAAP; Herbert Fuchs, MD, PhD; Ann Marie Flannery, MD; John Jane Sr, MD, PhD; Joseph McCarthy, MD (Boston, MA)

**Introduction:** Craniosynostosis is a relatively common congenital disorder, but the care and treatment of children with this disorder has never been standardized. A multidisciplinary meeting sponsored by the CDC was held in Atlanta, GA, entitled Craniosynostosis: Developing Parameters for Diagnosis, Treatment, and Management.

**Methods:** Fifty-two conference attendees representing a broad range of clinical expertise, including neurosurgery and fifteen other specialties, attended the conference. Sixteen professional societies and journals, including the Pediatric Section of the AANS/CNS and the ASPN, were represented. The current state of knowledge related to each discipline was reviewed. Based on literature review and expert clinical experience, participants developed recommendations in four multidisciplinary subspecialty groups to facilitate exchange and consensus across disciplines, and produced a draft document. The specialty-specific parameters of care documents were then presented to all conference attendees for approval, and combined into a final document.

**Results:** Consensus was reached among the 52 conference attendees and two post-hoc reviewers in 18 areas of craniosynostosis care. Longitudinal parameters of care were developed for the diagnosis, treatment, and management of craniosynostosis in each of the 18 specialty areas of care from prenatal evaluation to adulthood.

**Conclusion:** This is the first multidisciplinary, concerted effort to develop parameters of care for craniosynostosis. These parameters were designed to help: 1) facilitate the development of educational programs about craniosynostosis; 2) create a national database and registry to promote research, especially in the area of outcome studies; 3) improve credentialing of interdisciplinary craniofacial clinical teams; and 4) improve the availability of health insurance coverage for all individuals with craniosynostosis.

## 33. Use of Underplating Techniques for Fronto-Orbital Reconstruction in Craniosynostosis

Jennifer Gentry Savage, MD; Micam Tullous, MD; Patricia Mancuso, MD (San Antonio, TX)

**Introduction:** Advances in absorbable plating systems for craniofacial reconstruction allow surgeons the ability to create custom plating solutions for each patient. The authors describe novel techniques for cranial contouring utilizing unique plating constructs and fixation for correction of deformities related to craniosynostosis. In these techniques, plating materials are applied to the underside of the cranium allowing for several advantages over traditional plating techniques.

**Methods:** Patients aged 6 to 15 months underwent variations of frontal craniotomies, orbital osteotomies with orbital bar and forehead advancement and recontouring dependent upon the type of deformity. Frontal bone recontouring was performed utilizing a combination of partial and full thickness channel osteotomies. Fixation was primarily performed utilizing custom designed X plates and plates designed and cut intraoperatively for each individual. Plates were secured to the inner surface of the bones.

**Results:** Twenty-one patients underwent cranial remodeling utilizing the underplating techniques described. Forms of craniosynostosis treated include metopic, uni- and bi-lateral coronal synostosis. There were no apparent complications in this series of patients. Immediate correction of the deformity was achieved in all patients and all constructs maintained their original shape and position.

**Conclusion:** The underplating techniques described for fronto-orbital reconstruction provide firm, semi-rigid fixation as well as novel methods for cranial recontouring, in both young and older patients. By fixing the plates on the underside of the cranial construct, the cosmetic appearance is also improved while reducing the possibility of skin breakdown.

## 34. Bioabsorbable Fixation Systems in the Treatment of Pediatric Skull Deformities: Good Outcomes and Low Morbidity

Melanie Hayden, MD, MAS; Joslyn Iman Woodard; Robert Arrigo, BS; Herman Lorenz, MD; Stephen Schendel, MD; Michael Edwards, MD; Raphael Guzman, MD (Menlo Park, CA)

**Introduction:** Bioabsorbable fixation systems have been widely employed for use in pediatric patients for cranial reconstruction, obviating the complications of hardware migration and imaging artifact occurring with metallic implants. Recent concern over complications unique to bioabsorbable materials, such as inflammatory reaction and incomplete resorption, necessitates additional conclusive studies to further validate their use in pediatric craniofacial surgery. Likewise, long term follow-up in this clinical cohort has not previously been described.

**Methods:** We included consecutive pediatric patients under the age of two, from Lucile Packard Children's Hospital, who underwent cranial vault reconstruction with the use of Synthes bioabsorbable fixation system (RapidSorb) between 2003-2010. Hospital records were queried for patient characteristics, intra-operative data, and post-operative complications.

**Results:** Ninety-five patients with the following pre-operative pathology were analyzed: craniosynostosis (87), cloverleaf skull (5), frontonasal dysplasia (1), frontonasal encephalocele (2). Median age was six months. Average case duration was 204 min, with median 154 mL blood loss. Ninety-three percent of patients had 1-4 plates implanted with 48 percent receiving 3 plates. The median number of screws used was 59. The median length of hospital stay was four days with an average follow-up of 22 months (five post-operative visits). 94 percent of all cases had no complications. The complications related to hardware implantation included swelling (1 percent) and broken hardware (1 percent), the latter of which required reoperation.

**Conclusion:** The RapidSorb Bioabsorbable fixation system for cranial vault reconstruction in children less than two years of age is safe with tolerable morbidity rates.

## 35. Low Dose Craniofacial CT/ Rapid Access MRI Protocol in Craniosynostosis Patients: Decreased Radiation Exposure and Cost Savings

Raymond Harshbarger, MD; Patrick Combs, MD; David Leake, MD; Tim George, MD (Austin, TX)

**Introduction:** Craniosynostosis patients often receive CT scans to assist with diagnosis and treatment. Previous studies have discussed potential risks associated with ionizing radiation exposure in children. Our institution adopted a new protocol for radiologic examination of craniosynostosis patients utilizing a combination of low-dose CT and rapid acquisition MRI.

**Methods:** All craniosynostosis patients receive CT scans in the preoperative, immediate postoperative, and long term follow-up periods. The existing protocol included an average radiation dose of 26.1 mGray. CT scan dose was reduced while maintaining scan quality. Rapid acquisition (RA) MRI was used to rule out structural brain anomalies. To assess scan quality, specific bone and brain morphologic features were examined in 10 low-dose CT/RA MRI protocol scans and compared to a retrospective cohort of age matched craniosynostosis patients with traditional protocol CT scans. Three radiologists read these scans, blinded to radiation dose.

**Results:** Comparing specific parameters, low-dose CT/RA MRI scans were read as having similar bone/brain detail as traditional protocol. Radiation exposure was decreased 89 percent to 2.85mGy using the new protocol. There was a cost savings of \$1918 per scan compared to the old protocol.

**Conclusion:** CT scans performed in craniosynostosis patients carry an associated cost and inherent radiation exposure. Modification of a traditional craniofacial CT scan to a low-dose CT/RA MRI protocol decreased radiation exposure by 89 percent, with cost savings of 36 percent per scan. Comparison of new protocol to traditional scans yielded no notable differences in specific brain and bone structural criteria.

## 36. Subtotal Calvarial Remodelling for the Correction of Scaphocephaly: Aesthetic Outcomes and Pilot Study on Cerebral Perfusion.

Jothy Kandasamy, MBBS, BSc; Paul Sillifant; Ajay Sinha; David Richardson; Laura Parkes; Burn Sasha; Christian Duncan (Liverpool, United Kingdom)

Institution: Liverpool Supraregional Craniofacial Unit, Alderhey Children's NHS Foundation Trust, Liverpool, United Kingdom. +Imaging Sciences Research Group School of Cancer and Imaging Science, University of Manchester, United Kingdom

**Aim:** Present Liverpool Technique and Outcomes for the Correction of Scaphocephaly in Children older than 6 months with Pilot Study Cerebral Perfusion Data.

**Introduction:** Numerous surgical therapies have been utilized to manage scaphocephaly due to sagittal craniosynostosis. These include strip craniectomy and micro barrel staving to spring assisted cranioplasty, subtotal vault remodelling, and total calvarial vault remodelling. We present our technique of subtotal calvarial remodelling and the results and complications in the first 61 patients and recommendations for timing and indications for the technique. Pilot study data on ICP generated during the PI squeeze procedure and the effect surgery has on cerebral perfusion evaluated by MRI is discussed.

**Results:** Mean age = 17( 7 -5) months Mode age = 10 months Mean Cephalic index (preop) 66 (58-76) Mean Cephalic index (postop) 76 (68- 88) P<0.05 Mean FU (months) 13 (1-72 ). Only 6 patients had a relapse in the CI by <3 pts in followup period.

**Conclusion:** Subtotal calvarial remodelling addresses most of the features of scaphocephaly namely normalising cephalic index, correcting bitemporal pinching. frontal bossing and correcting the location of the vertex. This procedure avoids the risk associated with total vault remodelling to the posterior venous sinuses.



### 37. Non-Endoscopic, Minimally Invasive Calvarial Vault Remodeling Without Postoperative Helmeting for Sagittal Synostosis

Ian Mutchnick, MD (Cincinnati, OH); Todd A. Maugans, MD

**Introduction:** Minimally invasive techniques for the correction of sagittal synostosis (SS) have emphasized the use of endoscopy and postoperative helmeting.

**Methods:** A single institution cohort analysis was performed on eighteen infants treated for SS using a non-endoscopic, minimally invasive calvarial vault remodeling procedure without postoperative helmeting. The surgical technique is described. A retrospective analysis of a prospective database studied relevant clinical variables. Additionally, we present the results of a brief outcomes survey administered to patient caregivers.

**Results:** Eleven males and seven females, mean age 2.3 months were studied. Mean follow-up was 16.4 months. Mean procedural time was 111 minutes. Average length of stay was 2 days. Mean EBL was 79.4 cc. There were no deaths or intraoperative complications. The mean cephalic index (CI) was 69 preoperatively versus 79 postoperatively, a statistically significant difference ( $p < 0.0001$ ). One patient was helmeted for suboptimal surgical outcome and showed improvement at 2 months. No patient has undergone further surgery. 86 percent were pleased with the outcome, 92 percent were happy to have avoided helmeting, 72 percent were doubtful that helmeting would have provided more significant correction, and 86 percent were doubtful that further surgery would be necessary.

**Conclusion:** Our small series demonstrates the safety and efficacy of a non-endoscopic, non-helmeting procedure for SS, with outcomes commensurate to other techniques, and overall high family satisfaction.

### 38. Combined Chiari Decompression and Posterior Cranial Vault Remodeling for Cerebellar Tonsillar Herniation Associated with Craniosynostosis

David John Sacco, MD, FAANS (Dallas, TX)

**Introduction:** Chiari malformations are a frequent finding in patients with syndromic craniosynostosis, complex craniosynostosis, and lambdoid craniosynostosis. In an attempt to address these issues, a combined chiari decompression and posterior cranial vault remodeling (PCVR) was undertaken.

**Methods:** A retrospective chart review was undertaken to select patients operated on simultaneously by a craniofacial surgeon and a pediatric neurosurgeon for PCVR and a chiari malformation at the same setting through a coronal incision. The subtype of craniosynostosis and associated findings were noted.

**Results:** Seventeen patients underwent a combined PCVR and chiari decompression through a coronal incision at the same setting. The presenting pathologies were Apert's syndrome (7), Pfeiffer's syndrome (3), unilateral lambdoid craniosynostosis (3), Crouzon's syndrome (2) and nonsyndromic complex craniosynostosis (2). Associated findings were syrinx (5), central sleep apnea (2), hydrocephalus (1), and radiographic presence or progression (9). Bone was decompressed to the lateral edges of the foramen magnum. Cervical laminectomies were performed in eight patients. The dura was not opened. The radiographic appearance of the syringes improved or stabilized. The central sleep apnea improved. The hydrocephalus improved and has not required further treatment. One patient required a directed chiari decompression with duraplasty after the development of a new syrinx. Abnormal venous anatomy in the region of the posterior fossa is common and should be noted and preserved. There were no complications related to the procedure.

**Conclusion:** Chiari malformations are common in complex craniosynostosis and in patients with lambdoid suture fusion. A combined approach is safe and effective, and may prevent additional surgical interventions.

### 39. Open and Endoscopic Surgical Excision of Calvarial Dermoid and Epidermoid Cysts

Luigi Bassani, MD; Tracey Ma, BA; Omar Tanweer, MD; John Engler, MD; Robert Elliott, MD; David Harter, MD; Jeffrey Wisoff, MD

**Results:** Epidermoids and dermoids rank among the most common pediatric tumors. We analyzed the outcomes of surgical excision of dermal and epidermal inclusion cysts in a large consecutive series of children.

**Methods:** We retrospectively reviewed 128 consecutive children who underwent dermoid or epidermoid resections between 2000 and 2010 at NYU Medical Center. Data collected included demographic information, neurological exam, lesion location, lesion diameter, type of treatment, extent of resection, time of follow-up, and recurrent disease.

**Results:** The cohort includes 67 girls (52.3 percent) and 61 boys (47.7 percent). Age at diagnosis ranged from birth to 6.5 yrs (1.2  $\pm$  1.2) with surgical intervention between 1 month and 20 yrs of age (1.5  $\pm$  2.1). Of the 128 patients, 108 underwent open resection. Surgical approach was determined by the senior surgeon, however location and post-operative cosmesis was an important factor in this determination as there was a tendency toward endoscopic resection with supraorbital and glabellar lesions (75 percent endoscopic v. 8.5 percent open). Erosion of the outer table and involvement of the inner table was noted in 20 patients (15 percent). In fourteen of these, a split thickness calvarial graft used for reconstruction, with these noted to be significantly larger than lesions where cranioplasty was not used (1.9  $\pm$  2.81 v. 1.23  $\pm$  0.98, mean (cm)  $\pm$  SEM,  $p=0.022$ ). Gross total resection was achieved in all cases.

**Conclusion:** Complete removal and cure from dermoid and epidermoid scalp and calvarial lesions are possible. Complications are few. Endoscopic approaches are useful to improve cosmesis and limit tissue damage for lesions near the orbits.

### 40. Natural History of Scoliosis in Patients with Chiari I Malformation

Jennifer Mae Strahle, MD; Joseph Kapurch; Hugh J.L. Garton; Karin M. Muraszko; Cormac O. Maher (Ann Arbor, MI)

**Introduction:** Type 1 Chiari malformation (CM) and scoliosis are often linked by syringomyelia. A better understanding of this association may lead to improved treatment decisions.

**Methods:** We performed a retrospective review of 14,116 consecutive patients  $\geq$  18 years old who underwent brain or cervical spine MRI at the University of Michigan from 1997 to 2008. In 509 patients diagnosed with CM, we identified 114 patients with scoliosis (Cobb angle  $<$  10).

**Results:** Mean radiographic follow-up was 4.7 years. Scoliosis was the indication for initial MRI in 69 percent of patients. Seventy-nine (70 percent) were female, 77 (68 percent) were diagnosed with syrinx, 86 (75 percent) underwent Chiari decompression, 26 (23 percent) underwent spinal fusion, 21 had both operations and 23 had neither. Although there was no difference in greatest initial curve in patients with and without syrinx (33 vs 29,  $p=0.3$ ), 69 percent of those with syrinx had initial curves greater than 20 compared to 46 percent of those without syrinx ( $p<0.02$ ). 107 patients had follow-up imaging prior to surgery. Of 73 patients with syrinx in this population, 4 percent regressed, 88 percent remained stable and 8 percent progressed compared to 12 percent, 79 percent and 9 percent of patients without a syrinx, respectively ( $p=0.3$ ). There were no associations between initial tonsillar herniation, CSF flow, or age at Chiari diagnosis and scoliosis progression.

**Conclusion:** In patients with CM and scoliosis, those with syrinx are more likely to present with curves greater than 20, but no clear association exists between syrinx status and scoliosis progression. Tonsillar herniation does not appear to be correlated with scoliosis severity or progression.

#### 41. Intracranial Meningocele in the Pediatric Population

Subash Lohani, MD; Diana Rodriguez, MD; Hart Lidov, MD; R. Michael Scott, MD; Mark Proctor, MD (Boston, MA)

**Background:** Intracranial meningocele is a rare cystic lesion within the sacral canal. The etiology is poorly understood, but it appears to be an isolated intracranial extradural arachnoid cyst. When symptomatic it can cause pain or sacral nerve root dysfunction due to local compression. It is a rare phenomenon with all existing literature in the form of case reports, and this is the first case series.

**Methods:** This is a retrospective series from Children's Hospital Boston. All patients diagnosed with symptomatic or expanding intracranial meningocele that required surgical treatment between May 1994 and March 2011 were included. Spine MRI was the diagnostic modality of choice. All patients underwent ligation and obliteration of the cyst.

**Results:** There were 14 patients treated, 12M:2F. Average age was 7.45 years with age range of 5 months to 16 years. The most common presenting symptom was pain (5 patients), followed by urinary incontinence (4) and constipation (3). Three cysts were found incidentally in asymptomatic patients, but the cysts were expanding over time. Associated findings on MRI included tethered cord (5 patients) and spina bifida occulta (4). After surgery most patients had partial to complete symptomatic improvement.

**Conclusion:** Intracranial meningocele is a rare and likely congenital lesion resulting in an arachnoid diverticulum which herniates through the distal thecal sac. It presents in childhood either incidentally or with symptoms secondary to nerve root compression. Identification of the point of connection and ligation of the cyst provides cyst cure and resolution of symptoms in most patients.

#### 42. Infections of the Spinal Subdural Space in Children: A Series of Cases and Review of All Published Reports. A Multi-National Collaborative Effort

Adam Lance Sandler, MD; Dominic Thompson, MBBS, BSc, FRCS; James Goodrich, MD, PhD; Lawrence Daniels III, MD; Arundhati Biswas, MD; Mostafa El Khashab, MD, PhD; Farideh Nejat, MD; Jasper van Aalst, MD; Erwin Cornips, MD; Sandeep Monhinda, MD; Rahul Gupta; Reza Yassari, MD, MS; Rick Abbott, MD (Bronx, NY)

**Introduction:** Positioned anatomically between the spinal epidural space and the intramedullary compartment, the spinal subdural space remains the least common area of localized infection in the central nervous system. Infectious processes of the subdural spinal space include subdural spinal empyema (SSE), subdural spinal abscess (SSA), infected spinal subdural cyst (IdSC) and infectious spinal subdural cyst (IsSC). To date, there has been no systematic review of these entities in children.

**Methods:** International authors have collaborated on a series of twelve cases of spinal subdural infection. An exhaustive Medline search and manual review of the international literature was performed, identifying an additional sixty-one cases. Data of interest include age, sex, signs and symptoms at presentation, spinal location of infection, presence of spinal dysraphism and other comorbidities, offending organism, treatment, outcome, and follow-up.

**Results:** Patient's ages ranged from four months to twenty years. Spinal subdural infections occur twice as often in males (67 percent) as in females (33 percent). Spinal Dysraphisms were found in half of patients with subdural spinal infections, with dermal sinus tract being the most common dysraphism (91 percent) identified. Patients harboring spinal dysraphisms were most commonly infected by staphylococcus species, whereas M. tuberculosis (n=16) and E. granulosus (n=15) were the commonest pathogens to invade the subdural space in patients with normal, non-dysraphic spines.

**Conclusion:** Though rare, infection of the spinal subdural space is a neurosurgical emergency with the potential for significant morbidity. This study analyzes the various pathophysiologic, microbiologic, and demographic characteristics of these infections in children.

#### 43. The Importance of Evaluating for and Ruling Out a Chiari Malformation in All Patients with Scoliosis

Keyne K. Johnson, MD (Orlando, FL)

**Introduction:** Scoliosis is often associated with chiari malformations. The incidence of spinal cord or brainstem anomalies in the patient with idiopathic scoliosis ranges from 4 to 58 percent. Not only is it therefore important to look for these lesions to potentially prevent deformity correction surgery but also to prevent potential neurologic complications. It was recently published that the complication rate for scoliosis surgery in the pediatric population is 8.2 percent. With the advent of performing chiari decompressions without opening the dura the complication rate ranges from 0.3 to 4 percent. At our institution we have begun to routinely evaluate most of our scoliosis patients with MR imaging. Obtaining MR imaging on all patients with scoliosis has been a point of controversy specifically in those patient with the diagnosis of idiopathic scoliosis. Chiari malformations Type I have been shown to be a possible cause of scoliosis. The goal of the present study is to evaluate the effects of a chiari decompression on pediatric patients with scoliosis.

**Methods:** Patients with Chiari malformation Type I decompressions from 2006-2010 with or without scoliosis were retrospectively reviewed. Seventy-eight patients were identified, ranging in age from 12 months to 18 years. 10 patients were noted to have scoliosis with Cobb angles measuring 20° to 45°. All patients underwent a posterior fossa decompression with or without dural opening. Most patients who were found to have scoliosis had pre and postoperative measurements of the curve.

**Results:** All patients with scoliosis had improvement of their curve. Nine of the 10 scoliosis patients also had an associated syrinx, which also improved after surgery. None of the patients required further treatment of their scoliosis after Chiari decompression. Only 2 of the 10 patients had a dural opening.

**Conclusion:** This study shows the importance in the diagnosis of Chiari malformation Type I and syringomyelia in the patient with scoliosis. A chiari decompression alone not only prevents progression of the curve but also improves the severity of the curvature. This study also strongly suggests that a dural opening is not necessary to achieve improvement in both the scoliosis and syrinx.

#### 44. Decompression of Chiari I Malformation without Dural Patch Graft

Heather Stevens Spader, MD; Gerald Boxerman, MD; David Mandelbaum, MD; Craig Ebersson, MD; Jeff Rogg, MD; Petra Klinge, MD (Providence, RI)

**Objective:** To report a single center experience in the treatment of a consecutive series of patients diagnosed with Chiari I with and without syringomyelia.

**Methods:** Patients included in this study met clinical and radiological evidence of Chiari I malformation. Surgical technique consisted of a posterior fossa craniectomy with emphasis to widely open the foramen magnum to the level and exposure of both condyles, a C1 and, if necessary, C2 laminectomy. A straight dural opening was performed, the ectopic cerebellar tonsils were reduced using bipolar cauterization until the obex, fourth ventricle outlet, lateral cisterns, and the exit of the accessory nerve on both sides were fully exposed. Dural closure was performed without dural grafting.

**Results:** Seventeen patients (19 +/- 3 to 41 years) met the study criteria. Syringomyelia was present in seven cases. Two of these presented with progressive syringomyelia after initial decompression with dural graft. In three patients there was co-existing shunted hydrocephalus. Surgical and perioperative morbidity was low. One patient needed an external ventricular drain for hydrocephalus due to posterior fossa swelling. After follow-up of 6 months, full or significant reduction of the syrinx was seen on post-surgical MRI. Signs associated with Chiari I did disappear or improve in all but one patient. Associated headaches persisted in 3/15 (20 percent) patients despite improvement in CINE MRI.

**Conclusion:** The only reported series of Chiari I patients showing superior outcomes for Chiari I decompression without dural patch graft. This warrants multicenter efforts to prospectively address the most appropriate and efficient treatment of the Chiari I spectrum.

### 45. Closed Neural Tube Defects in Children with Multisystem Malformations and Caudal Regression Syndrome

Yasser Jeelani, MD; Gina Mosich, BS; Jenny Souster, MD; Alexander Tuchman, MD; Caleb Standafer, BA; Mark Krieger, MD; J. Gordon McComb, MD (Los Angeles, CA)

**Introduction:** Children born with caudal agenesis have varying forms of closed neural tube defects (cNTD) accompanying complex multisystem abnormalities. We reviewed our institutional experience in managing occult spinal dysraphism (OSD) in patients with progressive neurological symptoms.

**Methods:** Under an IRB-approved protocol, children who presented with congenital malformation syndromes & symptomatic OSD were identified. Five children with caudal agenesis associated with asymptomatic OSD discovered incidentally on imaging were excluded.

**Results:** Twenty-one children (8 female) meeting the above criteria were identified. Patients included ten cases of VACTERL, two cases of OEIS, one case each of Klippel Feil, Noonan's, Pallister Hall, Prune Belly, and Cytochrome C oxidase deficiency syndrome. Four children had miscellaneous congenital vertebral segmentation defects associated with various multisystem anomalies. Major presenting neurological symptoms were progressive motor loss in lower limbs (13), worsening of bladder function (5) & pain in lower extremities (2). Only one patient presented with a cutaneous marker in the form of a skin tag. Spinal lesions included lipomatous malformation of the cord (n=11), low lying conus with thickened filum terminale (n=12), thoracic meningoceles (n=4), and vertebral segmentation anomalies (n=10). Surgeries performed were tethered cord release (n=14), repair of meningocele (n=4), and myelotomy for syringomyelia (n=4). Mean age at surgery was 24 months (range: 14 days to 114m). There was only one instance of re-tethering.

**Conclusion:** Progressive weakness in the lower extremities and deterioration in bladder control were the most common neurological symptoms prompting surgical intervention. The relative absence of cutaneous markers in this patient population with cNTDs makes it imperative to evaluate children born with such congenital anomalies to undergo evaluation of the spine.

### 46. Regression of Symptomatic Hydrosyringomyelia after Non-Dural Opening for Chiari I Malformations

Elizabeth J. Fontana, MD; Neil Feldstein, MD; Richard Anderson, MD (New York, NY)

**Introduction:** Hydrosyringomyelia is present in 30-50 percent of children with Chiari I malformations (CMI). Hydrosyringomyelia is often an indication for surgery and may influence the surgeon's decision to perform duraplasty as part of a suboccipital decompression (SOC). SOC without dural opening is associated with less morbidity, but may delay resolution of hydrosyringomyelia. We sought to determine the rate of resolution in a group of children following SOC with non-dural opening for CMI.

**Methods:** We retrospectively reviewed 440 cases of CMI evaluated at Columbia University/Morgan Stanley Children's Hospital from 1998-2010. Age, sex, imaging studies, presenting and post-operative symptoms, and surgical intervention were reviewed.

**Results:** One hundred twenty-three patients were identified with hydrosyringomyelia; 60 underwent decompression without duraplasty. Post-operative imaging was available for 48 patients: 35 (73 percent) had initial radiographic improvement of their hydrosyringomyelia, 11 (23 percent) had no change, and two (4 percent) progressed despite surgery. The majority of patients showed radiographic improvement within one year of surgery, but eight (25 percent) did not show significant improvement until over two years post-operatively. Irrespective of imaging findings, 55 patients experienced sustained symptomatic improvement.

**Conclusion:** Our data suggest that SOC without dural opening leads to stabilization of hydrosyringomyelia in the majority of patients with CMI, but radiographic improvement may take longer when compared to duraplasty procedures. Regardless of the rate of syrinx resolution, children undergoing SOC without dural opening seem to have a similar rate of clinical improvement as children undergoing SOC with duraplasty.

### 47. A Sustainable Sheep Colony of NTD for Testing of Novel Therapies

Timothy M. George, MD, FAANS; Yohannes Asfaw, DVM (Austin, TX)

**Introduction:** We have established a sheep colony that exhibit a spectrum of caudal neural tube defects. The goal is to use this colony to study future therapeutic options in the treatment of these defects.

**Methods:** A colony of sheep has been strategically cross-bred for the last seven years. Multiple strains of rams with tail defects have been mated to a variety of ewe strains in order to build sustainability.

**Results:** There has been a consistent colony of sheep born with two forms of caudal defects each year. The first type, at a rate of approximately 12 percent per year, is the offspring with an open neural tube defects similar to myelomeningocele. Greater than 90 percent have hindbrain herniation and ventriculomegaly. The second, at a rate of approximately 20 percent per year, is the offspring with a variety of tail defects without any other associated anomalies.

**Conclusion:** Critical in the future treatment of neural tube defects is the establishment of appropriate animal models. A large animal colony of sheep may represent the best sustainable platform for testing novel therapies.

### 48. Meta-Analysis of Treatment Outcomes of Pediatric Intracranial and Spinal Ependymomas

Tene A. Cage, MD; Aaron Clark, MD; Derick Aranda; Nalin Gupta, MD, PhD; Kurtis Auguste, MD (San Francisco, CA)

**Introduction:** Ependymomas account for approximately ten percent of primary pediatric brain tumors. We investigated disease-free survival, overall mortality, and recurrence in a large study population of patients with WHO grade II and III ependymomas.

**Methods:** Results from peer-reviewed articles were used to analyze rates of morbidity, mortality, and recurrence. Treatment modalities include gross total resection (GTR), subtotal resection (STR), GTR plus radiation treatment (XRT), STR plus XRT, and XRT alone.

**Results:** Data from 749 children, 18 years or younger, with intracranial or spinal ependymomas were analyzed. Two hundred eighty-eight patients underwent GTR (169 had adjuvant XRT), 434 underwent STR (405 had adjuvant XRT), 27 underwent upfront radiotherapy. Average length of follow-up was 85.2 months. Two hundred thirty-five patients had disease recurrence, 34 suffered treatment-related morbidity, and 135 died. Outcomes were analyzed based on pathological grade, location, and treatment modality. Progression free survival was greatest for spinal (26 months) v. intracranial (20 months) ependymomas. There was no survival difference between supratentorial v. infratentorial location. STR plus XRT had the greatest progression free survival (30.4 mos). Radiotherapy alone portends the shortest progression free survival (10 months). Overall mortality is highest in supratentorial ependymomas (57.2 percent), WHO grade II tumors (33.3 percent), and those treated by STR +XRT (43.7 percent). Treatment associated morbidity is highest with supratentorial tumors (56.5 percent) and after GTR (36.4 percent).

**Conclusion:** Our findings contribute to predicting treatment outcomes of pediatric ependymomas. We study important aspects to consider when choosing the most appropriate treatment strategy for patients based on tumor pathology, location, and likely achievable extent of resection.

#### 49. Predicting the Clinical Behavior of Pilocytic Astrocytomas in Children: Utility of Magnetic Resonance Spectroscopy

Ryan Casserly; Yasser Jeelani, MD; Brian Lee, MD, PhD; Caleb Standafer, BA; J. McComb, MD; Stefan Bluml, PhD; Mark Krieger, MD (Los Angeles, CA)

**Introduction:** Despite generally favorable prognosis for children with pilocytic astrocytomas, outcomes are not always predictable. This study aims to establish the predictive value of magnetic resonance spectroscopy (MRS) in the clinical course of juvenile pilocytic astrocytoma (JPA; WHO Grade I).

**Methods:** Medical records from 40 patients (22 females) with histologically diagnosed JPA (Supratentorial 11; Infratentorial 29) and pre-treatment MRS scans were retrospectively analyzed under an IRB approved protocol. All spectra were acquired using single-voxel, short-echo point-resolved spectroscopy.

**Results:** Thirty-eight patients underwent surgical resection of tumor; 9 patients required multiple resections. Median age at diagnosis was 5 years (range: 1 month-16 years). Five patients received pre-resection chemotherapy with 1 patient also receiving radiation therapy. Ten patients received post-resection chemotherapy. No other patients received radiation therapy. All patients except one (n=37) were followed for at least 6 months post-operatively. Patients were categorized by outcome: (1) progressive or recurrent disease at most recent follow-up or deceased (n=5), and (2) stable residual tumor or no evidence of disease (n=35). MRS data were analyzed for absolute concentration and concentration relative to creatine (Cr) concentration. The following six metabolites were found to be significantly higher in patients with progressive disease compared to those with non-progressive disease: (glutamine+glutamate)/Cr, lactate/Cr, N acetyl aspartate/Cr, and choline/Cr ( $p < 0.01$ ); and citrate/Cr and LipMM13 ( $p < 0.05$ ).

**Conclusion:** Progressive JPAs may have a distinct metabolic profile when compared with stable residual tumor. This discernible property may allow better prognostication of JPAs and aid in planning postoperative management.

#### 50. Weight Profile in Children Following Endoscopic Endonasal Approach to Craniopharyngioma.

Kimberly Anne Foster, MD; Maria Koutourousiou; Matthew Tormenti; Nii Addo; Selma Witchel, MD; Carl Snyderman; Paul Gardner; Elizabeth Tyler Kabara (Pittsburgh, PA)

**Introduction:** With increasing use of the endoscopic endonasal approach (EEA) in the adult craniopharyngioma population, this surgical method is now employed to treat children.

**Methods:** We retrospectively examined our pediatric cohort with particular emphasis on weight profiles before and after resection.

**Results:** From July 2007 to present, 14 children underwent EEA for their histologically confirmed craniopharyngioma, with 10 children having this procedure as initial treatment (71.4 percent). Pre-operative imaging revealed all tumors to be suprasellar, with sellar (n=7, 50 percent), third ventricular (n=7, 50 percent) and retroclival (n=4, 28.6 percent) involvement. Preoperative tumor volume ranged from 1.49 to 45.10 cm<sup>3</sup> (mean 11.85 cm<sup>3</sup>). All children had postoperative imaging with MRI and extent of resection was classified as gross total resection (GTR, n=8) and near total resection (n=6). Two children underwent repeat EEA for recurrence, one required post-operative shunting and two underwent adjuvant stereotactic radiosurgery. There were no deaths. All children required some level of postoperative endocrine supplementation. Based on BMI for age calculations, no children experienced new onset obesity following surgery (0 percent). Five children were obese preoperatively (BMI <95 percentile) and remained as such postoperatively, three of these had prior treatment with open craniotomy. Two children were overweight (BMI 85 to 95 percentile) and remained as such postoperatively. One child was obese preoperatively but lost weight postoperatively. Six children had normal BMI-for-age preoperatively and did not experience significant weight gain.

**Conclusion:** EEA is a safe and effective surgical option for pediatric craniopharyngioma. In particular, it allows for visualization of hypothalamic structures and may help avoid postoperative central obesity.

#### 51. Brainstem Tumors in Children and Adolescents, a 30 Years Institutional Experience

Magda E. Garzon Tarazona, MD; Ofelia Cruz Martínez, MD, PhD; Marionna Suñol, MD; Antonio Guillén, PhD, MD; Jaume Mora, PhD, MD (Barcelona, Spain)

**Introduction:** Brainstem tumors (BsT) in children are a heterogeneous group of diseases. We analyze our experience to find out prognostic factors.

**Methods:** Retrospective study of patients with BsT between 1980-2010. Clinical variables, extension of surgery, pathology and adjuvant therapy were analyzed and correlated with outcome: overall survival (OS) and progression-free survival (PFS).

**Results:** We analyzed 59 BsT patients, 38 of them girls (64.4 percent). Median age of 8 years (13,9 m 18,2y). Eighteen patients (30.5 percent) had diffuse pontine gliomas (DIPG) and 41 (69.5 percent) presented focal brainstem gliomas. Histology was available in 36 patients; most frequent low-grade glioma in 21 patients (59.5 percent), usually pilocytic or low-grade-astrocytoma NOS. DIPG's patients were not biopsied, histology obtained at necropsy (HGG in 5 patients). Outcome related variables: histology (OS/PFS better for low-grade glioma,  $p < 0.001$ ), surgery (better if operated OS  $p=0.002$ ), and adjuvant therapy (worse if radiation or chemotherapy was given PFS  $p=0.006$ , OS  $p=0.001$ ). Results showed differences between DIPG (HGG, not operated, given adjuvant therapy,) and Focal gliomas (LGG, biopsy or partial surgery, minimal adjuvant therapy). Median time of follow-up of 49.3 months. 15/18 (83.3 percent) of DIPG have died, while 27/41 of Focal (65.85 percent) are alive. Outcome for DIPG was OS/EFS 12,7/8,7 months, while for Focal mesencephalic tumors OS/EFS was 115,2/82,8 months, exophytic 56,2/24,9 months, and for Cervico medullary tumors 89,1/43,3 months.

**Conclusion:** BsT in children comprise two different groups, Diffuse (DIPG) and Focal (intrinsic, exophytic or cervico medullary) gliomas. Focal tumors comprise low-grade gliomas, may be amenable to surgical procedures and share better prognosis with minimal adjuvant therapy. Diffuse Pontine gliomas have dismal prognosis and need new treatment.

#### 52. Age-Dependant Anatomic Variation in Pediatric Endonasal Endoscopic Skull Base Surgery

Jeffrey Peter Greenfield, MD, PhD; Prajwal Rajappa, MD; Theodore Schwartz, MD; George Chater-Cure, MD; Felipe Perez, MD; Linda Heier, MD (New York, NY)

**Introduction:** Endoscopic endonasal surgery is widely utilized to treat adult anterior skull base pathology. Knowledge gained through this experience is useful but not directly transferable to the pediatric population due to variable anatomy and pathology. No anatomic study directly addresses how to evaluate the anatomy of a child's sinuses and skull base for suitability of endoscopic endonasal approaches.

**Methods:** A retrospective review of 170 consecutive normal pediatric MRIs was evaluated for five different age ranges from 2 and 16 years. We measured grade of sinus pneumatization, width, length and volume of sphenoid, rare to sellar and rare to odontoid distances, maximal reachable distance of dens, inter-turbinate distance, inter-carotid distance, vomer to clival distance, transsphenoidal angle, and several other variables.

**Results:** Age-dependant anatomic details vary in a statistically significant fashion throughout the age continuum. These measurements are crucial in assessing the feasibility of varying approaches to the pediatric skull base. Of the variables measured, degree of pneumatization and inter-carotid width are among the most significant factors to allow a safe operative corridor.

**Conclusion:** Age is a crucial variable in assessing suitability of children for endoscopic endonasal approaches to the skull base. A bi-nostril corridor facilitates adequate bimanual working space through small nares. A working knowledge of these anatomic distances and spaces facilitates pre-operative planning and risk stratification when comparing against trans-cranial options. Prospective analysis of these criteria prior to surgery will be useful to study limitations and outcomes in this unique population.



### 53. Differences in VEGF Expression Correlate with Degree of Enhancement in Medulloblastoma

Shawn Level Hervey-Jumper, MD; Douglas Quint, MD; Patricia Robertson, MD; Cormac Maher, MD; Karin Muraszko, MD; Hugh Garton, MD, MPH (Ann Arbor, MI)

**Introduction:** In most cases medulloblastomas enhance on MRI with the administration of gadolinium contrast, however a minority do not. The use of VEGF R2 inhibitors for medulloblastoma has shown promising preclinical results. The goal of this study was to compare gadolinium enhancing to non-enhancing medulloblastomas to evaluate differences in vascular endothelial growth factor (VEGF) expression. Differences in surgical complication rates, outcome, and tumor histopathology were secondary outcome measures.

**Methods:** We retrospectively reviewed the records of children with medulloblastoma over an 18-year period. Tumor enhancement was graded as enhancing, partially enhancing, or non-enhancing based on greater than 50 percent tumor enhancement, less than 50 percent enhancement, or the complete absence of enhancement. Tumors were analyzed for VEGF-R2 expression by RT-PCR and immunofluorescence.

**Results:** Thirty-four (59 percent) were gadolinium enhancing and 24 (41 percent) partially or non-enhancing. Non-enhancing tumors showed significantly less VEGF-R expression by RT-PCR and Immunofluorescence ( $p < 0.005$ ). There was no difference in secondary outcome measures. All patients received chemotherapy and/or radiotherapy.

**Conclusion:** While medulloblastoma enhancement does not seem to affect patient risk, complications, or outcome, patients with non-enhancing tumors exhibit less VEGF-R2 expression. Medulloblastoma enhancement on MRI should be noted when considering the use of VEGF-R inhibition in children with medulloblastoma.

### 54. Angioarchitectural Determinants of Hemorrhagic Presentation in Children with Arteriovenous Malformations

Michael John Ellis, MD; Derek Armstrong, MD; Shobhan Vachhrajani, MD, FRCP; Abhaya Kulkarni, MD, PhD; Peter Dirks, MD, PhD; James Drake, MD, MBBCH, MSc; Edward Smith, MD; R. Scott, MD; Darren Orbach, MD, PhD (Toronto, Canada)

**Background:** To date, there have been few published studies examining the relationship between arteriovenous malformation (AVM) angioarchitecture and hemorrhagic presentation among children with cerebral AVMs. This study examines this relationship in this unique population.

**Methods:** A cohort of children with AVMs from the Hospital for Sick Children, Toronto, Canada and Children's Hospital Boston, Boston, MA, from 2000 to 2011 were included. Predictors studied included patient age, gender, and angioarchitectural features including AVM location, Spetzler-Martin grade, nidus size and morphology, presence of venous outflow lesions, and associated aneurysms. Predictors of hemorrhagic presentation were delineated using multivariable logistic regression.

**Results:** One hundred thirty-five children (70 male, mean age 10.1 years) were included. 86/135 (63.7 percent) children presented with hemorrhage, 18 (13.3 percent) with seizures, 17 (12.6 percent) with headaches or neurological deficits, and 14 (10.4 percent) were asymptomatic. AVM location, morphology, and the presence of associated aneurysm, venous ectasia, draining vein stenosis, and single draining vein were not significantly associated factors. After multivariate analysis, small AVM size (OR 0.57, 95 percent CI 0.43 0.77;  $P < 0.01$ ), exclusive deep venous drainage (OR 4.94, 95 percent CI 1.30 18.8;  $P = 0.02$ ), and infratentorial location (OR 9.94, 95 percent CI 1.71 51.76;  $P = 0.01$ ) were independently associated with hemorrhagic presentation.

**Conclusion:** Small AVM size, exclusive deep venous drainage, and infratentorial location are specific angioarchitectural factors independently associated with initial hemorrhagic presentation in children with AVMs.

### 55. Follow-Up Imaging of Surgically Treated Pediatric Arteriovenous Malformations

Shih-Shan Lang, MD; Joanna Ekstrom; Philip Storm, MD (Philadelphia, PA)

**Introduction:** The true post-operative residual arteriovenous malformation (AVM) incidence in the pediatric population remains largely unreported. Some literature suggests obtaining delayed imaging six months to one year after a negative post-operative angiogram. The aim of this study is to determine the best imaging modality and length of time for post-surgical resection follow-up in pediatric AVM patients.

**Methods:** A retrospective review was performed to include all pediatric patients treated surgically for AVM resection. Patients were followed radiographically with MRI/MRA or cerebral angiography at 3 months, 6 months, 1 year and 2 years or more post-surgical resection.

**Results:** A total of 28 patients (13 female, 15 male) underwent an AVM resection. Eighteen patients (64 percent) received an intra-operative angiogram during surgery. In two cases, the intra-operative angiogram revealed residual AVM and was re-resected immediately. There were five recurrences (18 percent) occurring at 3 months (1), 6 months (1) and 1 year (3).

**Conclusion:** Diagnostic angiography was the most sensitive technique in detecting both primary and recurring AVMs. AVM negative angiograms at 3-6 months had low sensitivity as evidenced by three patients with recurring AVMs at one year. AVM positive angiograms at 3-6 months had low specificity as supported by two patients with follow-up imaging over years showing no residual without surgical intervention. No patient with a normal angiogram at 1 year developed a recurrence on either a 5-year angiogram or an angiogram at 18 years of age. Our data suggest that the one year angiogram is crucial in detecting recurrence.

### 56. Postoperative Seizure Outcome in Children with Supratentorial Tumors

Courtenay Pettigrew; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BA; J. Gordon McComb, MD (Philadelphia, PA)

**Introduction:** Many reports have focused on seizure outcome in children with gangliogliomas and DNETs. Less data exist concerning seizure outcome in children presenting with supratentorial tumors of other histology.

**Methods:** Under an IRB approved protocol, we performed an institutional retrospective chart review of 39 patients with non-ganglioglioma /DNET supratentorial tumors presenting with seizures treated with surgical resection between 1990 and 2011. We analyzed seizure outcome across the following variables: preoperative duration of seizures, seizures type, seizure frequency, preoperative anti-epileptic drug requirements, tumor location, tumor histology, patient age, and extent of resection.

**Results:** Thirty-nine patients met the above criteria. Mean age at time of resection was 119 months (range 5-233). Mean preoperative seizure duration was 22 months (0-192). Seventeen (44 percent) had temporal lesions. Twenty-three (59 percent) had generalized seizure. Twenty-seven (69 percent) underwent gross total resection. Twenty-eight patients (76 percent) were seizure free at last follow-up (mean follow-up 36 months) or had only isolated seizures in the immediate postoperative period. In this data set, preoperative seizures duration less than or equal to 1 month was the only factor predictive of postoperative seizure control ( $p = 0.0071$ ).

**Conclusion:** While preoperative seizure duration was predictive of seizure outcome, extent of resection, type of preoperative seizure, tumor histology, location of lesion, and age at time of operation had no significant association with seizure control.

### 57. Chemotherapy Administration Directly into the Fourth Ventricle in a Non-Human Primate Model

David I. Sandberg, MD, FAANS; M. Melissa Peet, MA; Mark Johnson, MS; Phaedra Cole, DVM; Tulay Koru-Sengul, PhD; Ali Luqman, MD (Miami, FL)

**Introduction:** We developed a new non-human primate model to assess chemotherapy administration directly into the fourth ventricle as a potential treatment for malignant posterior fossa brain tumors.

**Methods:** Six rhesus monkeys underwent posterior fossa craniectomy and catheter insertion into the fourth ventricle. In Group I (n=3), intradural lumbar catheters were placed simultaneously. In two animals, methotrexate (0.5 milligrams) was infused into the fourth ventricle on five consecutive days. The experiment was aborted in the third animal due to a postoperative neurological deficit. In Group II (n=3), two animals received four cycles of intraventricular methotrexate over eight weeks. Each cycle included four consecutive daily methotrexate infusions. The third animal had wound breakdown and received three of four planned cycles. All animals underwent detailed neurological evaluations, MRI scans, pharmacokinetic analysis of methotrexate distribution, and post-mortem pathological analysis.

**Results:** Methotrexate infusions did not cause any new neurological deficits. MRI scans demonstrated accurate catheter placement without signal changes in the brainstem or cerebellum. Pathological analysis showed predominantly intraventricular and meningeal inflammation in four animals and two small focal areas of brainstem injury in one animal. Statistically significant differences between fourth ventricular and lumbar CSF area under the concentration time curve (AUC) were detected at peak time points (p=0.04). Serum methotrexate levels were undetectable or negligible.

**Conclusion:** Methotrexate can be infused into the fourth ventricle in non-human primates without clinical or radiographic evidence of injury. Inflammation and other pathological changes had no clinical correlate. Significantly higher peak methotrexate levels are observed in the fourth ventricle than in lumbar CSF.

### 58. Epilepsy Surgery Using 3-Tesla Intra-Operative MRI and Neuronavigation: The Montreal Children's Hospital Experience

Roy William Roland Dudley, MD; Jeffrey Atkinson, MD; Jose Montes, MD; Jean-Pierre Farmer, MD (Montreal, Canada)

**Introduction:** Modern epilepsy surgery focuses on tailored resections of specific epileptogenic foci, which require rigorous pre-operative imaging investigations. In recent years 3-Tesla MRI has become an invaluable tool in this regard. However, even the most meticulous preoperative delineation of an epileptogenic focus cannot perfectly guide the surgeon in the operative suite, as these imaging abnormalities often have the same appearance and texture as normal brain. Therefore, intra-operative MRI (iMRI) would seem a useful adjunct for epilepsy surgery. For the past two years at the Montreal Children's Hospital we have been using a 3-Tesla MRI based neuronavigation suite with iMRI capability for pediatric epilepsy surgery.

**Methods:** We conducted a chart review of all epilepsy cases performed using the 3-Tesla MRI operative suite to assess the impact of this technology.

**Results:** The 3-Tesla MRI suite was used for 24 epilepsy surgeries, accounting for 30.4 percent of all cases performed in this setting. An iMRI was performed in 19 of 24 (79.2 percent) cases. In 25 percent of the cases, further surgery was performed based on the iMRI results. Of 18 cases where an epileptogenic lesion was delineated pre-operatively, a complete resection was performed in 83 percent of these cases. The most common pathologies encountered were various epileptogenic tumours (41.7 percent) and focal cortical dysplasia (25 percent).

**Conclusion:** 3-Tesla MRI-based neuronavigation with iMRI has greatly assisted in tailored epilepsy surgery for our patients. Longer follow-up studies will be needed to assess if this translates into improved seizures outcomes.

### 59. MEG Contributes in the Surgical Management of Lesional Epilepsy

Jeffrey P. Blount, MD, FAAP, FAANS; Cody Smith, BS; Benjamin Ditty, MD; Curtis Rozzelle, MD (Birmingham, AL)

**Introduction:** Seizures that arise from a brain region where radiographic abnormality exists are considered lesional epilepsy. Developments in sophisticated imaging have expanded the definition of lesional epilepsy. Simple lesionectomy may lead to significant failure rates. As such the definition and approach to lesional epilepsy is evolving. The aim of this study was to evaluate the contribution of magnetoencephalography (MEG) imaging to surgical decision making in pediatric lesional epilepsy patients.

**Methods:** Following IRB approval we identified twenty-nine children with lesional epilepsy who underwent MEG as part of their pre-operative evaluation. There were 5 tumors (3 ganglioglioma, 1 DNT, 1 JPA), 8 MRI visible cortical dysplasias, 6 cases of gliosis/encephalomalacia and 4 tubers that co-localized with seizure onset.

**Results:** For lesional tumors (n=5) all had lesionectomy. Two had ictal spect (IS) and each co-localized with MEG. MEG was most useful in defining adjacent eloquent sensorimotor cortex. For MRI visible cortical dysplasias (n=8) MEG defined ictal onset zone (as defined by grid co-localization) in 6/8 cases. All but one patient was seizure-free at average follow-up of 2.4 years. All patients had SPECT and MEG co-localized 5/8 times. MEG was co-registered to frameless navigation for 5 cases and guided subdural electrode placement. MEG studies co-localized with epileptogenic tubers in 2/4 cases. All underwent grid based resections and 3/4 are seizure free. For epileptogenic regions of gliosis and encephalomalacia (n=7) MEG provided localization where other modalities failed.

**Conclusion:** MEG studies can significantly contribute to the assessment of lesional epilepsy in children.

### 60. Seizure Outcome After Anatomic and Functional Hemispherectomies in Pediatric Epilepsy Patients

Tsulee Chen, MD; Peter Madsen; Phillip Storm; Gregory Heuer (Philadelphia, PA)

**Introduction:** Anatomic hemispherectomy (AH) is associated with multiple post-operative complications which motivated surgeons to develop methods of disconnection achieving the same outcome. Functional hemispherectomy (FH) was founded on the principle of developing a procedure that provides the benefits of the original surgery with a decreased risk of post-operative complications.

**Methods:** Seventeen patients in this retrospective study had ages from 4 months to 13 years. Average duration of epilepsy was 3.6 years, with average length of follow-up of 30 months. Success of the procedure was measured by Engel class at last follow-up. Five patients had undergone previous resections prior to hemispherectomy.

**Results:** Fourteen of the 17 patients were Engel class I at follow-up. Five patients underwent FH versus 12 who underwent AH. All FH patients are seizure free. Two patients were Engel class IV. These two have the longest follow-up, suggesting that early data is promising, but long-term data is necessary to determine efficacy. One patient had dual pathology while the other had porencephaly. One patient died during the same hospital stay due to complications from hypotension.

**Conclusion:** While AH is a successful procedure to treat catastrophic epilepsy, it carries a risk of potential complications. Functional hemispherectomy can achieve the same result and should be a part of the treatment paradigm, however it is yet to be determined if this is etiology specific. Patients with prior surgical procedures remain good candidates for hemispherectomy.

### 61. Invasive Intracranial Monitoring and Resective Surgery for Insular Epilepsy in Children

Louis Crevier, MD; Alain Bouthillier, MD; Philippe Major, MD; Dang Nguyen, MD; Lionel Carmant, MD (Montreal, Canada)

**Introduction:** Failure to recognize insular seizures might explain some of the failures of epilepsy surgery. The deep anatomical location of the insular cortex and the dense Sylvian vascularisation explains why the insula is seldom a target for invasive studies and resective surgery. In this study, we sought to investigate the feasibility, safety, and efficacy of insular region epilepsy surgery in children.

**Methods:** A retrospective analysis of all children (< 18 y.o.) who underwent resective surgery involving the insula, with or without invasive intracranial studies, between 2002 and 2010 was performed.

**Results:** Four patients were included in the study. The mean age at surgery was 11.8 years (2.0-17.1) with a mean postoperative follow-up of 29 months (10-49). Three patients had subdural grids and direct microsurgical insular implantation followed by resective surgery. One patient underwent frontal operculectomy and anterosuperior insular resection without monitoring. Half the patients had transient hemiparesis that recovered over a few weeks. Lesions on histopathology included multifocal polymicrogyria, tuberous sclerosis, ischemic encephalomalacia, and Rasmussen's encephalitis. At their last follow-up, three patients were Engel class 1A and only one patient showed no improvement with surgery (Engel class IV).

**Conclusion:** In our experience, insular epilepsy surgery in children, with direct insular cortex implantation when necessary, is feasible and safe. Epilepsy outcome showed good results in the majority of our patients with no permanent complication.

### 62. Pediatric Experience with Insular Epilepsy Surgery

Sanjiv Bhatia, MD, FACS, FAANS; Ngoc Le, MD; John Ragheb, MD; Prasanna Jayakar, MD, PhD; Trevor Resnick, MD; Ian Miller, MD; Michael Duchowny, MD (Miami, FL)

**Introduction:** Medically refractory epilepsy due to insular onset is often difficult to diagnose and treat surgically. Seizure semiology in insular epilepsy can mimic frontal, temporal, or parietal lobe semiology, resulting in incomplete resections and poor seizure outcome.

**Methods:** Since May 2009, six children underwent insular resection. After a detailed initial workup five patients had extraoperative recording with subdural electrodes over cortical convexity and insular depth electrodes after wide transsylvian exposure of the insula; intraoperative ECoG was performed in one patient.

**Results:** Preoperative EEGs revealed widespread electrographic field across frontoparietotemporal opercular region. Four patients were MRI negative, one had frontal FCD and one an insular tuber. Insular abnormalities were seen on PET (1) and SPECT (3). Five patients showed frequent spikes arising from the insular electrodes. In addition to insular resection, all patients had cortical resections involving frontal (6) or temporal (2) opercular regions. Resection was complicated by ischemic stroke in one patient. Four patients were Engel class I, one Engel class III, and one Engel class IV at last follow-up (mean 8 months). Pathology revealed cortical dysplasia (3) and cortical tuber (1); two reports are pending.

**Conclusion:** Insular onset should be suspected in children who present with atypical semiology for suspected lobe of involvement, broad epileptogenic zone on scalp EEG involving opercular region, or abnormality in the insula on anatomic/functional neuroimaging. Depth electrodes implanted directly into the insula are useful to evaluate seizure activity. Resection with inclusion of insular cortex in carefully selected cases can be safe and effective.

### 63. Effectiveness of Vagal Nerve Simulators for Pediatric Epilepsy Patients

Ann Marie Flannery, MD, FACS, FAANS; Richard Bucholz, MD (Frontenac, MO)

Vagal Nerve stimulators (VNS) have been found effective in the treatment of medically refractory epilepsy. VNS have been implanted in pediatric patients since the late 1990s. We report on our pediatric patients and find efficacy, and safety, as well as long term benefit as demonstrated by end of generator life generator replacement in a substantial number of patients. We performed a retrospective review on 56 patients, and found data sufficient for report on 46 patients who have been followed for 8 months to 6 1/2 years, including 24 females, ranging in age from 3 to 18 years. 80 percent (37) of the patients were improved; 28 improved enough to have no or fewer seizures, and some were able to decrease or eliminate medications. 20 percent (9 patients) were able to achieve control with additional medications. Nine patients did not benefit from the VNS. There were 4 complications of hoarseness, 3 mild/temporary, 1 permanent, but no infections, and no wound complications. One patient required lead replacement. Notably, 9 patients had a second generator implanted at the end of generator life, demonstrating satisfaction with the treatment. Our review demonstrates outcomes comparable to other reported series for seizure control and low rate of complications. Our patient population demonstrated their satisfaction with the procedure by a high rate of generator replacement.

### 64. Post-Hemispherectomy Hydrocephalus in Children: Results of a Comprehensive, Multi-Institutional Review

Anne E. Matthews, PA-C; Adam Hartman; Yong D. Park; Anup D. Patel; Sean M. Lew (Milwaukee, WI)

**Introduction:** Hemispherectomy surgery for medically intractable epilepsy is known to cause hydrocephalus in a subset of patients. Identification of risk factors for hydrocephalus after hemispherectomy has been limited by the relatively small number of hemispherectomy cases performed by any single center. To identify these risk factors and better understand this phenomenon, a multi-institutional retrospective chart review was performed.

**Methods:** Fifteen pediatric epilepsy centers participated in this study. A retrospective chart review was performed on all available patients who had hemispherectomy surgery. Data collected included surgical techniques, etiology of seizures, prior resective brain surgery, symptoms and signs of hydrocephalus, timing of shunt placement and basic demographics.

**Results:** Pertinent data were collected on 736 patients who had hemispherectomy surgery between 1986 and 2011. Forty-seven patients had pre-existing hydrocephalus. Of the remaining 689 patients, 171 (24.8 percent) developed hydrocephalus during the postoperative period. Factors associated with postoperative hydrocephalus included anatomic hemispherectomy, resection of basal ganglia/thalamic tissue, and prior resective brain surgery. Factors that did not have significant impact on the development of hydrocephalus included the use of hemostatic agents, post-operative CSF drainage, and etiology of epilepsy. While the majority of patients established a need for shunting in the acute postoperative period, 51 patients (29.8 percent) were shunted more than 90 days after surgery.

**Conclusion:** Hydrocephalus is a common sequela of hemispherectomy surgery. Surgical technique and prior brain surgery influence the occurrence of post-hemispherectomy hydrocephalus. A significant portion of patients develop hydrocephalus on a delayed basis, indicating the need for long-term surveillance.

# 65. Bilateral High-Grade Intraventricular Hemorrhage is Associated with Male Sex, Younger Gestational Age and Lower Birth Weight, But Not Other Perinatal Factors

Ashley Grosvenor Tian, MD; Raphael G. Guzman; Susan R. Hintz; Ronald S. Cohen; Michael S.B. Edwards (Stanford, CA)

**Introduction:** High-grade intraventricular hemorrhage has been shown in many studies to be associated with younger and smaller premature infants. We were interested in other factors that may contribute to worse hemorrhage, such as sex, PPRM, placental abruption, placenta previa, advanced maternal age, chorioamnionitis, maternal diabetes or congenital anomalies.

**Methods:** A database of 310 premature infants with IVH (177 males and 133 females) was constructed with data from our institution from January 2005 to December 2009. Medical records were combed for birth weight, gestational age and perinatal factors (PPROM, placental abruption, placenta previa, advanced maternal age, chorioamnionitis, maternal diabetes or congenital anomalies). Statistical regression analysis on this data compared worse grade and bilateral grade to these factors.

**Results:** Statistical analysis showed that lower birth weights and male sex were associated with higher grade ( $p<0.001$ ) and bilateral hemorrhage ( $p<0.05$ ). Regression analysis showed that a lower gestational age ( $p<0.001$ ) or a bilateral hemorrhage ( $p<0.001$ ) also was associated with a higher grade of hemorrhage. Worse hemorrhage was not significantly associated with placental abruption, advanced maternal age, chorioamnionitis, maternal diabetes or congenital anomalies, but could be associated with PPRM ( $p<0.05$ ) or placenta previa ( $p,0.05$ ).

**Conclusion:** More severe hemorrhage is associated with lower birth weight male sex, younger gestational age, PPRM and placenta previa, but not with other perinatal factors. A larger cohort of children may be needed to further elucidate these characteristics.

# 66. Continuous Irrigation for Neuroendoscopy: A Modification of the Biomedicus Centrifugal Pump

Brandon Rocque, MD; Jordan Henry, RN, BSN; Taryn Bragg, MD; Bermans Iskandar, MD (Madison, WI)

**Introduction:** An important adjunct for successful intraventricular endoscopy is continuous irrigation, which allows better visualization by washing out blood and debris, improves navigation by expanding the ventricles and assists with tissue dissection. We present a novel method of irrigation delivery using a centrifugal pump designed for cardiac surgery.

**Methods:** The biomedicus centrifugal pump has the desirable ability to deliver a continuous laminar flow of fluid that excludes air from the system. We performed a series of modifications to the pump tubing, adapting it to neuroendoscopy. In vitro trials determined flow and pressure responses at various settings and simulated clinical conditions. The pump then was studied in vivo in 11 endoscopy cases and eventually utilized in <150 cases.

**Results:** Modifications of the pump tubing allowed for integration with different endoscopy systems. Flow of 0.1 L/min was achieved with and without surgical instruments through the working ports. In vitro trials showed that as intracranial pressure increases pump flow decreases, providing some safety against increased intracranial pressure. Intraoperative use was well tolerated with no permanent morbidity, and showed consistent flow rates during prolonged surgery, minimal air accumulation and seamless irrigation bag replacements. Two cases of transient bradycardia early in the series resolved upon assuring adequate CSF drainage, showing that the pump does not replace good ventricular outflow and sound surgical judgment.

**Conclusion:** We have modified a commonly available cardiac pump to provide continuous irrigation for intraventricular endoscopy. This system alleviates the problems of inconsistent flow rates, air in the irrigation lines and delays in changing irrigation bags.

# 67. Outcomes of Instrumented Fusion in the Pediatric Cervical Spine

Steven W. Hwang, MD; Loyola Gressot; William Whitehead; Daniel Curry; Robert Bollo, MD; Thomas Luerksen; Andrew Jea (Boston, MA)

**Introduction:** Adult studies have suggested improved outcomes with lower rates of instrumentation failure using screw constructs, however the pediatric literature is limited by small retrospective series.

**Methods:** A review was performed of the existing pediatric cervical spine arthrodesis literature. Eighty manuscripts with a total of 883 patients were included in the review with an additional 31 cases of our own series. Patients were grouped based on instrumentation type (screws vs wiring) and fusions bridging the occipitocervical junction or not.

**Results:** The entire series comprised 914 patients with a mean age of 8.30 years. Congenital abnormalities were encountered most often (55 percent) and patients had a mean follow-up of 32.5 months. From the entire cohort, 242 patients experienced post-surgical complications (26 percent) and 50 patients (5 percent) had multiple complications. The overall fusion rate was 94.4 percent. For occipitocervical fusions (N=285), both screw and wiring groups had very high fusion rates (99 percent and 95 percent respectively,  $p=0.08$ ). However, wiring was associated with a higher rate of complications. From a sample of 252 patients, 14 percent of those having undergone screw instrumentation encountered complications as compared to 50 percent of wiring patients. In cervical fusions not involving the occipitocervical junction (N=181), screw constructs had a 99 percent fusion rate whereas wire instrumentation only had an 83 percent fusion rate ( $p<0.05$ ). Similarly, patients having undergone screw fixation had a lower complication profile (15 percent) when compared to wiring constructs (54 percent,  $p<0.05$ ).

**Conclusion:** Our study outcomes suggest that instrumentation of the cervical spine in children may be safer and more efficacious using screw constructs rather than wiring techniques.

# 68. Prognostic Factors in Management of Primary Spinal Cord Astrocytoma in Children

Elizabeth Goodman; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BA; J. McComb, MD (Philadelphia, PA)

**Introduction:** Astrocytomas are the most common primary intramedullary spinal neoplasms in children. Scant data exists regarding prognostic factors and efficacy of treatment modalities.

**Methods:** This IRB approved study retrospectively reviewed 38 children with primary spinal astrocytomas presenting from June 1981 to June 2011. Multifactorial analyses examined the following factors: prognostic value on progression free survival: symptom type and duration; tumor location, size and grade; extent of resection; chemotherapy; and radiation.

**Results:** Tumors included 5 pilocytic astrocytomas, 20 low-grade astrocytomas, and 13 anaplastic astrocytomas. 14 patients received biopsy only, 17 underwent partial resection, and 7 had gross total resection. Median age at resection was 124 months (range 16-204). Median follow-up was 45 months (range 1-396). Sixteen children received chemotherapy. Twenty-two received radiation. Overall and progression-free survivals were 94.7 percent and 71.1 percent, respectively, at 6 months. Anaplastic astrocytomas and age over 7 years independently had significantly worse progression free survival ( $p = 0.003$ ,  $p = 0.008$ , respectively). Extent of resection showed benefit in low-grade tumors only ( $p = 0.048$ ).

**Conclusion:** Anaplastic histology and age over 7 were associated with worse progression free survival. Extent of resection was associated with increased progression free survival in low-grade tumors.



## 69. Degenerative Changes in Adolescent Spines: A Comparison of Motocross Racers and Age Matched Controls

David John Daniels, MD; Michelle Clarke, MD; Ross Puffer, BS; Fredric Meyer, MD; Nicholas Wetjen, MD (Rochester, MN)

**Introduction:** Motocross racing (MX) is a popular sport, however, its impact on growing/developing pediatric spine is unknown. Using a retrospective cohort model, we compare the degree of advanced degenerative changes in young MX racers to age-matched controls.

**Methods:** Patients between 12 and 17 years treated for MX injury between 2000 and 2007 with plain films or CT scans of any spinal region were included. Imaging was reviewed by three physicians; each spinal motion segment was evaluated for advanced degenerative abnormalities. Acute pathologic segments were excluded. Spine films from age-matched controls were similarly reviewed.

**Results:** The MX cohort consisted of 29 riders (mean age 14.7 years, 82 percent male); the control cohort consisted of 45 adolescents (mean age 14.3 years, 71 percent male). In the cervical spine, the MX cohort had 55 abnormalities in 174 motion segments (average 1.90/patient) compared with 20 abnormalities in 182 segments in the controls (average 0.65/patient;  $p=0.006$  using student t test). In the thoracic spine, the MX riders had 51 abnormalities in 267 motion segments (average 2.04/patient) compared with 25 abnormalities in 274 segments in the controls (average 1.00/patient;  $p=0.045$ ). In the lumbar spine, the MX cohort had 11 abnormalities in 123 motion segments (average 0.44/patient) compared with 15 abnormalities in 150 segments in the controls (average 0.50/patient;  $p=0.197$ ).

**Conclusion:** Increased advanced degenerative changes in the cervical and thoracic spine were identified in adolescent motocross racers compared to age-matched controls. The long-term consequences of these changes is unknown; however, athletes and parents need to be counseled accordingly about participation in motocross activities.

## 70. Retrospective Review of the Incidence of Facial Palsy in Treatment of Posterior Fossa Pediatric Tumors

Norianne M. Pimentel; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BS; J. McComb, MD (Monterey Park, CA)

**Introduction:** The study examines factors related to the incidence of postoperative facial weakness in children with posterior fossa tumors.

**Methods:** This dataset examined medical records for children diagnosed with infratentorial tumors between June 1, 1991, and June 14, 2011, treated at one institution. One-hundred-ninety-nine patient records (44.7 percent female) were retrospectively analyzed under an IRB approved protocol.

**Results:** Average age at surgery was 7.0±4.6 years old (range: 0 to 19.6 years). There were 99 pilocytic astrocytomas, 67 medulloblastomas, 23 ependymomas and 10 anaplastic ependymomas. Thirteen cases (6.5 percent) presented with facial weakness preoperatively, and 40 cases (20.1 percent) had a new postoperative facial weakness. Data showed that gender, preoperative symptom duration, histology, extent of resection, chemotherapy and radiation therapy had no significant prognostic value for postoperative facial weakness. There was a statistically significant ( $p<0.05$ ) relationship between craniotomy for recurrent disease and facial weakness. Only 24 of the 157 patients (15.3 percent) with only an initial surgery had postoperative facial weakness. However, 16 of the 42 individuals (38.1 percent) with surgery for recurrent tumor had postoperative facial weakness.

**Conclusion:** Analyses showed a statistically significant ( $p<0.05$ ) association between operation for tumor recurrence and new onset facial nerve weakness.

## 71. The Impact of Direct Vertebral Body Derotation on the Lumbar Prominence in Lenke 5c Curves

Steven W. Hwang, MD; Ornella Dubaz; Alex Rothkrug; Jeffrey Kimball; Amer Samdani (Boston, MA)

**Introduction:** With thoracolumbar/lumbar curves (lenke 5), the lumbar prominence can be disfiguring and often is associated with waist asymmetry that is cosmetically dissatisfying. Although direct vertebral body derotation (DVBD) has been shown to improve the thoracic rib hump, little is known of its impact on the lumbar spine.

**Methods:** A prospectively collected multicenter database was queried for pediatric patients with adolescent idiopathic scoliosis (AIS) and Lenke 5 curves treated with pedicle screw constructs. All patients with concurrent thoracoplasty procedures performed were excluded.

**Results:** The entire cohort of 34 patients had a mean age of 14.9±2.3 years, with the majority of patients being female (88 percent). All patients had Lenke 5C curves with a mean major curve of 46.0±8.7 degrees, which corrected to 13.7±7.2 degrees (70 percent correction). A mean of 10.8±3.0 levels were fused. Fifteen patients did not undergo DVBD and served as a control, whereas the remaining 19 had DVBD performed. Only thoracic kyphosis was significantly different between both groups, preoperatively. Similarly, post-operative radiographic parameters were comparable between both groups with equivalent percent correction. Although improvement in the thoracic rib hump was comparable between both groups, our DVBD group had 56.2 percent correction of the lumbar prominence, whereas the control group had 76 percent improvement ( $p<0.05$ ).

**Conclusion:** Although DVBD has been a valuable tool in the management of AIS, our results suggest that its application for thoracolumbar curves may be limited.

## 72. Surgical Treatment of Intractable Post-Traumatic Epilepsy in Children

Nathan Joseph Ranalli, MD; Usman Akhtar, BA; David Limbrick, MD, PhD; T.S. Park, MD; Matthew Smyth, MD (Saint Louis, MO)

**Introduction:** Seizures are a common complication of traumatic brain injury (TBI) in children, and post-traumatic epilepsy (PTE) is associated with a worse functional outcome for these patients. Pediatric PTE may be intractable to medical management and an analysis of the surgical interventions for this disorder has not yet been published. The goal of this study was to report on the characteristics and surgical outcomes for medically intractable PTE at a single academic children's hospital.

**Methods:** A retrospective review was performed of 15 patients (ages 2-17 years) who underwent surgical resections for PTE at the authors; institution over an 18-year period (1993-2010). Data including patient demographics, seizure types, magnetic resonance imaging (MRI) findings, electroencephalography (EEG) results, surgical approaches and postoperative outcomes, which were collected and analyzed.

**Results:** The mechanism of TBI was divided equally among the 15 children (9 males, 6 females) into motor vehicle collisions (MVC), falls and non-accidental trauma (NAT). Seizure types included simple and complex partial, generalized tonic clonic (GTC), absence, atonic and mixed. Focal electrographic abnormalities were demonstrated in 11 of 15 patients, and MRI findings included mesial temporal sclerosis as well as both uni- and bilateral encephalomalacia. The mean duration of epilepsy prior to surgery was 6.3±4.6 years. Approaches included functional hemispherotomy (5), corpus callosotomy (4 patients with diffuse EEG abnormalities), temporal lobectomy or selective amygdalohippocampectomy (SAH) (4) and lesionectomy (1). Twelve of fourteen patients achieved worthwhile improvement (Engel Class III or better), and 40 percent of the patients were seizure-free at the conclusion of the study (Engel Class I, mean follow-up 29 months).

**Conclusion:** Operative intervention guided by electrographic and radiologic findings can result in long-term seizure reduction and favorable outcomes in selected pediatric patients suffering from medically intractable post-traumatic epilepsy.

### 73. Shorter Stay and Similar Complication Rate with Limited Laminotomy for Selective Dorsal Rhizotomy; A Comparison Study

Sara Foppe, BS; Chevis Shannon, MBA, MPH, DrPH; Michael Falola, MD, MPH; John Wellons III, MD; Walter Oakes, MD (Birmingham, AL)

**Introduction:** Historically, selective dorsal rhizotomy (SDR) has utilized an extensive multilevel laminotomy technique. In recent years, limited laminotomy has been adopted to minimize exposure of the cauda equina. The purpose of this study was to compare traditional inpatient cost surrogate endpoints between procedures.

**Methods:** A retrospective review was conducted on 127 cerebral palsy patients who underwent SDR at a pediatric acute care facility between the years 1993 and 2011. Of the 127 patients, 72 (57 percent) underwent limited laminotomy, and 55 (43 percent) underwent extensive laminotomy. In addition to standard demographics and pre- and post-operative functional status, OR time, complication rates, ICU time and inpatient hospitalization time were examined.

**Results:** The mean age at operation was 4.3 years for the entire cohort, similar across both groups. No statistical difference was found when looking at preoperative or change in ambulatory status, OR time or complication rates between groups. Mean post-operative days spent in the ICU for limited and extensive laminotomy patients were 1 and 1.7, respectively ( $p = 0.001$ ). Mean hospital stay was 2.7 days for limited laminotomy and 4.4 days for extensive laminotomy ( $p = <0.001$ ).

**Conclusion:** A limited laminotomy for SDR leads to a shorter hospital stay and reduced amount of time in the ICU compared to extensive laminotomy in similar patients. OR time, complication rates, preoperative ambulatory status and change in ambulatory status were similar. This data will be useful in formal comparative cost analysis of the two procedures.

### 74. Excitotoxic Injury Causes NG-2 Cell Proliferation and Stress: Pathway to Neoplastic Glial Transformation?

David M. Frim, MD, FACS, FAANS; David Wright, PhD (Chicago, IL)

**Introduction:** NG-2 cells are a stem cell class precursor to glial cells such as astrocytes. Specific stimuli for NG-2 cell proliferation and differentiation are under investigation. We noted stimulation of NG-2 cell proliferation/migration in a rat model of neural injury that causes stress to NG-2 cells. This stressed state may increase NG-2 cell susceptibility to neoplastic transformation.

**Methods:** Rats underwent standard unilateral quinolinic acid lesioning of the striatum. Rats were sacrificed in time course; brains were harvested and immunostained for NG-2, PDGFR- $\alpha$  and hsp72. Lesion volumes were confirmed and measured by NeuN immunostaining.

**Results:** Large NG-2 cells (NG 2+ and PDGFR  $\alpha$ +) were noted to accumulate in high numbers in the striatum 1.5 to 7 days post lesioning with a peak at 3 days. These cells also were hsp72+, indicating a state of cellular stress. NG-2+ cells were seen only sparsely in the contralateral non-lesioned striatum.

**Conclusion:** NG-2 cells either proliferate or migrate in high numbers into an excitotoxic lesion marked by neuronal death. During this phase of proliferation/migration, the cells elaborate markers of metabolic stress. We hypothesize that this state predisposes the NG-2 cells to mutational injury. If so, these observations describe a mechanism by which neural injury in an environment of metabolic stress may underlie glial precursor transformation into glioma.

### 75. Use of Shared Medical Appointment Clinics for Common Pediatric Neurosurgical Conditions

Ann-Christine Duhaime, MD, FAANS; Sharon Haire, RN, MSN, PNP (Boston, MA)

**Introduction:** Shared medical appointments involve a combination of a brief individual assessment along with a group educational and question and answer session for those conditions in which a significant portion of the interaction is informational. We recently instituted this paradigm for infants referred for abnormal head shapes and for youth concussions. We report our experience with implementing this type of clinic.

**Methods:** In the past year, we began a Head Shapes Shared Medical Appointment Clinic for infants referred mostly for positional molding. We modeled this on a clinic run by the Plastic Surgery Department at another institution which had a high patient satisfaction rating. Because of success with this model, in response to a state mandate for concussion evaluation, we organized a multidisciplinary Shared Medical Appointment clinic for youth concussions.

**Results:** The Head Shapes Clinic was relatively simple to organize and implement, and to date, surveys suggest high patient and referrer satisfaction, while improving efficiency of our clinics overall. The Youth Concussion Clinic effort involved many more specialties and required approximately six months of meetings to organize, in part because of different opinions on appropriate counseling and management strategies among specialties involved. However, this clinic also was felt to improve efficiency and patient throughput for this common referral condition, and minimizes multiple repetition of the same material for individual patients. The clinic is modeled to be revenue neutral.

**Conclusion:** Shared medical appointment clinics can improve efficiency and reduce waiting time for common, homogeneous conditions for which a large portion of the interaction involves imparting common educational information.

### 76. Treatment Trends and Overall Outcomes in Pediatric Arteriovenous Malformations

Melanie Hayden, MD, MAS; Robert Arrigo, BS; Maxwell Boakye, MD; Michael Edwards, MD; Raphael Guzman, MD (Stanford, CA)

**Introduction:** The low incidence of pediatric arteriovenous malformations (AVMs) limits our ability to counsel patients on the associated risk of intervention. National databases that compile data on medical outcomes allows for this assessment. Likewise, we can use this pooled data to determine national treatment trends.

**Methods:** The Kids Inpatient Database (KID) was queried over 2000/2003/2006 for a primary diagnosis of brain arteriovenous malformation (747.81). Treatment groups (via ICD 9 code) were divided into surgery, endovascular surgery, radiosurgery and diagnostic only or unknown. Fields to be queried were pre-determined.

**Results:** The national estimate of pediatric AVM inpatient admissions per year was 833. Ninety-four percent of cases were in urban, teaching hospitals. Females comprised 48 percent. Treatment trends from 2000 to 2006 were significant for a decrease in radiosurgery (6 percent to 2 percent), a decrease in surgical intervention (37 percent to 29 percent) and an increase in endovascular procedures (22 percent to 39 percent). Overall death rate was 1.9 percent, with a general morbidity rate of 8 percent. Neurologic complications occurred at a rate of 3 percent. Surgery had lower death rates (0.5 percent) compared to endovascular (1.6 percent), but an overall higher complication rate (9.5 percent vs. 8.4 percent) and rate of non routine discharge (12 percent vs. 8.7 percent). Overall length of stay was 5.5 days (7.9 for surgery vs. 4.7 for endovascular).

**Conclusion:** Treatment trends for pediatric AVMs have shown an increased use of endovascular techniques, with a resulting decrease in open surgical procedures. Our descriptive study is useful for practitioners to counsel their patients regarding national outcomes and general treatment trends.

## ORAL ABSTRACTS

### 77. Progression of Moyamoya Arteriopathy Discovered in Asymptomatic Pediatric Syndromic Populations

Lissa Catherine Baird, MD; Ning Lin, MD; Kimberly Kopecky, BS; R. Scott, MD; Edward Smith, MD (Boston, MA)

**Introduction:** Limited data exists to guide management of incidentally discovered pediatric moyamoya. We present our experience in patients diagnosed during routine surveillance of the cerebral vasculature in the setting of unilateral moyamoya, sickle cell disease (SCD), and neurofibromatosis type I (NF1) to better characterize the natural history of radiographic and clinical progression in asymptomatic moyamoya.

**Methods:** Retrospective review of 418 consecutive patients who underwent surgical revascularization for moyamoya disease at Children's Hospital, Boston, from 1988 to 2010.

**Results:** 83 patients were asymptomatic at the time of radiographic diagnosis of moyamoya, while also having a history of unilateral disease or an associated diagnosis of SCD or NF1. Mean follow-up was 5.4 years, with 45 (54 percent) patients demonstrating radiographic progression and 37 (44.6 percent) patients developing symptoms within this period. The time interval between diagnosis of syndromic or unilateral disease to radiographic evidence of arteriopathy, slow cortical blood flow and stroke was 5.8 (sd 4.7) years, 0.7 (sd 1.1) years and 0.3 (sd 0.5) years, respectively. SCD patients had the highest incidence of both radiographic (n=15, 75 percent) and clinical (n=13, 65 percent) progression, followed by NF1 (n=20, 59 percent radiographic progression, n=15, 44 percent clinical progression) and unilateral patients (n=10, 34.5 percent radiographic progression, n=9, 31 percent clinical progression).

**Conclusion:** Radiographic progression occurred in the majority of asymptomatic patients and generally heralded subsequent clinical symptoms. SCD or NF patients with asymptomatic moyamoya are more likely to progress than unilateral moyamoya patients without syndromic disease. This data demonstrates that moyamoya is a progressive disorder in asymptomatic populations and supports the rationale of early surgical intervention to minimize morbidity from stroke.

### 78. Cerebral Angiography in the Infant Population: Procedure Related Morbidity

Caitlin Elizabeth Hoffman, MD; Mark Souweidane, MD; Y. Pierre Gobin, MD; Lauren Rotman, BA; Alejandro Santillan, MD (New York, NY)

**Introduction:** The indication for cerebral angiography (CA) in infants is growing in pediatric vascular malformations, stroke, and neuro oncology (intra arterial (IA) chemotherapy and pre-surgical embolization). Presumed higher morbidity, however, limits its use in young children. We aim to evaluate the morbidity of CA in infants to improve accurate counseling and to identify modifiable risk factors.

**Methods:** Data was collected from 309 consecutive cerebral angiograms in 87 infants at a single institution from 2004 to 2010. Demographics, diagnosis, angiographic findings and complications were reviewed.

**Results:** Our patient population included 40 boys and 47 girls with a mean age of 14.36 months (range 1 to 36 months). Chemotherapy was administered in 292 procedures; the remainder were for vascular malformations (8), stroke assessment (4), tumor embolization (2) and spontaneous intracranial hemorrhage (3). The neurologic complication rate was 0.0 percent. The non-neurologic complication rate was 2.5 percent: 7 contrast allergies and 1 groin hematoma. The radiographic complication rate was 1.2 percent: 1 asymptomatic intra-arterial dissection and 3 asymptomatic vasospasms. Post-procedural MRI was performed in 33.3 percent of cases with no evidence of ischemia. There was no delayed lower extremity morbidity. Mean follow-up was 16.59 months. There was no association between morbidity, age, length of sedation, number of vessels catheterized or emergent procedure.

**Conclusion:** The morbidity of cerebral angiography in infants is not increased compared to currently reported morbidity rates in adults and older children.

### 79. Non-Invasive Autoregulation Monitoring with Near-Infrared Spectroscopy (NIRS) During Surgical Revascularization for Moyamoya Disease

Edward S. Ahn, MD; Lori Jordan, MD, PhD; Abby Larson, BS; Jessica Jamrogowicz, BS; Jennifer Lee, MD (Baltimore, MD)

**Introduction:** Blood pressure limits that support cerebrovascular autoregulation are unknown in children with moyamoya disease. Identifying an optimal range of blood pressure is crucial to minimize the risk of peri-operative cerebral ischemia. We present a novel method of non-invasively monitoring autoregulation with indices derived from near-infrared spectroscopy (NIRS) in children undergoing surgical revascularization for moyamoya disease.

**Methods:** In an observational study, pediatric patients undergoing operations for revascularization were monitored. Non-invasive, cerebral oximetry sensors were applied to their foreheads, and autoregulation monitoring was established throughout the operation and 24 hours post-operatively. Cerebral blood flow autoregulation and cerebral vasoreactivity were continuously assessed using the cerebral oximetry (COx) and hemoglobin volume (HVx) indices. Clinicians were blinded to these autoregulation values. Patients were followed for 30 days post-operatively and monitored for ischemic events.

**Results:** Five patients (age 2-16 years, all females) were monitored during seven operations. The autoregulation indices successfully identified optimal ranges of blood pressure where autoregulatory function was most robust in all patients. Two patients with unilateral disease demonstrated worse autoregulation on the affected versus contralateral side during intraoperative monitoring. One patient had several transient ischemic attacks between four and nine days post-operatively. This patient spent a greater percentage of time at blood pressures associated with impaired autoregulation intra-operatively. There were no permanent neurological deficits post-operatively, nor complications with autoregulation monitoring.

**Conclusion:** Non-invasive NIRS derived autoregulation indices may be clinically useful tools to identify optimal blood pressure goals intra-operatively and post-operatively in pediatric patients undergoing surgery for moyamoya disease.

### 80. Increased Risk of Hemorrhage in Pediatric Patients with Arteriovenous Malformations and Associated Aneurysms: A Trend

Kevin Z. J. Chao, MD; Arjun Pendharkar; Raphael Guzman; Michael Edwards (Stanford, CA)

**Introduction:** Approximately 15 percent of all patients with AVMs have an associated aneurysm (AA). The risk of hemorrhage is reportedly 7 percent, higher than the 3 percent risk for patients with AVMs alone. The risk in AVMs with intranidal aneurysms is even higher at 9.8 percent per year. AVMs with AAs have not been clearly described in children, nor has the added risk of having an AA been quantified.

**Methods:** We performed a retrospective chart and film review of 120 pediatric patients with AVMs and identified 16 with AAs. Fisher exact test was applied to determine the risk of hemorrhage in patients with AAs compared to those without.

**Results:** The patients were aged 4 to 17 years (mean=11.3 years). Twelve of 16 patients presented with hemorrhage. Nine intranidal aneurysms were identified; eight of these presented with hemorrhage and one died from delayed re-hemorrhage. Seven feeding artery aneurysms were identified; four of these presented with hemorrhage, and one had delayed hemorrhage after embolization. All patients were treated with multimodality therapy comprising of embolization, stereotactic radiosurgery, and microsurgery. Compared to pediatric patients with AVMs alone, those with associated aneurysms are 2.474 times more likely to present with hemorrhage (p=0.176, 95 percent CI=0.7481 8.180).

**Conclusion:** Children can have coexistent aneurysms and AVMs. In our series, a larger proportion of these patients presented with hemorrhage than in those with AVMs alone. In some, the aneurysm was identified as the source of bleeding. There is a trend toward increased bleeding risk for pediatric patients with AVMs and AAs compared to those without AAs.

## 81. Peritoneal Catheter Exchange Using a Modified Seldinger Technique

Jennifer Gentry Savage, MD; Micam Tullous, MD; Patricia Mancuso, MD; Kimberly Terry, MD (San Antonio, TX)

**Introduction:** The Seldinger technique, or modifications thereof, has been utilized for vascular catheter, pleural and peritoneal drain placement, and recently for cerebral ventricular catheter replacement in patients with multi-loculated hydrocephalus. The authors now describe the use of this technique for replacement of peritoneal catheters during the process of ventriculoperitoneal shunt revision.

**Methods:** Seventy-three patients underwent distal ventriculoperitoneal shunt revision using this technique. After identification and opening of the peritoneal catheter in the abdominal subcutaneous tissue, a J-wire was inserted into the distal end of the catheter under fluoroscopic guidance. The old catheter was removed over the wire and replaced with a new peritoneal catheter, with the assistance of a vein retractor and a peel away introducer.

**Results:** The authors report successful replacement of peritoneal catheters in distal ventriculoperitoneal shunt malfunctions with a 1.3 percent complication rate. Only one patient experienced an infection requiring treatment with intravenous antibiotics and recovered without further incident.

**Conclusion:** The modified Seldinger technique provides a safe and convenient method for replacement of peritoneal catheters with low risk of complication. This technique also appears to be very beneficial in facilitating catheter replacement in obese individuals and in patients with limited access secondary to multiple abdominal adhesions.

## 82. CSF Pulsations in Shunt Systems: Implications for Overdrainage and New Valve Design

Wendell Lake, MD; David Hsu, MD; Taryn Bragg, MD; Bermans Iskandar, MD (Fitchburg, WI)

CSF overdrainage in shunt systems traditionally has been attributed to gravitational effects related to patient position and the resulting siphoning phenomenon. Overdrainage in chronic hydrocephalus patients is of particular concern because it has been implicated in slit ventricle syndrome and frequent shunt malfunctions. Positional effects on CSF overdrainage have been studied extensively in CSF shunting systems, and several medical devices, such as commercially available valves and anti-siphon devices, specifically address positional CSF overdrainage. Based on preliminary data from mathematical modeling and bench testing, we propose that intracranial pressure pulsations may be another source of chronic overdrainage in CSF shunts, a phenomenon that may have significant implications on both shunt valve function as well as CSF flow dynamics within the shunt system. Specifically, CSF pulsations may lead to a pumping effect that causes CSF overdrainage independently from positional effects such as siphoning. We propose a novel valve system that dampens CSF pulsations in the shunt system via the use of a recurrent flow loop. This system has been modeled mathematically and with preliminary bench testing. An improved understanding of CSF flow dynamics in shunt systems may lead to better shunt valve design and improved hydrocephalus treatment.

## 83. Does Optic Nerve Sheath Diameter on MRI Decrease with Improved Pediatric Hydrocephalus?

Ashutosh Singhal, MD, FRCSC, FAANS; Michael Yang, HBSc, MBIotech; D. Douglas Cochrane, MD, FRCSC (Vancouver, Canada)

**Introduction:** It is widely recognized that serial change in ventricular size is an imperfect indicator of ongoing hydrocephalus in a child. It is possible that other radiographic features might be useful in assisting in the determination of success of hydrocephalus interventions. In this study, the optic nerve sheath diameter (ONSD) is assessed as an indicator of hydrocephalus in children who have undergone endoscopic third ventriculostomy (ETV) or posterior fossa tumor resection.

**Method:** Thirty-seven children underwent ETV or posterior fossa tumor resection for the treatment of clinically and radiologically confirmed hydrocephalus. T2-weighted axial MR images of the orbit were obtained, and the ONSD was measured just behind the optic globe pre- and post-surgical intervention. Evidence of optic disk bulging and optic nerve tortuosity also were assessed.

**Results:** There was significant reduction in the ONSD post ETV (n=19) and posterior fossa tumor resection surgery (n=18). The average pre-operative ONSD was 6.42 mm versus 5.73 mm, post-operatively (p<0.0001, paired t-test). There also was a 90 percent (p<0.0001, chi square) and 61 percent (p=0.005, chi square) reduction in optic bulging and tortuosity, respectively, after surgery. The magnitude of ONSD reduction was similar in both ETV and tumor resection group. After intervention, all 37 patients showed improvement in signs and symptoms of hydrocephalus.

**Conclusion:** The ONSD appears to diminish, in response to measures to reduce hydrocephalus. Findings such as optic bulging and tortuosity also appear to resolve. It may be that serial ONSD is a clinically relevant measure in determining improvement in hydrocephalus after a variety of pediatric neurosurgical interventions.

## 84. Generation of Normative Pediatric Skull Models for Use in Cranio-Orbital Remodeling Procedures

Nikoo Saber, PhD; John Phillips, MD; Thomas Looi, MSc, MBA; Peter Kim, MD, PhD; James Drake, MD, PhD (Toronto, Canada)

**Introduction:** The purpose of this study is to generate a library of normative paediatric skull models for use in craniofacial surgery, from which a guiding template could be fabricated for a more standardized, objective and precise correction of craniosynostosis. Current surgical methods rely primarily on the subjective judgment of the surgeon as to the normal profile and placement of the fronto-orbital bar.

**Methods:** Computed tomography data from 103 normal subjects, classified by age, were compiled, and a three dimensional (3D) computational model of the skull was generated for each subject. The models were mathematically registered and averaged, resulting in a single 3D point cloud representing each data class. An external cranial surface then was passed through the point cloud, and its shape and size customized to fit the head circumference of individual patients. Additionally, it was possible to extract the fronto-orbital anatomy from the normative model.

**Results:** The resultant fabricated skull model provides a novel and applicable tool for a detailed, quantitative comparison between the normative and patient skulls, in order for surgeons to pre operatively assess, plan and practice a variety of craniofacial procedures. The fabricated size- and age-customized orbito-frontal bar acted as an intra-operative template for use in surgical vault reshaping.

**Conclusion:** Early clinical results from a pilot study show great promise for the application of this technique and its incorporation in the surgical workflow for vault remodeling procedures.



## ORAL ABSTRACTS

### 85. Conflict of Interest in Pediatric Neurosurgery Research Comparing Company Data to Surgeon Disclosure

Patrick J. McDonald, MD FRCSC; Emma Schon; Michael Ellis, MD; Colin Kazina, MD (Winnipeg, Canada)

**Introduction:** Little is known about rates of conflict of interest (COI) disclosure in neurosurgical research. Increasingly, scientific meetings require voluntary disclosure of potential COIs from presenters, including disclosure of payments from industry. Voluntary industry disclosure of payments to physicians allows for determination of the accuracy of physician disclosure.

**Methods:** We analyzed the number of COI disclosures by presenters/authors at the 2010 Meeting of the Joint Section on Pediatric Neurosurgery of the AANS/CNS. This then was compared to data provided by 3 major pediatric neurosurgery device manufacturers to determine the accuracy of disclosure among presenters at the meeting.

**Results:** In the meeting program, 9 of 162 (5.6 percent) researchers disclosed a potential COI. In the oral presentations, 56 of 81 (69 percent) presenters made either verbal disclosure or included it in a slide. The majority (43/56 or 77 percent) had nothing to declare, with 13 (23 percent) declaring a potential COI. 11/13 (85 percent) of these declarations involved grant funding from government or philanthropic agencies, with only 2/13 (85 percent) involving payments from industry. 25/81 (31 percent) presentations had no declaration. When we compared presenters disclosures with those provided by 3 major medical device companies, 2 examples of a failure to disclose a relationship with industry were found, representing 2.5 percent of presentations.

**Conclusion:** Most researchers at a major pediatric neurosurgery meeting included a COI declaration in their presentation. The majority of these indicated no potential conflict. Compared to data from other surgical specialties, we found a high rate of accuracy of such disclosures. Potential reasons for such accurate COI disclosure are discussed.

### 86. Trainees' Perceptions of Benefits of, and Barriers to, a Career in Pediatric Neurosurgery

Mark S. Dias, MD, FAANS; Susan Durham, MD, MS, FAAP; Jeffrey Sussman, BA (Hershey, PA)

**Introduction:** We hypothesized that we could identify specific perceived benefits and barriers influencing trainees' decisions to pursue careers in PNS. This may provide organized PNS ways to recruit residents to PNS careers.

**Methods:** A survey sent to neurosurgical trainees during the academic year 2009-2010.

**Results:** Four-hundred-eighty-seven residents and 8 pediatric neurosurgical fellows responded. Almost half owed &ge; \$100,000 in loans. During medical school, 55 percent identified a neurosurgical mentor, but only 7 percent a pediatric neurosurgical mentor. More than 60 percent trained in a dedicated Children's Hospital; 65 percent had &ge; 2 faculty pediatric neurosurgeons; 72 percent identified distinct PNS rotations; 36 percent trained in programs with PNS fellowships; and 70 percent received 6-11 months of PNS training. Seventy-five percent felt prepared to treat most or all PNS disorders after training. Seventy-three respondents expressed definite interest in PNS, 83 percent of whom were considering PNS fellowships. However, 45 percent would consider PNS if enfolded fellowships were available. Perceived benefits of a PNS career included working with children, developing patient relationships, a variety of cases, lack of co-morbidities and desire to help children. Perceived barriers included shunts and working with parents. The intrinsic practice of PNS, rather than financial or training issues, was the greatest barrier. Some respondents reported a lack of respect for PNS among department faculty.

**Conclusion:** There is ample interest in PNS among trainees, and almost half would consider enfolded fellowships. Earlier and more exposure to pediatric neurosurgical mentors, training residents to deal with parents, considering enfolded fellowships, and improving the perceptions of neurosurgical faculty are practical means of increasing resident interest.

### 87. Neurosurgical Complications of Left Ventricular Assist Devices in Children

Rory Mayer; Steve Hwang; Gaddum Reddy; William Whitehead; Daniel Curry; Thomas Luerksen; David Morales; Andrew Jea (Houston, TX)

**Objective:** Left ventricular assist devices (LVAD) are continuous or pulsatile flow devices that can be life-saving for patients with end-stage heart failure and have clear advantages over non-pulsatile devices, such as extracorporeal membrane oxygenation. While there is substantial experience with the use of LVADs in adults, there is only limited experience in the pediatric age group. With the increasing use of LVADs in children, associated neurological complications are likely to increase. The purpose of this study was to review the incidence of neurological complications of LVAD use in the pediatric age group and the role of neurosurgery in the treatment of these patients.

**Methods:** Four years of LVAD patient data was retrospectively reviewed at Texas Children's Hospital (2007-2011). Major neurological complications requiring neurosurgical consultation were identified, and the interventions and outcomes were recorded.

**Results:** The mean time interval between the cardiac surgery and the neurological events was 23.7 days [range 13-31 days]. Intracranial hemorrhage occurred in 6.6 percent (n=3) of LVAD treated patients at our institution (n=46). All patients were on therapeutic heparin. Two of these patients required craniotomy for life-threatening ICH. At last follow-up (mean 334 days; range 117-503 days), these two patients were stable and meeting milestones with no decline in neurological status in the postoperative period. One patient died from refractory cardiac failure.

**Conclusion:** Intracranial hemorrhage is a rare, but serious complication of LVAD treatment. While the surgical risk is substantial because of systemic anticoagulation and significant medical comorbidities, neurosurgical evacuation of hemorrhage may play an important life-saving role.

# 88. A Standardized Perioperative Care Protocol to Reduce Neurosurgical Infections — One Institution's Experience

Patricia A. Aronin, MD, MS, FAANS; Sarmistha Hauger (Austin, TX)

**Introduction:** Nationally, there has been an increased focus on prevention of surgical site infection as a quality improvement indicator. At Dell Children's Medical Center, a spike in neurosurgical infections led to the creation of a multidisciplinary team, which met to analyze the existing practices of the four pediatric neurosurgeons, and then to design and implement a protocol for the perioperative management of pediatric neurosurgical patients.

**Methods:** Following an initial analysis of the antimicrobial data by the infection control nurse, a team was organized comprised of an infectious disease physician, a pediatric neurosurgeon, and representatives from neurosurgery nurse practitioners, pharmacy, safety officer, director of surgery, acute care nursing and nursing education. The team reviewed the existing practices of the four pediatric neurosurgeons. A questionnaire was sent to members of the ASPN to determine best practices nationally. A literature review was done to determine the basis for existing practices. Based upon this review, a protocol was established for the perioperative management of all neurosurgical patients. Staff in clinic, emergency room and inpatient settings then were educated on the implementation of the new protocol.

**Results:** The initial assessment determined that most of the infections were skin organisms with a high incidence of MRSA and MRSE. Additionally, it was clear that there was tremendous variability in practice parameters for the four neurosurgeons in regards to type and duration of prophylactic antibiotics and surgical prep used, as well as postoperative wound care. None of the surgeons used any type of preop bathing. Additionally, the ASPN survey confirmed that there is no uniformity in practice on a national level, either. This provided an opportunity to create some consistency in our hospital practices with a goal to minimize skin flora. With the information obtained from the survey and analysis of scientific basis for best practices, we were able to establish a protocol for perioperative care that includes a specific preoperative bathing, consistent use of prophylactic antibiotic, surgical site scrub, assurance of normothermia at skin incision, limitation of OR traffic and use of double gloving for all implants, use of specified dressings for all CSF drains and education of all nursing staff in regards to managing neurosurgical wound care.

**Conclusion:** The effects of this new protocol will be discussed, including the difficulties encountered and the effects not only on neurosurgical infections, but also on the how this process has been expanded to other surgical services and our continued monitoring process.

# 89. When Pressure of the Uterine Cervix Meets Intracranial Pressure: A Scientific Approach to Prenatal Counseling

Hector E. James, MD, FAANS; Teresa MacGregor, MSN, CPNP; Philipp Aldana, MD (Jacksonville, FL)

**Introduction:** The fetal head during delivery is submitted to significant intrauterine pressure (IUP) and head-to-cervix pressures (HCP). The consulting pediatric neurosurgeon should be familiar with these for correct prenatal counseling for fetuses with macrocrania and ventriculomegaly.

**Methods:** The fetus is submitted to continuous IUP tone with pressure waves (range: 10-21 mmHg) that does not seem to interfere with brain development. During vaginal delivery, the IUP waves increase, and as the fetal head enters the lower uterus and engages, the HCP pressures progressively rise (Basal: 17.5-76 mmHg, Maximal: 127-514 mmHg). The pressures are higher in primiparas than in multiparas.

**Results:** The fetus with macrocrania with ventriculomegaly will have elevated fetal intracranial pressure (fICP) and intracranial distortion. Vaginal delivery will expose the fetal head to significant external pressure and mechanical distortion, and could further impair fetal cerebral blood flow (fCBF) and lead to cerebral ischemic hypoxia [fetal cerebral perfusion pressure (fCPP) = (fICP + HCP) &ndash; fetal mean systemic arterial pressure].

**Conclusion:** Pediatric neurosurgeons providing prenatal counseling should be aware of these findings when consulted by perinatology for the fetus with macrocrania and/or ventriculomegaly. Fetuses with ventriculomegaly without macrocrania could be safely delivered vaginally. For fetuses with macrocrania and ventriculomegaly, an alternative delivery route should be considered.

# 90. Pupil Findings and Survival in Pediatric Patients Undergoing Decompressive Craniectomy

Julian J. Lin, MD; Arnima Bhasin; Michail Vasilakis, MD; Lynne Lyle, RN (Peoria, IL)

**Introduction:** Decompressive craniectomy is effective in reducing intracranial pressure. The indications are at times controversial. We reviewed our series to see whether there is a certain group of patients that may not benefit from the procedure.

**Methods:** Retrospective review of 25 children undergoing decompressive craniectomy.

**Results:** The age ranges from 9 months to 15 years (mean = 5.77 years); 33.3 percent of patients suffered from non-accidental trauma, 16.7 percent falls and 25 percent MVA. Patients presented with GCS between 3 and 13 (mean = 5.47); 12.5 percent of patients had contusions, and 45.8 percent had acute SDH. Average time to surgery was 8.79 hours. Eight (31 percent) patients did not survive. Of the 17 patients that survived, 52.9 percent had functioning capabilities. All 5 patients with bilateral fixed and dilated pupils died. Three of these patients blew their second pupil en route to the OR, while the remaining two patients were transferred directly to the OR after imaging studies were reviewed and patients were deemed salvageable prior to arrival. Three of five children with unilateral fixed and dilated pupil did not survive. Of the 8 patients who did not survive, the average GCS score was 5.25.

**Conclusion:** Based on our preliminary findings, the presence of bilateral fixed and dilated pupils is associated with death, despite decompressive craniectomy. GCS scores do not seem to be associated with the success rate of decompressive craniectomies.

## POSTER ABSTRACTS

### 91. Amygdalar Neuromelanosis Associated with Intractable Epilepsy

Douglas Taylor; Scott Wait, MD; Frederick Boop, MD; Jim Wheless, MD (Memphis, TN)

**Introduction:** Neurocutaneous melanosis (NCM) is a rare, congenital neuroectodermal dysplasia identified by the presence of large or multiple congenital melanocytic nevi (CMN) and the proliferation of melanocytes in the CNS. The latter typically presents in the form of a benign or malignant pigmented cell tumor of the leptomeninges. Case Report: A 14-year-old girl suffered from intractable, complex partial seizures secondary to a giant hairy cell nevus covering her back and chest, as well as multiple nevi on her extremities and face. Brain magnetic resonance imaging (MRI) showed areas of hyperintense T2/flair signal in the anterior, medial aspect of the temporal lobe and amygdala. An interictal single photon emission computed tomography (SPECT) showed decreased blood flow to the right anterior temporal lobe. Electroencephalogram (EEG) showed focal epileptiform discharges at F10, and monitoring concluded right temporal onset. A positron emission tomography (PET) showed consistent findings. Assessment of these studies indicated treatment by right temporal lobectomy.

**Results:** A right temporal lobectomy was performed, including resection of the amygdala and a portion of the hippocampus. Histologically, pathological features of the lesion included multiple scattered mononuclear cells with abundant golden brown pigment found in the amygdala specimen. Immunohistologically, the lesion was immunoreactive for Melan-A, S-100 protein, Melan-A-Red and Fontana-masson, which are profiles congruous with melanocytes.

**Conclusion:** Here, authors report a patient with amygdalar neuromelanosis associated with intractable epilepsy who was successfully treated by surgical resection and is now seizure-free. In comparison to related literature, this appears to be an atypical CNS manifestation of NCM.

### 92. Spontaneous Regression of a Cavernous Sinus Epidermoid Cyst

Ning Lin, MD; Vijay Yanamadala, MA; Lissa Baird, MD; Edward Smith, MD (Boston)

**Introduction:** Epidermoid cysts are relatively rare lesions in the pediatric population. The natural history of epidermoids usually is that of slow growth, although rupture and cases of malignant transformation have been reported. Spontaneous regression of an intracranial epidermoid cyst has not previously been described.

**Methods:** Case report and literature review. All medical records, radiological studies, and pertinent literature were reviewed.

**Results:** A three-year-old boy presented with severe vertigo. Magnetic resonance imaging (MRI) was performed, which revealed a 2-cm, non-enhancing lesion in the right cavernous sinus. The lesion was T1-hypointense and T2-hyperintense, and, with evidence of restricted diffusion, consistent with an epidermoid cyst. The patient was followed with annual MRI studies over the next three years, demonstrating progressive reduction in the size of the lesion over time, with complete resolution after three years. The child's symptoms also resolved during this period. Long-term follow-up imaging at 5 years showed no evident lesion.

**Conclusion:** To our knowledge, this is the first report documenting spontaneous regression of an intracranial epidermoid cyst. While isolated, this finding demonstrates the potential for involution of epidermoids and lends support to the clinical practice of careful observation of these lesions, especially when located in areas associated with high potential surgical morbidity. Importantly, the novelty of this observation suggests a need for further study to better elucidate the underlying mechanism of this regression.

### 93. Spinal Juvenile Xanthogranuloma in a Child: Case Report and Review of the Literature

James West; Sergio Gonzalez Arias, MD, PhD (Miami, FL)

Juvenile Xanthogranuloma (JXG) in the central nervous system is a rare occurrence, and the presence of JXG in the spinal column is an even more exceedingly rare event. Here, we report and discuss a case of JXG in the thoracic spine, and draw attention to the idea that, while less common, JXG should be included among the many possible of spinal tumors in children. In our case, a 17-month-old female presented with regression of spontaneous ambulation, noted by the child's mother. An MRI of the lumbosacral spine revealed an intradural extraaxial mass compressing the spinal cord at the levels of T11 and T12. Complete surgical resection of the tumor via laminoplasty was performed with no complications. The patient experienced improved spontaneous walking following the surgery, and follow-up contrast MRI showed no residual tumor. Our literature review and report note that there does not appear to be a preference of localization within the central nervous system for JXGs; however, it is interesting to note that all of the spinal JXG cases reported have been female. Because of this, solitary xanthogranuloma should be considered in the differential of spinal tumor in children, especially young females with a diagnosis of an intradural, extraaxial mass.

### 94. Endovascular Embolization Of Choroid Plexus Papillomas In Reducing Morbidity From Blood Loss

Dhruve Satish Jeevan, MD; Jayson Neil; Josh Meyers; Avinash Mohan; Michael Tobias; Michael Stiefel (Valhalla, NY)

**Introduction:** Choroid Plexus Papillomas are highly vascular benign tumors found predominantly in the pediatric population. Surgical resection carries a high morbidity and mortality rate from acute blood loss, which may be reduced with preoperative endovascular embolization. We present a case report and literature review for the use of Onyx embolization in these cases.

**Method:** A case report of a 4-month-old child with a large choroid plexus papilloma, who underwent pre-operative endovascular Onyx embolization, is presented. An extensive literature review documenting the validity and history of such approaches in this pathology was performed.

**Results:** Our case demonstrates successful embolization of the left anterior choroidal artery with Onyx and the subsequent resection of a left lateral ventricular choroid plexus papilloma. A total of 6 productive embolization cases have been reported in the literature out of only 13 attempts. One report noted tumor shrinkage without the need for further surgical resection. Unsuccessful attempts were attributed to tortuous, unclear vessels and difficulty cannulating the posterior choroidal artery.

**Conclusion:** With the advancement of endovascular techniques, and the advent of Onyx, microcatheterization of the posterior choroidal artery provides an attractive treatment modality for the management of choroid plexus papillomas.

## 95. Stereotactic Endoscopic Resection of a Subependymal Giant Cell Astrocytoma: Case Report and Surgical Management

Luigi Bassani, MD; Shaun Rodgers, MD; Howard Weiner, MD; David Harter, MD

**Background:** Subependymal giant cell astrocytomas (SEGA) are benign tumors, most commonly associated with Tuberous Sclerosis Complex (TSC). The vast majority of these tumors arise from the lateral ependymal surface adjacent to the foramen of Monroe, therefore potentially encroaching on one or both foramina, resulting in obstructive hydrocephalus and, thus, necessitating surgical decompression. While intrahemispheric transcallosal and transcortical transventricular approaches have been the standard methods for resecting these tumors, advances in neuroendoscopic techniques have led to SEGAs being potential targets for minimally invasive resection.

**Case Description:** We present the case of a neuroendoscopic resection of a subependymal giant cell astrocytoma in a 4 year old girl with TSC. The patient, who had initially been followed for a SEGA, had enlargement of her SEGA and development of moderate hydrocephalus. Using a purely endoscopic approach, a gross total resection of the SEGA was completed without a morbidity.

**Conclusion:** This case, to our knowledge, represents one of the early reported neuroendoscopic resections of a subependymal giant cell astrocytoma. While recent advances in medical treatment for SEGAs, specifically rapamycin as an mTOR pathway inhibitor, have shown clinically significant tumor control, the expansile tumor secondary to growth or hemorrhage and the development of ventriculomegaly will always require surgical intervention. In the age of minimally invasive neurosurgery, the neuroendoscopic poses a new approach for the safe and effective resection of SEGAs.

## 96. Neurogenic Claudication Associated with Posterior Vertebral Rim Fractures in Children

Jonathan George Thomas, MD; Jerome Boatey, MD; Alison Brayton, RN; Robert Bollo, MD; Daniel Curry, MD; William Whitehead, MD, MPH; Thomas Luerssen, MD; Andrew Jea, MD (Houston, TX)

**Introduction:** Neurogenic claudication associated with posterior vertebral rim fracture in the lumbar spine is an uncommon, but significant cause of pain and disability in children and adolescents. We describe the surgical results of 3 adolescents presenting with neurogenic claudication and posterior vertebral rim fracture treated with laminectomy alone.

**Methods:** The medical and operative records of all patients were retrospectively reviewed. Presenting signs and symptoms and interpedicular distances at T12 and L5 were obtained. Perioperative results were assessed, including length of hospital stay and complications. An informal survey of patient satisfaction was conducted at the last follow-up visit.

**Results:** Two of three patients were male. Mean age was 14.7 years (range 14-15 years), and mean follow-up was 7.7 months (range 2-16 months). Preoperative signs and symptoms included back and leg pain in all 3 patients; one patient also presented with a motor and sensory deficit. The range of T12 and L5 interpedicular distances was 20.3 24.1 mm and 22.9 27.2 mm, respectively. On average, two level laminectomies were performed. No complications were observed. Mean hospital stay was 4.3 days (range 3-6 days). All patients responded to the survey, stating they were satisfied with surgical outcome.

**Conclusion:** To our knowledge, this report is the first surgical series of pediatric patients presenting with neurogenic claudication in the context of posterior vertebral rim fractures. Posterior surgical decompression via laminectomy may be a safe and effective alternative to discectomy and removal of fracture fragments in the pediatric age group.

## 97. Sibling Group Presenting with Intracranial Hemorrhage from Intracranial Aneurysms, and Co-Existing Diffuse Cerebral Calcification and Pulmonary Emphysema

Khadija Khansia; Lauren Schwartz, MD; Catherine Mazzola, MD; John Paul Bouffard, MD; Leroy Sharer, MD (North Bergen, NJ)

Cerebral calcification is caused by accumulation of calcium and may contribute to neurological dysfunction manifesting as rigidity or involuntary movement, such as tremor or dystonia. Dementia, developmental delay, mask like facies and seizures also may occur. This is a case report of a sibling group presenting with intracranial hemorrhage from intracranial aneurysms, and co existing diffuse cerebral calcification and pulmonary emphysema. An 8 year old girl presented with severe headache and meningismus. In the emergency room, she became obtunded and had a generalized tonic clonic seizure. Emergent computed tomography (CT) revealed intracranial hemorrhage (ICH), hydrocephalus and diffuse, bilateral, laminar calcifications. CT angiography (CTA) showed an aneurysm of the anterior communicating artery (ACOM). Traditional cerebral angiography showed multiple intracranial aneurysms. Past medical history was significant for severe, congenital hypotonia and associated intestinal dysmotility with delayed gastric emptying, requiring gastrostomy placement. Pulmonary emphysema and chronic respiratory infections also were diagnosed prior to presentation. In addition, the child had mild global developmental delays associated with the diffuse hypotonia. Her brother had the same type of hypotonia, dysmotility and developmental delay with pulmonary emphysema. The child underwent an emergent ventriculostomy and coil embolization of her right ACOM aneurysm. A shunt was placed for persistent post hemorrhagic hydrocephalus. A skeletal muscle biopsy revealed type 1 fiber predominance and possible mild increase in lipid within fibers. Her cerebral biopsy revealed stenotic meningeal vessels. Although there have been case reports of children with neurological deficits and developmental delays, and cortical calcifications, this is the first case report of a sibling group with the aforescribed unusual presentation.

## 98. Clinical Outcomes of Pediatric Patients with Shunts From the Cisterna Magna

Sophia F. Shakur, MD; David Frim, MD, PhD (Chicago, IL)

**Introduction:** Shunting from a variety of locations has been attempted, including the use of ventricular and lumbar shunts. However, there are patients in whom the use of the ventricular system or lumbar subarachnoid space is not possible, namely pseudotumor cerebri patients with small ventricles and patients with scarring of the lumbar thecal space due to repeated lumbar punctures and lumbar catheter revisions. The cisterna magna has been reported as an alternative CSF drainage site in adults. We present the first case series of pediatric patients with shunts from the cisterna magna.

**Methods:** A retrospective chart review, 2005-2010, under IRB protocol.

**Results:** Ten patients underwent cisternal shunting: 3 males, 7 females. Median age at the time of initial shunting was 10.0 years (range 7-20 years). All patients had pseudotumor cerebri. For two patients, drainage from the cisterna magna was their primary approach to shunting; one patient had spina bifida, and the other requested it for cosmetic purposes. All patients had at least one revision (33 revisions total; mean 3.3 per patient). Two patients no longer have a shunt, since their pseudotumor cerebri resolved. Three patients still have a cisternal shunt. Five were converted to a lumbar shunt.

**Conclusion:** Shunting CSF from the cisterna magna in pediatric patients is an acceptable alternative in the absence of another suitable drainage site. This technique, though, is associated with a high rate of revisions and a high likelihood of conversion to lumbar shunting.



## POSTER ABSTRACTS

### 99. Using the SF-10 Health Survey to Determine Overall Health in Patients Referred for Chiari Consultation

Chevis Shannon; Camille Broome, MPH; Michael Falola, MPH; Leon Dure, MD; Walter Oakes, MD (Birmingham, AL)

**Introduction:** The impact of chronic symptoms on physical and psychosocial health has been well established in many diseases. The purpose of this study was to determine the overall health of pediatric patients with MRI confirmed chiari.

**Methods:** A prospective survey study was conducted using the validated SF 10 Health Survey for Children. The survey then was complemented with demographic and clinical data. Comparisons were made between the national averages and the chiari scores. Descriptive statistics and exploratory analysis were performed using SAS 9.2.

**Results:** 80 patients were seen during the study period, and 54 (68 percent) completed surveys. The mean age was 10.29  $\pm$  3.69 years. The average chiari physical health (PHH) was 37.07 compared to national averages of 52.43 ( $p < .0005$ ). Our cohort scored 49.47 on psychosocial health (PSS) compared to the national average of 52.81 ( $p < .0005$ ). The chiari cohort scored in the 5th percentile for PHH and in the 45th percentile for PSS. No statistical significance was found when looking at overall health and symptoms directly related to the chiari or chiari with a syrinx. No statistical significance was found when looking at survey questions individually.

**Conclusion:** The SF-10 was used to determine overall health scores in the chiari patient population. While this survey is an effective tool for the general population it does not address chronic symptoms or pain related to chiari diagnosis. Therefore, a study currently is underway to develop and validate a health tool specific to chiari in the pediatric population.

### 100. Management of Multiloculated Hydrocephalus in the Pediatric Population with Navigated Endoscopy

Sam Safavi Abbasi, MD, PhD; Randy Hlubek; Timothy Mapstone; Erik Hansen; Naina Gross (Oklahoma City, OK)

**Objective:** Multiloculated hydrocephalus is a challenging management problem in Pediatric Neurosurgery. The authors reviewed their experiences with navigated endoscopy to treat multiloculated hydrocephalus in the pediatric population.

**Methods:** Navigated endoscopy for treatment of multiloculated hydrocephalus was performed in 15 pediatric patients (median age 7 months, mean age 30 months) between the dates of 2006-2011. All patients had the total number of operations, endoscopic procedures and ventricular catheters recorded. Post-operative complications and imaging data were analyzed.

**Results:** In 15 children, the most common cause were IVH (4/15) and arachnoid cysts (4/15), followed by a combination of IVH and ventriculitis (3/15), ventriculitis (2/15) and congenital (2/15). A total of 46 procedures were performed, 23 of which included navigated endoscopic procedures. During the mean follow-up of 16 months, the mean preendoscopy shunt revision rate decreased from 2.38/year to .28/year following the endoscopic fenestrations. Complications were minimal, with only one subdural hematoma occurring. No CSF leaks or arterial hemorrhages were encountered. Mortality was 0 percent.

**Conclusion:** Navigated endoscopy is recommended for treatment of multiloculated hydrocephalus. It is a relatively simple and safe minimally invasive technique that should be considered as a first line surgical treatment option.

### 101. Neurosurgical Management of Acute Cerebellitis in Paediatric Patients

Mustafa Moh'D Y. Nadi, MD; Sevgi Serikaya, MD; William Halliday, MD; Seng Chye Lee, MD; James Drake, MD, MSc, FRCSC (Toronto, Canada)

**Objectives:** Acute cerebellitis is a rare and potentially lethal condition associated with cerebellar swelling, secondary hydrocephalus, and ultimately brainstem compression and dysfunction. We reviewed our pediatric cases to ascertain best management strategies.

**Methods:** Patients who presented to the The Hospital for Sick Children with acute cerebellitis and hydrocephalus between 1996 and 2011 were retrospectively reviewed. Demographics, clinical presentation, medical management, operative procedures, pathology and outcome were determined.

**Results:** There were 6 girls and one boy, ages 5-16 years. Six presented with precedent history of flu-like illness and headache, 4 with features of increase ICP and 3 with cerebellar ataxia. Four patients had a significant drop in level of consciousness at presentation, with evidence of obstructive hydrocephalus. Medical management included corticosteroids, antiviral agents and antibiotics. Five patients required surgical intervention, including an external ventricular drain. Four patients required an additional posterior fossa decompression, and one patient also required a bifrontal decompression. CSF cytology was normal in 3 patients and showed a lymphocytic pleocytosis in three. Cerebellar biopsy in 4 patients showed evidence of small vessel vasculitis. All patients are alive at last follow-up; one has a significant disability.

**Conclusion:** Acute cerebellitis requires both careful medical management and timely surgical intervention including CSF drainage and surgical decompression. Most patients do very well with this schema. The pathophysiology remains unclear but may be primarily inflammatory.

### 102. Ventricular Size Analysis in Pediatric Patients Undergoing Endoscopic Third Ventriculostomy

Jonathan A. Pindrik, MD; Edward Ahn, MD (Baltimore, MD)

**Introduction:** Optimal methods of evaluating radiographic data in endoscopic third ventriculostomy (ETV) are unknown. This study analyzes specific imaging parameters in pediatric ETV patients with correlations to clinical outcomes.

**Methods:** Children with hydrocephalus treated by ETV were retrospectively reviewed. Measured imaging parameters included third ventricular maximal width and mid sagittal cross sectional area, the ratio of greatest frontal horn width to co linear internal diameter of the calvarium (FH/ID) and the frontal occipital horn ratio (FOR). Clinical outcomes were used to separate patients into groups of successful versus unsuccessful ETV.

**Results:** After pre-operative scanning, ten successful ETV patients (age range 11 months to 19.8 years) obtained imaging at least 2.75 months following surgery, while four unsuccessful ETV cases (age range 4 months to 17.3 years) involved imaging before repeat intervention. Two patients demonstrated initial improvement, but subsequent delayed ETV failure. Third ventricular width showed an average decline of 0.36 cm and 18.3 percent per patient in the successful ETV cohort, but average increases of 0.36 cm and 18.7 percent in the ETV failure group. Successful ETV patients exhibited mean decreases of 1.85 cm and 19.7 percent in third ventricular mid sagittal cross sectional area, while unsuccessful ETV patients showed mean increases of 1.17 cm and 17.3 percent per patient. Measures of lateral ventricular size, FH/ID and FOR, showed similar trends with lower magnitude.

**Conclusion:** This study shows the utility of imaging parameters, specifically third ventricular width and mid sagittal cross sectional area, in the evaluation of pediatric hydrocephalic patients treated by ETV. Measures of third ventricular size demonstrated more pronounced responses to ETV success or failure.

## 103. Complications and Subsequent Removal of Retained Shunt Hardware After Endoscopic Third Ventriculostomy

Jonathan A. Pindrik, MD; Edward Ahn, MD (Baltimore, MD)

**Introduction:** Removal of shunt catheters following endoscopic third ventriculostomy (ETV) represents an important dilemma to the pediatric neurosurgeon. Prior studies have reported infections and organ perforation related to non functional shunts. This case series highlights multiple complications and subsequent removal of retained shunt hardware in pediatric patients after successful ETV.

**Methods:** Four children with hydrocephalus were retrospectively reviewed after experiencing complications with retained shunt hardware after ETV.

**Results:** Etiologies of hydrocephalus included tectal glioma, foramen magnum obstruction and intraventricular hemorrhage. Three patients with a history of multiple shunt revisions underwent urgent ETV after presenting with shunt malfunction. In each case, the entire shunt system was left in situ. post-operatively, two patients presented with shunt infection by gram negative bacilli at two weeks and five months, respectively. The third patient experienced wound breakdown overlying the valve of her retained shunt five months post-operatively. One patient underwent ETV followed by ventriculo peritoneal shunting two days later. Two weeks after surgery, the patient presented with scalp wound dehiscence and group B Streptococcus infection of shunt hardware, prompting externalization. Further imaging analysis revealed a patent ETV site and adequate ventricular decompression during clamping trials of the externalized shunt. All four patients were managed successfully with removal of shunt hardware. None of the patients required repeat shunt insertion from the time of removal to present day (range 5 months to 2.67 years).

**Conclusion:** This case series highlights complications involving retained shunt hardware after successful ETV. These examples argue for consideration of shunt removal in this context.

## 104. Post-Hemorrhagic Hydrocephalus in Preterm Neonates: Socioeconomic Characteristics in a Single Institution Experience

Courtney Pendleton, BS; Elizabeth Cristofalo, MD; Gabriella Biondo, BS; George Jallo, MD; Alfredo Quinones Hinojosa; Edward Ahn, MD (Baltimore, MD)

**Introduction:** Patients with post hemorrhagic hydrocephalus (PHH) from germinal matrix hemorrhages require numerous early interventions and long term follow-up care from pediatric neurosurgeons. The financial costs of these interventions have been calculated by other groups, and present a tremendous financial burden to families and insurers.

**Methods:** A retrospective analysis of the patient records for a single institution, from 2007 to 2010, was performed. All patients who underwent neurosurgical intervention for the treatment of PHH were selected. Data elements available included patient demographic features, inpatient treatments and procedures; inpatient mortality rates; length of stay; and post-operative follow-up at the institution. Socioeconomic status was assessed using the median household income for the patient's zip code, as reported in the United States Census for the year 2000.

**Results:** A total of forty patients were identified. More patients were female (52.5 percent); the majority of patients were Black (57.5 percent). No patients were uninsured; most patients had public insurance (62.5 percent), and 65 percent were below the Maryland State median household income (\$52,868). There were no significant differences in emergency room visits or readmission rate.

**Conclusion:** The majority of patients fall within lower household income brackets, are born into households earning less than the statewide median household income and are covered by public insurance. These patients typically require extensive medical and surgical care upon presentation, and throughout their lifetime. In light of the socioeconomic profile of the patient population reported here, pediatric neurosurgery may be challenged with the demands of maintaining appropriate care for this population of children who are traditionally from underprivileged households.

## 105. Applying the MOMS Shunting Criteria to a Single Institutional Experience

Anastasia Arynchyna; Chevis Shannon, MBA, MPH, DrPH; Benjamin Ditty, MD; Walter Oakes, MD; Jeffrey Blount, MD, FAAP; John Wellons, MD (Birmingham, AL)

**Objective:** The Management of Myelomeningocele Study (MOMS) tested efficacy and benefits of prenatal versus postnatal repair of myelomeningocele from 2003 to 2009. The present study retrospectively compares shunt placement rates in myelomeningocele patients at a single institution to the MOMS population during the same period.

**Methods:** A retrospective chart review identified 78 myelomeningocele patients treated and followed between 2003 and 2009. This was compared to the prenatal (PRE) and postnatal (POST) groups of the MOMS trial. The outcomes of interest were: 1) shunting within the first 12 months, and 2) meeting MOMS shunt criteria. Statistical analysis was performed using SPSS.

**Results:** Of the 78 patients, 42 (53.8 percent) patients met MOMS inclusion criteria. Of those who would have met study eligibility, 38 (90.5 percent) underwent shunt placement compared to 31 (40 percent) PRE ( $p < 0.0001$ ) and 66 (82 percent) POST ( $p = 0.2149$ ). Of those who would not have met study eligibility criteria, 28 (77.8 percent) underwent shunt placement [vs. PRE ( $p = 0.0003$ ), vs. POST ( $p = 0.5970$ )]. Of those who would have met study eligibility, 35 (83.3 percent) met MOMS shunt criteria compared to 51 (65 percent) PRE ( $p = 0.0364$ ) and 74 (92 percent) POST ( $p = 0.1470$ ). Of those who would not have met study eligibility, 26 (72.2 percent) met MOMS shunt criteria [vs. PRE ( $p = 0.4479$ ), vs. POST ( $p = 0.0055$ )].

**Conclusion:** One half of this population would not have been eligible for MOMS. Those eligible had similar shunting outcomes to the postnatal group, both actual and in meeting criteria. Those not MOMS eligible had similar actual shunting rates to the postnatal group, but were more similar to the prenatal group when looking at those who met shunt criteria. These results should be considered in the overall discussion of MOMS generalizability.

## 106. Ommaya Reservoir Placement in the Pediatric Cancer Population

Rory Mayer; Steve Hwang, MD; Andrew Jea, MD; James Debnam, MD; Robert Dauser, MD; Morris Groves, MD; James Lu; Ian McCutcheon, MD; Raymond Sawaya; Jeffrey Weinberg, MD (Houston, TX)

**Introduction:** Ommaya reservoirs often are placed for intrathecal therapy in adults, but there is limited literature describing its role in the pediatric population. We review our series of pediatric Ommaya reservoirs and describe techniques to avoid complications.

**Methods:** We reviewed all pediatric Ommaya operations at our institution (1993-2010;  $n = 23$ ). Demographic data, lab values, radiographic parameters, disease pathology, the presence of hydrocephalus or slit ventricles and use of adjuvant operative techniques (stereotactic navigation, endoscopy, brain needle) were documented. Complications, defined as neurological and device related, were assessed at 48 hours and 30 days.

**Results:** The mean age was 9.7  $\pm$  5.7 years. The most common primary diagnosis was leukemia. All patients had intracranial disease (LMD, 62 percent; primary CNS tumors, 33 percent; intraparenchymal metastases, 14 percent). Surgical indications included intrathecal chemotherapy (57 percent) and elevated intracranial pressure (19 percent). Ten percent of patients developed complications (5 percent neurological, 5 percent device related) at 48 hours. At 30 days, complications occurred in 20 percent (10 percent neurological, 10 percent device related). The most common complications were intraparenchymal hemorrhage (5 percent) and meningitis (5 percent). The catheter reached the intended location in only 71 percent of cases (compared to 79 percent of a comparative adult group). Adjuvant operative techniques resulted in a lower complication rate compared to freehand placement (7 percent vs 30 percent,  $p = 0.08$ ). Five patients required device conversion to a ventriculoperitoneal shunt.

**Conclusion:** To the best of our knowledge, we report the largest series of Ommaya catheter placement in the pediatric cancer population. Complications may be minimized with the use of adjuvant operative techniques including intraoperative navigation to guide catheter placement.

## POSTER ABSTRACTS

### 107. Colloid Cysts of the Third Ventricle in Children and Young Adults

Heather Jane McCrea, MD; Mark Souweidane, MD (New York, NY)

**Introduction:** The rarity of colloid cysts of the third ventricle in children and young adults has delayed a comprehensive assessment in this population. Further, most published series have not focused on any meaningful age related comparison.

**Methods:** From a prospective database (inclusion dates 1995-2011), all endoscopic colloid cyst removals were assessed with emphasis on age of the patient at time of surgery. Surgical indications, ventricular size, colloid cyst dimension and surgical outcome were compared (2 tail Fisher exact test) between patients aged 20 years or less with those greater than 20 years old.

**Results:** From a total of 70 endoscopic colloid cyst resections, 8 (11 percent) were performed on patients 20 years of age or younger (mean 15.25, range 9-20 years) and 62 on patients > 20 years of age (mean 44.77, range 21-81 years). Younger patients more frequently presented with an incidental finding (37.5 percent vs. 14.5 percent, p-value = 0.1318), less commonly had hydrocephalus (25 percent vs. 74 percent, p-value = 0.009) and had smaller cysts (mean maximal diameter 8.25 vs. 12.85 mm, p-value 0.037). There were no differences in surgical morbidity or recurrence rates. Average follow-up time was 25.13 months (range 5-90 months) for younger patients and 34.86 months for adults (range 0-163 months).

**Conclusion:** While differences exist between young patients compared with adults regarding colloid cyst presentation, there appears to be no difference in outcome following endoscopic removal. These results may impact the decision-making process for young asymptomatic patients given their expected life expectancy, projected rates of progression and safety of endoscopic removal.

### 108. Papillary Tumor of the Pineal Region Case Discussion and Review of the Literature

Mustafa Moh'D Y. Nadi, MD; Sevgi Serikaya, MD; Eric Bouffet, MD; William Halliday, MD; James Drake, MD, MSc, FRCS (Toronto, Canada)

**Objectives:** Papillary tumor of the pineal region (PTPR) is a new pathological diagnosis, first reported in 2003. We report the first case at this institution and review the relevant literature. Clinical Summary: A 10-year-old girl presented with personality change, memory impairment, unsteady gait and limited upward gaze. MRI revealed a pineal region cystic and solid mass with heterogenous enhancement measuring 6x5x3 cm, with acute hydrocephalus. Ventriculoperitoneal shunt insertion and biopsy were performed at an outside centre. Rapid regrowth prompted near total resection via a right occipital transtentorial route at this institution. Following adjuvant radiation therapy, she is neurologically intact and progression-free at 6-month follow-up.

**Results:** Fifty cases of PTPR have been reported. Less than 20 percent are in the pediatric age group with youngest age 15 months. Common presentation is headache and papilledema with hydrocephalus. Tumours typically are hyperintense on T1 images with solid and cystic components, and heterogenous enhancement. Thirty patients had total resection, 17 partial resection and 3 a biopsy. Histologically, the tumours have a papillary architecture with positive Cytokeratin 18 expression. Forty two cases received radiation and 15 chemotherapy. Recurrence was reported in 51 percent of patients and death in 15 percent, with a mean follow-up of 50 months. The longest reported survival is 20 years.

**Conclusion:** PTPR is a rare pediatric pineal region tumor with specific pathological characteristics. Radical resection and adjuvant radiation therapy is the mainstay of therapy. The role of chemotherapy still is being established. High risk of recurrence mandates careful follow-up.

### 109. Comparative Secretome Profiling in Pediatric Brainstem Glioma

Amanda Muhs Saratsis, MD; Sridevi Yadavelli; Suresh Magge, MD; Javad Nazarian (Arlington, VA)

**Introduction:** Understanding pediatric brainstem glioma (BSG) biology is limited due to lack of tissue available for molecular study. In contrast, proteomic analysis of cerebrospinal fluid (CSF) from children with BSG can detect tumor proteins. In order to explore CSF profiling as a reflection of tumor biology, we analyzed tumor cyst fluid and CSF from 6 year old male with BSG and compared results to normal controls (n=4).

**Methods:** CSF and tumor cyst fluid was submitted for quantitative proteomic analysis using LTQ-Orbitrap-XL. Isolated peptides were identified using the Sequest algorithm in the Bioworks browser against the Uniprot database. Protein and pathway analysis was performed with Partek Genomics Suite, ProteolQ and Ingenuity Pathway Analysis software. Proteins of interest were validated in tumor tissue with Western Blot.

**Results:** Four-hundred-ten total proteins were identified. Two-hundred-seventy-one were detected in the BSG patient, with 132 (49 percent) in CSF and cyst, 77 (28 percent) only in cyst and 62 (23 percent) only in CSF. Compared to controls, 54 proteins were downregulated in BSG (fold change expression < 2) and 24 upregulated (fold change expression > 2), with 7 unique to tumor. Upregulated proteins were validated in tumor tissue by western blotting assays. Functional analysis revealed molecular pathways relevant to tumorigenesis.

**Conclusion:** We report the first comprehensive protein profile CSF and tumor cyst fluid from a child with BSG. Comparison between CSF and cyst fluid reveals insight into brainstem gliomagenesis and demonstrates the relevance of CSF profiling as a tool for characterizing tumor biology to detect tumor specific proteins.

### 110. Recurrent Dysembryoplastic Neuroepithelial Tumours in Pediatric Age Group

Mustafa Moh'D Y. Nadi, MD; Abhaya Kulkarni, MD, PhD, FRCS; Eric Bouffet, MD; James Drake, MD, MSc, FRCS (Toronto, Canada)

**Objective:** Dysembryoplastic neuroepithelial tumors (DNETs) traditionally have been considered benign lesions. Recently case reports have described recurrences following resection.

**Methods:** We retrospectively reviewed the patients identified with the recurrent DNETs at The Hospital for Sick Children who presented between 1987 and 2011. Demographics, clinical presentation, operative procedures, pathology and outcome were determined.

**Results:** Out of a cohort of 40 patients with DNET, there were seven, four boys and three girls ages 5-11 years, with recurrence. The presenting symptom was complex partial seizure in 4 patients and headache in the others. Thirteen craniotomies and 3 intraventricular endoscopic resections were performed. Six patients showed residual tumor after their first operation and were followed by serial MRI that showed regrowth. One patient with a total excision also recurred. The average duration of follow-up was 7.3 years. The average interval between the first, and the second resection was 4.5 years. Two patients had adjuvant radiation therapy and one chemotherapy. One patient recurred as a rhabdoid tumour. All patients were alive at the last follow-up.

**Conclusion:** Recurrent DNETs are rare. Few cases of malignant transformation of DNET to high grade glial tumours have been reported, to our knowledge; there have been no reports of transformation to rhabdoid tumor. Residual tumor can be a risk factor for recurrence. Tumours not amenable to complete excision are more problematic and require close follow-up. The need for adjuvant treatment is exceptional and should raise the issue of atypical behavior or pathology. Reoperation still is the main treatment for recurrent DNETs.

## 111. Impact of Surgeon Experience on Outcomes of Craniopharyngioma Resection in Children: A Single Surgeon Experience of 116 Surgeries

Luigi Bassani, MD; Jeffrey Wisoff, MD; Tracey Ma, BA; Omar Tanweer, MD; Jessica Wisoff, MA; Robert Elliott, MD

**Introduction:** Preliminary evidence suggests a correlation between surgeon experience and improved oncological and functional outcomes in children with craniopharyngiomas.

**Methods:** We retrospectively analyzed the records of 99 consecutive children (40 females/59 males; mean age: 9.7 years) who underwent a total of 116 attempted radical resections by a single surgeon. Functional status before and after surgery was assessed using the Craniopharyngioma Clinical Status Scale (CCSS). Dividing the cases into quartiles of 29 surgeries, regression analysis was used to assess the impact of surgeon experience on extent of resection and complications.

**Results:** All primary tumors were completely removed, and the mean rate of complete resection for recurrent tumors was 60.8 percent. Preoperative COS scores predicted postoperative outcome better than clinical characteristics like patient age, sex, tumor size, location or presence of hydrocephalus. Controlling for differences between groups, multivariate regression analysis revealed increasing surgeon experience to be correlated with less deterioration in neurological, hypothalamic and cognitive functioning at latest follow-up. There was no impact on pituitary or visual outcomes.

**Conclusion:** The surgical philosophy of attempted radical resection did not change during the 25 year experience as evidenced by the stable extent of resection over time. Preoperative CCSS scores predicted outcome more highly than clinical or imaging characteristics. However, increasing surgeon experience with craniopharyngioma resection correlated with improved neurological, hypothalamic and cognitive outcomes. Such data support the notion of early referral of children with craniopharyngiomas to centers with high volume.

## 112. Resection of Metastatic Mesenchymal Chondrosarcoma of the Thoracic Spine and Review of the Literature

William Lee Titsworth, MD; Jeffery Bennett, MD; Jacquelyn Knapik, MD; Mike Chen, MD; David Pincus, MD, PhD (Gainesville, FL)

Mesenchymal chondrosarcoma (MCS) is an extremely rare form of chondrosarcoma that differs from its conventional form in its young age of onset (20's vs. <50 years old), its poor prognosis and a high proportion of extraskelatal tumors. Here, we present a rare case of spinal MCS. All published cases of spinal MCS then are reviewed and compared to non spinal MCS. We discovered that spinal MCS presents a decade earlier than conventional MCS (10-20 y.o.) and with a marked female predominance (3:1) not seen in conventional MCS. Additionally, when present in the spine, it has a propensity for the lower thoracic and lumbar regions. Finally, aggregation of all spinal MCS cases from the literature shows a median survival time of 82 months with a 5-year and 10-year survival of 72 percent and 43 percent, respectively, and no survival difference between spinal and conventional MCS. Current diagnostic and treatment options are reviewed.

## 113. Retrospective Review of the Incidence of Facial Palsy in Treatment of Posterior Fossa Pediatric Tumors

Norianne M. Pimentel, MD; Mark Krieger, MD; Yasser Jeelani, MD; Caleb Standafer, BS; J. McComb, MD (Monterey Park, CA)

**Objective:** The study examines factors related to the incidence of postoperative facial weakness in children with posterior fossa tumors.

**Methods:** This dataset examined medical records for children diagnosed with infratentorial tumors between June 1, 1991, and June 14, 2011, treated at one institution. One-hundred-ninety-nine patient records (44.7 percent female) were retrospectively analyzed under an IRB approved protocol.

**Results:** Average age at surgery was 7.0±4.6 years old (range: 0 to 19.6 years). There were 99 pilocytic astrocytomas, 67 medulloblastomas, 23 ependymomas and 10 anaplastic ependymomas. Thirteen cases (6.5 percent) presented with facial weakness, preoperatively, and 40 cases (20.1 percent) had a new postoperative facial weakness. Data showed that gender, preoperative symptom duration, histology, extent of resection, chemotherapy and radiation therapy had no significant prognostic value for postoperative facial weakness. There was a statistically significant ( $p<0.05$ ) relationship between craniotomy for recurrent disease and facial weakness. Only 24 of the 157 patients (15.3 percent) with only an initial surgery had postoperative facial weakness. However, 16 of the 42 individuals (38.1 percent) with surgery for recurrent tumor had postoperative facial weakness.

**Conclusion:** Analyses showed a statistically significant ( $p<0.05$ ) association between operation for tumor recurrence and new onset facial nerve weakness.

## 114. Use of an Operating Microscope for Aggressive Surgical Resection Can Improve Survival for Intracranial Ependymoma

Jonathan Jay Stone, MD; Howard Silberstein, MD (Rochester, NY)

**Introduction:** The management of intracranial ependymomas remains a challenging entity. Review of the literature revealed a progression free survival of 23-45 percent and survival rate of 50-67 percent. Advances in surgical operating equipment and radiotherapy have improved clinical outcomes. There appears to be agreement that the extent of surgical resection is strongly correlated to outcome.

**Methods:** All pediatric intracranial ependymomas resected at Strong Memorial Hospital from 2001 through 2011 were retrospectively reviewed. For all cases, a gross total resection (GTR) was performed, which we define as removal of all visible tumor using the operating microscope. This includes adherent tumor meticulously dissected free from the brainstem and cranial nerves. In addition to GTR, all patients received focal radiotherapy.

**Results:** A total of 168 pediatric brain tumors were found, of which 9 cases were intracranial ependymomas (5 percent). The average age at procedure was 6 years old (range 1-17). Three cases were classified as anaplastic ependymoma, and 6 cases were WHO grade 2. Six cases were infratentorial. Two patients received a perioperative ventriculostomy, and the average length of stay was 6 days. The average follow-up length was 4.5 years. One patient had recurrence and died, creating a progression-free and overall survival rate of 88 percent. One patient lost unilateral hearing, and one became shunt dependent; otherwise, there were no immediate or long term complications.

**Conclusion:** Aggressive surgical resection utilizing the operating microscope with adjuvant radiotherapy produces excellent clinical outcomes in comparison to historical reports. The microscope and thorough dissection of adherent tumor were key elements to achieving this low recurrence rate.



## POSTER ABSTRACTS

### 115. Quality Improvement in the Care of Children with Spina Bifida

Hector E. James, MD, FAANS; David Wood, MD; Richard Postlethwait, PA-C; Philipp Aldana, MD (Jacksonville, FL)

**Introduction:** This report provides the quality improvement aspects of the staged process executed to develop a comprehensive multidisciplinary clinic for the longitudinal management of infants, children, and adolescents with spina bifida, including a transition program to the adult medical home.

**Methods:** A quality improvement assessment was performed with a survey of the parents and/or caregivers. A total of 139 families were evaluated from the initial period of the first clinic (2004) through February 2009.

Multidisciplinary support provided in the clinic included, but was not limited to: pediatric neurosurgery, developmental medicine, physical medicine and rehabilitation, pediatric urology, pediatric orthopedics, physical therapy, occupational therapy, child psychology and social services.

**Results:** Of the 139 families evaluated in the clinic, a total of 110 parents/caregivers responded how the clinic assisted in the care of their child. Sixty two percent (62 percent) indicated the clinic allowed them to be better informed about their child's medical condition and care plans; 52 percent stated the healthcare needs were better coordinated than prior to the clinic; and 26 percent responded that the initiation of the clinic had reduced their medical care travel.

**Conclusion:** This multidisciplinary longitudinal management seems to facilitate healthcare delivery and leads to better patient care, as perceived by parents/caregivers.

### 116. Towards the Development of Better Protective Helmet Design: Shear Strain Analysis

Ian M. Heger, MD, FAANS; Ghatu Subhash (Jacksonville, FL)

**Introduction:** Protective helmets are designed to prevent catastrophic injuries cause by linear acceleration. It is clear that they work for this purpose, as head injury mortalities have declined. It is becoming increasingly apparent that milder forms of brain injury have significant morbidity. However, current helmets have not been updated to account for this. Therefore, new ways of testing materials and evaluating their mechanical properties would be advantageous. We propose a method of understanding how helmet materials behave mechanistically to rotational shearing.

**Methods:** The Split Hopkinson pressure bar (SHPB) technique is a popular method to impart high rates of loads. We utilized a polymer SHPB (PSHPB) to load a thin layer of ballistic gelatin, 30 percent corn starch and colloidal silica under high rates of shear. The energy dissipated by the fluids also was calculated.

**Results:** Energy dissipation for colloidal silica, corn starch and ballistic gelatin was calculated. The total energy was 1.5, 1 and 12 Joules, and the maximum energy per unit area was 650, 450 and 10,000 Joules/m<sup>2</sup>, respectively.

**Conclusion:** Using the proposed method, a more scientifically rigorous process to developing helmet prototypes can take place, rather than the current standard.

### 117. Direct, High-Flow Bypass for a Pediatric Giant, Fusiform Aneurysm of the Inferior Division of M2: Case Report and Review of the Literature

Vignesh Alamanda; Luke Tomycz, MD; Dennis Velez, MD; Robert Singer, MD (Nashville, TN)

In this case report, we describe the first reported case of treating a seven-year-old male patient who has a giant, fusiform aneurysm confined to the inferior M2 segment by means of a saphenous vein graft. Given the lack of good endovascular management options for this particular scenario, craniotomy was recommended and an end to side ECA-ICA anastomosis was carried out with technical details of the surgery outlined in the presentation. The patient did not sustain any major post-operative complications. The graft remained patent upon completion of the surgery, and at the time of last follow-up, nine months post surgery. This case serves as an illustrative example of the need for high flow bypass for a select few patients even as endovascular technology continues to improve.

### 118. Eight Second MRI Scan for Ventricular Evaluation in Patients with Shunted Hydrocephalus.

Scott Daniel Wait, MD; Patrick Lingo, BS; Frederick Boop, MD; Stephanie Einhaus, MD (Phoenix, AZ)

**Introduction:** Pediatric patients harboring shunts placed early in life are subjected to numerous radiographic studies during development of their central nervous system. Studies have shown radiation to be detrimental to these young patients. MRI avoids the risk of radiation, but is thought more difficult due to the increased time a young patient must lie motionless during scan acquisition. Standard MRI in children often necessitates sedation. Optimal radiographic interrogation would be quick and radiation free, and allow accurate ventricular evaluation.

**Methods:** The authors reviewed the electronic medical records system of the senior author (SE) for the terms hydrocephalus and shunt malfunction. All patients currently younger than 18 years were included. In the last 5 years, pediatric patients have been evaluated in the office setting with a limited MRI sequence (T1 sagittal, T2 axial, T1 axial and T2 diffusion weighted image (DWI), lasting a total of 178 seconds. In the event of significant motion artifact, the total sequence is abandoned, and an 8-second DWI scan is performed.

**Results:** Forty-four patients were included in the study (20 males, avg age 10.4 yrs). Eighty-eight rapid acquisition scans were ordered. Adequate ventricular evaluation was performed without sedation in every case. In each instance where there was excessive motion artifact, the 8-second scan provided adequate evaluation. Cost analysis is little different than a CT scan.

**Conclusion:** Rapid acquisition MRI scanning avoids the deleterious cumulative effects of radiation in pediatric patients and allows adequate evaluation of the ventricles without the need for sedation and at no increased cost.

### 119. Case Series for a Minimally Invasive Technique for Distal Ventriculoperitoneal Shunt Revision

Christian Burnette Kaufman, MD; Frederick Sklar, MD; David Wrubel, MD (Atlanta GA)

**Introduction:** Shunt revisions represent the single most common surgery in pediatric neurosurgery. The complication rate of shunt surgery remains comparatively high to other neurosurgical procedures. As such, even minor technical advances, which can potentially reduce risk factors such as operative time and operative exposure, may be significantly beneficial, given the large volume of these cases. We present a case series of a minimally invasive technique for distal shunt revisions that we feel is safe and effective for distal revision surgery.

**Methods:** A retrospective analysis of a case where the minimally invasive distal revision technique was used was performed. The technique involves a minimal incision over the distal scar, cutting the distal obstructed tubing, insertion of a soft 0.035 nitinol guide wire through the present distal shunt catheter, removal of the distal catheter over the guidewire, insertion of a 13-French introducer sheath and dilator over the guidewire, removal of the guidewire, insertion of a new distal catheter and peel away removal of the sheath.

**Results:** Forty-two patient cases were identified and reviewed. No operative complications such as vascular injury, bowel perforation or extraperitoneal placement of the distal catheter were noted. No abdominal pseudocyst formation occurred in any patient. No post-operative shunt infections occurred in any of the patients. One patient later underwent complete removal of his shunt system due to exposed shunt hardware at the cranial incision site, although no infection was later identified.

**Conclusion:** The minimally invasive distal revision technique as described and reviewed here appears to be safe, effective and efficient.

## 120. Rapid -Sequence Magnetic Resonance Imaging as a Preferable Alternative in the Post-Operative Period

Dhruve Satish Jeevan, MD; Jayson Neil, MD; Avinash Mohan, MD; Michael Tobias, MD; Hasit Metha, MD; Daphne Li (Valhalla, NY)

**Introduction:** Rapid-Sequence (RS) Magnetic Resonance (MR) imaging was originally used to assess ventricular size in shunted hydrocephalus. The indications for its use have since widened at many institutions. At our institution, it has become the imaging modality of choice for pediatric patients, often used for postoperative follow-up. We document our use of RS MR in non hydrocephalic indications — in particular, its use as a post-operative screening tool.

**Methods:** A retrospective evaluation was performed of all post-operative pediatric patients at our institution who had undergone RS MR imaging for non hydrocephalic indications between July 2009 and September 2010. Key data points then were analyzed, including the need for further CT imaging, image quality, ease of attainment, clinical relevance of findings and clinical outcomes.

**Results:** A total of 40 pediatric patients underwent RS MR imaging in their postoperative period as a follow-up imaging tool. RS MR imaging was used extensively for the initial evaluation and follow-up in selected patients with little need for additional studies. The overall use of CT imaging was negligible, with high-quality imaging being produced with few children requiring sedation. In few occasions, the acquisition of MRI imaging also allowed the detection of postoperative changes that explained clinical findings that would otherwise be neglected on CT imaging, with a low false negative rate.

**Conclusion:** RS MR imaging provides a safe and effective means of imaging in select post-operative pediatric patients, while reducing radiation exposure without the need for sedation.

## 121. Preliminary Experience Using Intraoperative Ultrasound During Surgery for Intractable Epilepsy in Children

Sanjiv Bhatia, MD, FAANS, FACS; Luisa Cervantes, MD; John Ragheb, MD; Nolan Altman, MD (Miami, FL)

**Introduction:** Surgical resection of epileptogenic tissue offers a high chance of seizure control, but the recognition of the margins of the epileptogenic zone can be challenging. Intraoperative electrocorticography and neuronavigation have been used in outlining the epileptogenic zone and outline the boundaries of specific lesions associated with epilepsy. Intraoperative ultrasound imaging can provide information regarding the location and extent of lesions. We describe our preliminary observations using intraoperative US to localize epileptic pathology, guide resection and assist in placement of depth electrodes.

**Methods:** Preoperative and postoperative imaging studies, surgical, pathology reports and hospital records were reviewed retrospectively for 22 procedures where intraoperative ultrasonography was performed during surgery for intractable epilepsy in patients ages 3 months to 17 years.

**Results:** The procedures included lesion resection and electrode placement. Final diagnosis included cortical dysplasia in 8 cases, cortical tubers in 6, tumors in 5 and other lesions in 3. Intraoperative imaging provided valuable information on the localization of the lesion, extent of resection and electrode placement. It was of special value in guiding entry to the lateral ventricle during hemispherectomies. No untoward events attributable to the imaging were encountered. Postoperatively, all patients had documented successful resection of the lesion or placement of electrode.

**Conclusion:** Intraoperative US can safely assist pediatric neurosurgeons during treatment of patients with intractable epilepsy. Its ease of use and ability to distinguish areas of cortical dysplasia from normal brain can help achieve precise resections, guide placement of depth electrodes and assist in performing hemispherectomies.

## 122. Paraspinal Subfascial Placement of Lumbar Intrathecal Baclofen Catheters: Short-term Outcomes of a Novel Technique

Luigi Bassani, MD; David Harter, MD

**Background:** Techniques for the placement of intrathecal baclofen (ITB) systems have been described in detail, with consideration given to complications from hardware placement, including catheter kinking and migration, hardware erosion through the skin and lumbar CSF leak. Patient's low BMI and poor nutritional status along with the bulk of a spinal catheter and fascial connector within the lumbar wound increase the potential for the aforementioned risks. Our experience has led us to develop a novel method of paraspinal subfascial lumbar catheter placement to address these risks.

**Methods:** Twenty patients undergoing ITB system placement by the senior author at NYU Medical Center between July 2010 and March 2011 underwent this technique. A 2-cm midline lumbar incision was created, followed by a 1.5 cm cephalo-caudal fascial opening. A Thore needle was inserted through the incision into thecal sac, lumbar and abdominal catheters placed in the standard fashion and the fascial incision closed, thus placing all hardware subfascial. Patients were followed up by the surgeon and managed by their physiatrist for an average of 6 months.

**Results:** Of the 20 patients undergoing this method, none developed any hardware erosion, catheter migration or CSF leak. One patient developed an abdominal wound infection 3 weeks after implantation, necessitating pump removal.

**Conclusion:** In our initial short term experience, subfascial placement of the lumbar intrathecal catheter may be an improvement over the traditional method. There is reduced risk of catheter migration or kinking, hardware erosion and CSF leak, as well as decreased operative time, all yielding a decreased re-operation rate in this population.

## 123. Importance of Neurologic Exam in Determining Management of Posterior Fossa Epidural Hematomas

Teddy Earl Kim; David Gonda, MD; Hal Meltzer, MD; Michael Levy, MD, PhD (San Diego, CA)

**Introduction:** Posterior fossa epidural hematomas (PFEDH) are considered an emergent condition requiring immediate evacuation to prevent further neurological damage.

**Methods:** The authors performed a retrospective chart review of all children with diagnosis of PFEDH from 2004 to 2009 at Rady Children's hospital with thickness <0.5 cm. Patients were stratified based on treatment modality (surgical vs non-operative), GCS, hydrocephalus, clot thickness and volume, pupil response, midline shift and presence of emesis.

**Results:** Eleven patients met the criteria, of which 9 were managed non operatively. One patient was operated on immediately and another one had delayed surgery 24 hours post admission after failing conservative management. The PFEDH thickness was 1.5 cm and 1 cm, and volume 19 ml and 8 ml in the operated patients. Non operated patients had an average hematoma thickness of 1.7 cm (range 1.2 to 2.5cm) and volume of 11 ml (range 3 to 20ml). Eight of 11 patients had emesis, but none had focal neurologic deficit. Early and delayed operation patients had deteriorating GCS scores from admission, GCS 14 and 13 respectively. Conservatively managed patients had stable or improving GCS scores; all were GCS 15 except for a single patient with an improving GCS 14. Of 3 patients with hydrocephalus on imaging, one was managed surgically, while 2 were managed non operatively. All patients had excellent outcomes, regardless of treatment group.

**Conclusion:** Many PFEDHs can be managed non operatively with close observation, even with thickness greater than 1.0 cm and development of hydrocephalus. Neurological exam is the most reliable criteria for determining surgical candidates with PFEDH.

## POSTER ABSTRACTS

### 124. Spontaneous Cranial Bone Regrowth in an Adolescent After Craniectomy

Daniel Edward Couture, MD; Alexander Powers; Mark Witcher (Winston Salem, NC)

**Introduction:** Reconstruction of osseous defects after hemicraniectomy for trauma remains a significant problem. Alloplastic materials are frequently required to close defects. The ability of calvarial bone to regenerate in these settings is limited after 1 year of age, and significant spontaneous ossification in adolescents has never been reported. The authors report a case of a fifteen-year-old who developed significant autogenous bony regrowth.

**Methods:** A case report is described with a literature review. Imaging studies and histologic examination of the bone was performed.

**Results:** A fifteen-year-old presented with a severe traumatic head injury. He underwent emergency hemicraniectomy and subsequent bifrontal craniectomy. His bone flap was found to be contaminated on routine cultures. He eventually improved and was discharged to an inpatient rehabilitation facility. A methylmethacrylate implant was prepared from post-surgical imaging, but he did not follow-up for approximately five months. Significant bony regrowth occurred in the interim, requiring significant graft reduction. The regrown autologous bone identified intraoperatively demonstrated histologically well developed trabeculae and structural competence.

**Conclusion:** It is generally accepted that neural tissue accommodation dictates the shape and size of the cranial vault. While developmental theory describes volumetric growth of the developing skull, significant regrowth is not addressed. The mechanism is possibly based on delimitation of lateral bony expansion caused by resection, coupled with intact dural and periosteal surfaces, which provide a basal matrix. This phenomenon is previously unreported in this age group. The factors influencing cranial growth must be reviewed to accommodate this finding.

### 125. Ski Club Safety Briefings for Targeting Youth Head and Neck Injury Prevention: A Pilot Study

Michael Vassilyadi, MD, FAANS; Matthew Coyle, BSc; Anastasia Lyras, BSc, MScA (Ottawa, Canada)

**Introduction:** Youth participating in skiing and snowboarding in Quebec account for 59 percent of all injuries seen on the ski hill; 87 percent occur during recreational outings with family and schools, with 19 percent involving the head and neck. As such, we felt that targeting local area elementary and high school ski clubs for an injury prevention program was necessary to: educate ski clubs on safe skiing and snowboarding, present the importance of wearing a helmet, and inform both teachers and students of the signs and symptoms of an injury to the head or spine.

**Methods:** A 45-minute ski club safety briefing was developed consisting of a 15-minute video called "A Little Respect" on ski-hill safety, the ski code of conduct and anatomical models. The total cost of implementing the program was \$60.

**Results:** There were five presentations to 600 students. Following the completion of each presentation, a sample of both teachers and students evaluated the program based on the educational components (average result: 4/5), message of injury prevention during skiing (average result: 4/5) and on the overall presentation (average result: 4/5).

**Conclusion:** This program stands as an opportunity to open a dialogue with and teach youth about downhill sport safety. We plan on prospectively following the injury rates of local area school clubs to determine the true effectiveness of the program. It is hoped that by continually engaging youth through this program that the number of downhill sport related injuries will decrease.

### 126. Prophylactic Antibiotics in Pediatric Open Skull Fractures: A Meta-Analysis

Sandi K. Lam, MD; David Frim, MD, PhD; Peter Warnke, MD (Chicago, IL)

**Introduction:** Controversy exists about the use of prophylactic antibiotics in open skull fractures in the pediatric population.

**Methods:** A systematic review of the literature was performed using PubMed and the search strategies "Open skull fracture children" and "Prophylactic antibiotic skull fracture."

**Results:** Two-hundred-seventy-one papers were found under the first rubric with 9 relevant papers. The second search strategy revealed 41 papers, including one Cochrane review on skull base fractures and a meta-analysis. Five papers were relevant. Selected papers were analyzed according to the Oxford CEBM levels of evidence. The pediatric literature does not support any treatment recommendation at an evidence level 1 or 2, but only at level 3b. The results of these studies are contradictory and support either option. The adult literature contains two randomized controlled trials with adequate cohort sizes, but both deal with skull base fractures. Those represent evidence level 1b data. One trial showed no difference in infection rates versus the other. RCT confirmed this as far as meningitis is affected, but showed an overall reduction of infectious complications in the antibiotic group. The Cochrane analysis again in skull base fractures concluded that only insufficient evidence exists to recommend prophylactic antibiotic treatment, as even the existing RCTs are methodologically flawed, primarily based on inhomogeneous cohorts and insufficient follow-up.

**Conclusion:** Given the prevalence of open skull fractures in children and the economic constraints to be expected in healthcare, a high quality, randomized controlled trial on the use of prophylactic antibiotic treatment for open skull fractures is urgently needed.

### 127. Corticospinal Tract Mapping in Children with Ruptured Arteriovenous Malformations Using Functionally-Guided Diffusion Tensor Imaging

Michael John Ellis, MD; Elysa Widjaja, MD, MBBS, MRCP, FRCP; Abhaya Kulkarni, MD, PhD, FRCSC; Peter Dirks, MD, PhD, FRCSC; James Rutka, MD, PhD, FRCSC (Toronto, Canada)

**Background:** Conventional neuroimaging techniques are limited in their ability to characterize the relationship between functionally eloquent pathways and arteriovenous malformations (AVMs). To improve the accuracy of corticospinal tract (CST) mapping, recent studies have examined the use of functional imaging techniques to help localize cortical motor function and use these as seed points to reconstruct CSTs using diffusion tensor imaging (DTI).

**Methods:** We examined the role of pre treatment functionally-guided DTI CST mapping in three children with ruptured AVMs.

**Results:** In two patients, magnetoencephalography (MEG) motor activations of the affected hemisphere were detected within the expected region of the precentral gyrus. However, in one child, functional magnetic resonance imaging (fMRI) motor activations were detected in both hemispheres suggestive of partial transfer of cortical motor function. Qualitative analysis showed that fractional anisotropy values and fiber density indices were reduced in the CSTs of the hemisphere harboring the AVM compared to the unaffected side. In two children, CST caliber was slightly diminished, corresponding to no motor deficits in one patient and a temporary motor deficit in the other. In contrast, one child demonstrated a significant reduction and displacement of the CSTs, correlating with severe motor deficits. Pre operative imaging findings were confirmed by intra-operative direct cortical motor mapping in two cases treated successfully with surgical resection.

**Conclusion:** These preliminary results confirm the feasibility of CST mapping in children with ruptured AVMs using functionally-guided DTI and tractography. Prospective studies are needed to assess the full value of this technique in the risk stratification, prognosis, and multi-modality management of pediatric AVMs.

## 128. Pial Arteriovenous Fistula: An Institutional Experience

Peter J. Madsen; Shih-Shan Lang, MD; Jared Pisapia, MD; Gregory Heuer, MD, PhD; Robert Hurst, MD (Philadelphia, PA)

**Introduction:** Pial arteriovenous fistulas (PAVFs) are considered subpial, arteriovenous shunts lacking an intervening nidus that represent a rare form of cerebrovascular disease. This entity, overrepresented in the pediatric population, has been reported rarely in literature; thus, the true disease pathogenesis and clinical presentations remain elusive. The aim of this study is to characterize the clinical course, treatment, and outcome of this disease at our institution.

**Methods:** A retrospective review was performed to include all patients in the past 10 years who demonstrated angiographic evidence of a PAVF, including rapid venous filling, large arterial feeder(s) and direct filling of a venous varix.

**Results:** A total of 4 patients, with a mean age of 15.2 years, underwent intervention for a PAVF. These 4 patients all had supratentorial PAVFs involving the MCA. Presenting symptoms included seizure (2), macrocephaly (2), CN III palsy (1), hemiparesis (1) and asymmetric tone (1). Treatments included embolization only, surgery only, and combined embolization and resection of varix. Complications of treatment included hemiparesis and lateral rectus palsy in one patient. Obliteration of the PAVF was proven angiographically in all patients with no recurrences reported.

**Conclusion:** PAVFs represent a rare, yet serious form of cerebrovascular disease with multiple variations in presentation. Prior to the advancement of endovascular techniques, these lesions were effectively treated with surgery. As embolization technology has improved, there is a clear role for endovascular intervention in all age groups whether as a sole interventional technique or in combination with surgery.

## 129. Open Surgical Disconnection for Congenital, Multi-Hole, Pial AV Fistulae in Non-Eloquent Cortex

Alexander S. Maris; Luke Tomycz, MD; Mayshan Ghiassi, MD; Mahan Ghiassi, MD; Dennis Velez, MD; Robert Singer, MD

**Introduction:** Although endovascular methods continue to evolve for the treatment of various intracranial vascular malformations, open surgery may be preferable for a certain subset of pial AV fistulae when the location is superficial and non-eloquent. We report on an incidentally-discovered pial arteriovenous fistula (AVF) in a young girl which was treated with partial embolization followed by definitive open surgical disconnection.

**Methods:** Partial embolization was effected with a nest of platinum coils followed by liquid embolic deposition into the fistulous point. Residual filling of the venous varix was observed via numerous tiny arterial feeders. After a failed attempt at further embolization, open surgical disconnection was performed.

**Results:** Complete obliteration of the fistula was achieved and confirmed with postoperative angiography. There were no complications.

**Conclusion:** Based on the particular characteristics of a subset of pial AV fistulae—(1) multiple, small arterial feeders, (2) superficial location, (3) proximity to non eloquent cortex—open surgical disconnection may be preferable to endovascular treatment strategies. While staged embolization has recently gained popularity as a treatment option, the additive risk of multiple embolizations (eg. thromboembolism, venous congestion), as well as repeated exposure to ionizing radiation should not be understated, especially in the pediatric population.

## 130. Catheter Malfunction in Pediatric Patients with Baclofen Pumps

Julian J. Lin, MD; Arnima Bhasin; Jay Vachhani, MD; Lynne Lyle, RN (Peoria, IL)

**Introduction:** Baclofen pumps are effective in reducing spasticity of cerebral origin. The main indication for pump revisions includes battery failure. We reviewed our series to determine catheter related problems in baclofen pump revision surgeries.

**Methods:** Retrospective review of 17 children who underwent baclofen pump revision surgeries.

**Results:** Over a ten-year period, 28 children underwent baclofen pump implantations; 17 of these patients had a total of 22 revisions. These children ranged from ages 4 to 18 years (mean = 9.52). Pre operation evaluation showed 3 instances of catheter migration as well as 2 abnormal side port aspirations. Of the 22 revision surgeries, 15 (68.2 percent) had pump replacements for battery changes alone, 4 (18.2 percent) suffered from wound infection or dehiscence, and 6 (27.3 percent) had Catheter-related revisions. Of these six catheter-related revisions, two had catheter migrations that led to catheter revision without pump replacement, while four had catheter revisions with pump replacements. Of these 4 patients with both catheter and pump revisions, one catheter was relocated to a higher point in the thoracic spine, another catheter migrated and coiled under the pump, and two had obstructed catheters along with expiring batteries.

**Conclusion:** Given this high rate of catheter malfunction in this series, we routinely order x-rays and aspirate side ports to evaluate catheter placement and function, especially in patients who do not appear to respond or stop responding to intrathecal baclofen.

## 131. Comparison of 5-Year Results Between Pedicle Screw and Hybrid Constructs in Adolescent Idiopathic Scoliosis

Steven W. Hwang, MD; Ben Wormser; Hari Amin, MD; Jeffrey Kimball; Amer Samdani, MD (Boston, MA)

**Introduction:** Pedicle screw fixation has been theorized to provide greater screw purchase, allow more powerful corrective forces and provide better correction of scoliotic deformity. However, controversy over the benefit of pedicle screw only constructs over hybrid instrumentation remains.

**Methods:** We retrospectively reviewed a multicenter database of pediatric patients (ages <18) and identified 127 patients with Lenke 1-4 type adolescent idiopathic scoliosis curves with a minimum 5 years of follow-up who had pedicle screw or hybrid constructs.

**Results:** When comparing preoperative parameters between both groups, differences were noted in the magnitude of the main thoracic curve ( $p=0.04$ ), flexibility of the main thoracic curve ( $p<0.05$ ), coronal balance ( $p=0.05$ ), T2-12 kyphosis ( $p=0.02$ ) and gender ( $p=0.02$ ). The pedicle screw cohort had fewer spinal segments instrumented ( $p<0.05$ ), fewer anterior releases performed ( $p=0.02$ ) and fewer thoracoplasties performed ( $p<0.05$ ). At 2 years of follow-up, both groups had loss some degree of correction in both the sagittal and coronal planes. There was no significant difference in the magnitude of correction loss between both groups ( $p<0.05$ ). By 5 years of follow-up, significant differences were apparent between both cohorts with respect to upper thoracic curvature ( $p=0.01$ ), T2-12 ( $p=0.02$ ) and T5-12 ( $p=0.02$ ) kyphosis; lumbar lordosis ( $p<0.05$ ); and sagittal balance ( $p=0.01$ ). No differences were observed in the thoracic rib hump or lumbar prominence.

**Conclusion:** Although some pre-op differences did exist, outcomes were comparable between hybrid and screw constructs at 2 and 5 years, but hybrid constructs had more concurrent anterior releases, and thoracoplasties to achieve similar results.



## POSTER ABSTRACTS

### 132. Expanding Indications and Device Refinement in Posterior Cranial Vault Distraction Osteogenesis

Raymond Harshbarger, MD; Patrick Combs, MD; Patrick Kelley, MD (Austin, TX)

**Introduction:** Expansion of the posterior cranial vault can be used to treat cephalocranial disproportion and cranial vault dysmorphism. Posterior cranial vault distraction has been described in syndromic patients with craniosynostosis a viable method for expanding the posterior cranial vault, and has potential advantages over traditional expansion. The purpose of this study was to demonstrate the utility of posterior cranial vault distraction osteogenesis for treating a variety of craniosynostosis and cranial vault anomalies.

**Methods:** This was a retrospective analysis of patients who underwent posterior cranial vault distraction osteogenesis to expand the intracranial volume and remodel the cranial vault. Eight patients were identified for inclusion. The demographics, operative and distraction characteristics, complications, and evolution of distraction devices and protocols were reviewed.

**Results:** Of the 8 patients identified, 3 had syndromic multisuture synostosis, 3 had nonsyndromic multisuture synostosis, one had lambdoid synostosis, and one patient had a posttraumatic cranial vault deformity. Clinical, radiographic or ICP monitoring evidence of elevated ICP was found in 7 patients. Two patients underwent asymmetric distraction to correct their deformity. All 8 patients achieved bony union after distraction, and improvement of symptoms related to elevated ICP. Complications included the need for repeat distraction, CSF leak in one patient and minor scalp breakdown.

**Conclusion:** Posterior cranial vault distraction osteogenesis is an effective treatment for a variety of dysmorphologies, including single suture, syndromic, multi suture, and acquired deformities. Asymmetric distraction can be used to correct the underlying deformity. Refinement of a cranial specific distractor has allowed for successful distraction while minimizing complications.

### 133. Complications of Intracranial Monitors (ICMs) in Children

Roberto Rey-Dios, MD; William C. Hanigan, MD, PhD, FAANS (Jackson, MS)

**Introduction:** This study analyzed complications of ICMs in a consecutive series of 46 procedures in 37 children <17 y/o from August 1, 2009, to August 31, 2010.

**Methods:** Prospective clinical investigation.

**Results:** Eight (21.6 percent) patients were <8 y/o. No neonate underwent monitoring. Forty procedures were performed by upper-level residents; 31 procedures were performed in the ICU. Ventricular catheters were used in 40 procedures. Twenty seven (72.9 percent) patients underwent monitoring for < ten days. Thirty seven (80.4 percent) procedures were performed for trauma, shunt malfunction or shunt/ICM infection. All patients received antibiotics; no patient had a coagulopathy. There were two infections, for an incidence of 5.4 percent per patient or 4.3 percent per procedure. Nine (24.3 percent) patients required permanent CSF diversion. One (11.1 percent) patient developed an infection, with minimum follow-up of one year. Insertion and removal were assumed to represent 92 independent chances for hemorrhage. Five (5.4 percent) clinically silent hemorrhages were demonstrated by CT, with a mean volume of 1.4-cc. No hemorrhage occurred following removal.

**Conclusion:** Complications occurred in seven (18.9 percent) of patients with ICMs. The patient infection rate of 5.4 percent paralleled rates for simple shunts, while the incidence of 11.1 percent in permanent CSF diversions following ICMs was similar to rates for complex shunts. Hemorrhages were related to insertion and clinically silent. Patient age, level of resident training, location of insertion, duration and specific illness were not related to the incidence of complications.

### 134. Intracellular Germinoma Mimics Pituitary Adenoma. A Case Report

Rongsheng Cai, MD; Dale Swift, MD (Dallas, TX)

**Introduction:** Isolated intrasellar germinoma is rare. This case report describes an intracranial germinoma mimicking a pituitary adenoma.

**Methods:** A 12-year-old girl presented with a 4-year history of somatic growth retardation, and 2-year history of polyuria and polydipsia. Her height and weight were less than the third percentile. Neurologic examination was normal with full visual fields and 20/20 corrected visual acuity. Laboratory analysis revealed deficiencies in growth hormone, thyroid hormone and cortisol. Prolactin was 44ng/ml. Bone age was 7.6 years. Brain MRI revealed a heterogeneously enhancing intrasellar mass extended into suprasellar cistern. A presumptive diagnosis of non-secreting pituitary macroadenoma was made.

**Results:** She underwent partial resection of the tumor via a transsphenoid approach. Histologic diagnosis was CNS germinoma. Post-operative MRI showed the chiasm to be decompressed, and spinal MRI revealed no leptomeningeal metastases. CSF Alpha-FP and beta-hCG were negative. She was treated with a chemotherapeutic protocol. MRI at 6 months postoperatively demonstrated no tumor.

**Discussion:** Growth retardation in children may be caused by sellar masses, usually pituitary tumors. Since this may be the only symptom for a long period of time, neuroradiography of sellar region should be obtained. CNS germinoma rarely arises within the sella and may be initially mistaken for pituitary adenoma. The pattern of endocrine abnormalities is important in predicting the diagnosis, but ultimately tissue diagnosis may be required. Intraoperative frozen section may abort further tumor resection.

**Conclusion:** Neuroradiological investigation should be considered early for patients with growth retardation and/or diabetes insipidus. Intracranial germinomas are highly treatable and may masquerade intrasellar lesions.

### 135. Seizure History and Tumor Location Independently Predict Outcome in Gangliogliomas in Children

Nathan Joseph Ranalli, MD; Devon Haydon, MD; Matthew Smyth, MD; David Limbrick, MD, PhD; Jeffrey Leonard, MD (Saint Louis, MO)

**Objective:** Gangliogliomas are benign neuroepithelial tumors, but can recur/progress with varying frequency. We reviewed our institution's series of pediatric gangliogliomas in order to identify clinical features that predict progression free survival.

**Methods:** Clinical charts were retrospectively reviewed from St. Louis Children's Hospital. Twenty-seven patients were identified who had been treated for a ganglioglioma between 2000 and 2011. Demographic, radiologic, treatment and outcomes data were collected.

**Results:** Mean age at diagnosis was 10.5 years (range 10 months to 21 years) with a male to female ratio of 1.25:1. Temporal and/or frontal lobe involvement predominated with 16 cases (59 percent). Five tumors were infratentorial. Thirteen lesions were cystic, and all but 3 of the tumors demonstrated gadolinium enhancement on T1-weighted MRI. Seventeen patients presented with seizure (63 percent), while 4 patients had hydrocephalus. Gross total resection was achieved in 14 cases (52 percent). Ten children experienced disease recurrence/progression; one of which occurred 20 months after an MRI-confirmed complete resection. Mean follow-up was 4 years (range 4 months to 12 years). Kaplan-Meier analysis revealed a 5-year progression free survival of 66.3 percent. In univariate analysis, frontotemporal location ( $p=0.00025$ ), seizure ( $p=0.00012$ ), absence of hydrocephalus ( $p=0.0015$ ), and complete resection ( $p=0.006$ ) were all associated with delayed progression. A multivariate Cox regression model identified frontotemporal location ( $p=0.039$ ) and seizure ( $p=0.036$ ) as independent predictors of prolonged progression free survival.

**Conclusion:** Pediatric gangliogliomas are potentially curable neoplasms when complete resection is achieved. However, many subtotally resected and even some completely resected lesions progress requiring additional therapy. Both frontotemporal location and seizure are independently associated with delayed progression. Confirmation of these associations requires additional prospective studies.

## 136. Resection of Intraventricular Subependymal Giant Cell Astrocytomas in Tuberous Sclerosis Complex: Our Institution's Review of 18 Patients

Luigi Bassani, MD; Shaun Rodgers, MD; Jonathon Roth, MD; Orrin Devinsky, MD; Chad Carlson, MD; Jeffery Wisoff, MD; Howard Weiner, MD; David Harter, MD

**Background:** Subependymal giant cell astrocytomas are benign tumors, most commonly associated with Tuberous Sclerosis Complex. The majority arise from the lateral ependymal surface adjacent to the foramen of Monroe, therefore potentially encroaching on one or both foramina resulting in obstructive hydrocephalus, necessitating surgical decompression.

**Methods:** Eighteen patients who underwent craniotomy for SEGAs resection at NYU Medical Center between January 1997 and March 2011 were identified. Preoperative imaging, clinical characteristics, operative procedures and outcomes were reviewed.

**Results:** Eighteen patients underwent 21 surgical procedures for resection of SEGAs. The principal indication for surgery was radiographic progression of the tumor in 16 of 21 surgeries. The average age at time of operation was 9.5 years. Average follow-up was 40 months, ranging from 2 to 112 months. The operative approach was intrahemispheric-transcallosal in fifteen cases, transcortical-transventricular in five and neuroendoscopic in one. Eight tumors were on the right, ten on the left and three bilateral. Gross total resection was documented in fifteen of twenty-one cases, with radical subtotal resection achieved in five and subtotal resection in two. Three patients had undergone ventriculoperitoneal shunt placement pre-operatively and seven patients required shunt placement after surgery. Two patients experienced tumor progression requiring re-operation; both of these patients had initially undergone subtotal tumor resection.

**Conclusion:** Our patients underwent microsurgical resection of SEGAs with acceptable morbidity. Gross total or radical subtotal resection was achieved in 80 percent of cases, with no recurrences occurring. Approximately half of our series required CSF diversionary procedures. There were no instances of permanent neurological morbidity associated with surgery.

## 137. Neither Hydrocephalus Nor the Pre-Resection Use of External Ventricular Drains are Associate with Cerebellar Mutism

Angela Nicole Spurgeon, DO; Heather Spader; John Kestle; Jay Riva Cambrin (Columbia, MO)

**Introduction:** Cerebellar mutism may occur following posterior fossa tumor surgery. The literature detailing risk factors does not address the relationship between pre-resection CSF drainage and the development of cerebellar mutism. The objective of this study was to compare the incidence of cerebellar mutism in patients with and without peri-operative EVD placement.

**Methods:** Records of consecutive pediatric patients with new cerebellar tumors and dorsal exophytic brainstem gliomas at a single institution were included in this retrospective cohort study. Demographic, clinical, and radiological variables were collected and analyzed in a univariate fashion. Regression analysis was planned examining pre-resection EVD and mutism adjusting for known or suspected risk factors including hydrocephalus, vermian incision, pathology, age, tumor size, brainstem compression and invasion.

**Results:** Between July 1999 and June 2011, 22/153 (14.4 percent) patients developed cerebellar mutism following resection. Mutism occurred in 20/106 (18.9 percent) EVD patients and 2/47 (4.3 percent) non-EVD patients (univariate  $p=0.02$ ). However, logistic regression revealed that only vermian incisions ( $p=0.002$ ), larger tumors ( $p=0.02$ ) and presentation with an upper cranial neuropathy ( $p=0.02$ ) were independently associated with mutism. However, the degree of hydrocephalus, preoperative EVD use, pathology, age, brainstem invasion and brainstem compression were not statistically significant.

**Conclusion:** Both the degree of preoperative hydrocephalus and the use of pre-resection EVDs did not have any independent association with the development of cerebellar mutism. To our knowledge, upper cranial neuropathies and a large rostral-caudal dimension have not previously appeared in the literature as risk factors and may be a new focus for future investigations.

## 138. Defining Variation in Management of Children with Sports-Related Concussion: First Step to Standardization

Sara Anne Wilkins; Chevis Shannon, MBA, MPH, DrPH; Michael Falola, MD, MPH; Gavin Reed, MPH; Heloise Jones, MA; Amber King, RN; Drew Davis, MD; James Johnston, MD (Birmingham, AL)

**Introduction:** Patients diagnosed with concussion traditionally have been evaluated in relative isolation across various medical specialties. Recent concussion legislation and emerging medical evidence mandate a guideline based approach to diagnosis and management of sports-related concussion. In preparation for the implementation of a multi disciplinary concussion clinic, we performed a retrospective study to quantify variation in care for sports-related concussions at a single high-volume pediatric hospital.

**Methods:** All patients up to 18 years of age evaluated for sports related concussion between the years 2007 and 2010 were included in this retrospective study. Emergency Department (ED), Sports Medicine and Neurosurgery consultation records were reviewed. Data included patient demographics, injury mechanism, presenting symptoms, discharge instructions and subsequent referrals for specialty care. Descriptive statistical analysis identified incidence trends and management variation across specialties and time.

**Results:** There were 270 sports-related concussions diagnosed during the study period in 224 boys (83 percent) and 56 girls (17 percent), with an average age of 13.5 years. Organized youth football was the most frequent associated sport (49.3 percent). Headaches, dizziness, nausea and balance problems were the most common presenting symptoms. There was significant variation in diagnosis, imaging, coding, management, discharge instructions, and neuropsychological referral guidelines both within and across specialties.

**Conclusion:** As information regarding the long-term sequelae of concussion continues to emerge, patients will be best served by a coordinated multidisciplinary approach to management. Quantification of existing variations in care may be used to inform the successful design, implementation and maintenance of a uniform protocol for management of concussions based on best practice guidelines.

## 139. "Colossal" Breakthrough: The Callosal Puncture as a Precursor to Third Ventriculostomy

David A. Chesler, MD, PhD; Courtney Pendleton, BS; George Jallo, MD; Alfredo Quinones-Hinojosa, MD (Baltimore, MD)

**Introduction:** In 1908, Anton and von Bramann proposed the Balkenstich Method, a corpus callosum puncture which created a communication between the ventricle and subarachnoid space. This method offered the benefit of providing continuous CSF diversion without the implantation of cannula or other shunting devices, yet it received only slight reference in the literature of the time. It remained a novel and perhaps underutilized approach at the time Cushing began expanding his neurosurgical practice at Johns Hopkins Hospital.

**Methods:** Following IRB approval, and through the courtesy of the Alan Mason Chesney Archives, the surgical records of Johns Hopkins Hospital for the period of 1896 to 1912 were reviewed. Patients operated upon by Harvey Cushing were selected.

**Results:** Seven patients underwent puncture of the corpus callosum for treatment of hydrocephalus. Six patients were treated for obstructive hydrocephalus secondary to presumed intracranial lesions. One patient was treated for congenital hydrocephalus.

**Conclusion:** The series reported here documents Cushing's early use of the corpus callosum puncture to divert CSF in patients with obstructive hydrocephalus secondary to intracranial tumors, as well as an attempt to use the procedure in a pediatric patient with congenital hydrocephalus. Notably, three patients developed new onset left-sided weakness post-operatively, possibly due to retraction injury upon the supplementary motor intra operative manipulations.

## POSTER ABSTRACTS

### 140. Harvey Cushing's Early Management of Hydrocephalus: Ventriculosubgaleal Shunting in a Full-Term Infant

David A. Chesler, MD, PhD; Courtney Pendleton, BS; Edward Ahn, MD; Alfredo Quinones-Hinojosa, MD (Baltimore, MD)

**Introduction:** Throughout his early career, Cushing proposed a variety of methods for temporary and permanent drainage and diversion of CSF in his patients, and acknowledged that certain techniques were more suited to particular subsets of hydrocephalus.

**Methods:** Following IRB approval, and through the courtesy of the Alan Mason Chesney Archives, the surgical records of Johns Hopkins Hospital, from 1896 to 1912, were reviewed. Patients operated upon by Harvey Cushing were selected for further analysis. Within this cohort, we recovered all available records for a single patient with hydrocephalus and spina bifida, who was treated with a ventriculosubgaleal shunt prior to repair of the spina bifida.

**Results:** A 3-month old infant presented with hydrocephalus associated with spina bifida. Cushing performed serial lumbar and ventricular punctures. Following this, Cushing took the patient to the operating room for placement of a ventriculosubgaleal shunt. The patient subsequently underwent excision of the myelomeningocele sac, with post-operative mortality due to unspecified causes.

**Conclusion:** Cushing's publications document a preference for translumbar peritoneal drainage in patients with congenital hydrocephalus, particularly those with spina bifida. However, after a series of these procedures culminated in patient mortality from intestinal intussusception, Cushing performed a single ventriculosubgaleal shunt, with limited success.

### 141. Sub-Pericranial Placement of Shunt Valve: A Technique for Preventing Exposed Shunt in Preterm and Malnourished Children

Gyang Markus Bot, MD; Babagana Usman; Nasiru J Ismail (Sokoto, Nigeria)

**Introduction:** An exposed shunt or shunt valve is a serious neurosurgical emergency because of the risk of developing meningitis and ventriculitis, which are associated with high morbidity and mortality. Preterm and malnourished children are at risk of developing an exposed shunt or shunt valve if placed in the subgaleal layer because of the little subcutaneous tissue they possess. Hence, a technique of placing the shunt valve subpericranially to provide a thicker covering was considered.

**Methods:** A skin flap, including the pericranium, was raised and the pericranium dissected from the skull. The shunt introducer is passed, and the pericranium is incised to allow for connection between the subcutaneous layer and the subpericranial space. The shunt valve then is placed in the sub pericranial layer and anchored to the overlying pericranium, the proximal and distal catheter.

**Results:** This technique was carried out in four patients with risk of exposed shunt and shunt valve with good results, such that anchor stitch, which is visible and palpable in the subgaleal placement in preterm or malnourished children, was hardly noticeable in the subpericranial technique.

**Conclusion:** Subpericranial placement of shunt valve for management of preterm and malnourished children with hydrocephalus provides an easy, useful method for the prevention of an exposed shunt valve with its attendant morbidity and mortality. Therefore, this method could be tried in other centers in order to build up accurate statistical data to fully establish the finding of this technique.

## SECTION MEMBERSHIP ROSTER

### **Rick Abbott, MD**

Childrens Hospital At Montefiore  
3316 Rochambeau Ave  
Bronx, NY 10467-2841

### **Jafri Malin Abdullah, MD, PhD**

Hospital Universiti Sains Malaysia  
Neurosciences Jalan Sultanah Zainab 2  
Kota Bharu Kelantan 16150  
Malaysia

### **Laurie Lynn Ackerman, MD**

7614 Spring Ridge Dr  
Indianapolis, IN 46278-9618

### **P. David Adelson, MD, FACS**

Phoenix Children's Hospital  
1919 E Thomas Rd Bldg B  
Phoenix, AZ 85016-7710

### **Shameem Ahmed, MD**

Vrindaban Apt., Flat No. 205  
Chachal Rd. Six Mile  
Guwahati Assam - 781022  
India

### **Edward S. Ahn, MD**

Johns Hopkins Hosp./Neurosurgery  
600 N. Wolfe St. Harvey 811  
Baltimore, MD 21287-0001

### **Gregory W. Albert, MD**

Arkansas Children's Hospital  
Division Of Neurosurgery  
Little Rock, AR 72202-3500

### **Philipp R. Aldana, MD**

836 Prudential Dr, Pavilion Bldg., Ste. 1005  
Jacksonville, FL 32207-8334

### **Tord D. Alden, MD**

Children's Mem. Hosp./Neurosurgery  
2300 Children's Plaza, Box 28  
Chicago, IL 60614

### **Ghanem Al-Sulaiti, MD**

PO Box 1870  
Doha  
Qatar

### **Lance Luke Altenau, MD, FACS**

2100 5th Ave, Ste 200  
San Diego, CA 92101-2102

### **A. Loren Amacher, MD, FRCS**

3 Hospital Dr  
Lewisburg, PA 17837-9362

### **Richard C. E. Anderson, MD**

Neurological Institute  
710 W 168th St, Rm 213  
New York, NY 10032-3726

### **Jim D. Anderson, MD**

PO Box 658  
San Carlos, CA 94070-0658

### **Brian T. Andrews, MD**

45 Castro St, Ste 421  
San Francisco, CA 94114-1031

### **Patricia A. Aronin, MD, MS**

1301 Barbara Jordan Blvd, Ste 307  
Austin, TX 78723-3080

### **Elaine J. Arpin, MD**

### **Wilson T. Asfora, MD, FACS**

1210 W 18th St, Ste 104  
Sioux Falls, SD 57104-4650

### **Kurtis Ian Auguste, MD**

M779 Box 0112  
505 Parnassus Ave.  
San Francisco, CA 94143-0001

### **Anthony Michael Avellino, MD, MBA**

4105 55th Ave NE  
Seattle, WA 98105-4945

### **Saleh S. Baeesa, MBChB, FRCS**

King Abdulaziz University Hospital  
Jeddah 21589  
Saudi Arabia

### **Walter L. Bailey, MD**

500 River St  
Minneapolis, MN 55401-2542

### **Gene A. Balis, MD, FACS**

Neurological Surgeons Associates  
3000 E Fletcher Ave, Ste 340  
Tampa, FL 33613-4645

### **Benedicto Cortes Baronia, MD**

UERM/Neurosurgery  
Room 241 @F Aurora Blvd.  
Quezon City 1113  
Philippines

### **Luigi Bassani, MD**

New York Univ. Med. Ctr.  
550 1st Ave  
New York, NY 10016-6402

### **Darric E. Baty, MD**

4704 Ambassador Caffery Pkwy  
Lafayette, LA 70508-6908

### **David Frederick Bauer, MD**

1120 Castlemaine Dr  
Birmingham, AL 35226-5925

### **Andrew Michael Bauer, MD**

Univ. Of Wisconsin-Madison/Neurosurgery  
600 Highland Ave., Rm. K4/822  
Madison, WI 53792-0001

### **James E. Baumgartner, MD**

3418 Georgetown St  
Houston, TX 77005-2910

### **Robert Micheal Beatty, MD**

12200 W 106th St, Ste 400  
Overland Park, KS 66215-2305

### **Muhittin Belirgen, MD**

800 W Benton St, Apt 310A  
Iowa City, IA 52246-5916

### **William O. Bell, MD**

Neurosurgical Assoc. of The Carolinas  
2810 Maplewood Ave  
Winston Salem, NC 27103-4138

### **Ethan A. Benardete, MD, PhD**

134 Cheswold Ln  
Haverford, PA 19041-1802

### **Benjamin G. Benner, MD**

Neurosurgery Specialists  
6767 S Yale Ave, Ste A  
Tulsa, OK 74136-3303

### **Mitchel S. Berger, MD, FACS**

UCFS/Dept. Of Neurosurgery  
505 Parnassus Ave., M-786  
San Francisco, CA 94143-0001

### **Jose A. Bermudez, MD**

301 Hall St  
Monroe, LA 71201-7526

### **Bryan Bertoglio, MD**

20 Wescott Ln  
South Barrington, IL 60010-9526

### **William B. Betts, MD**

3218 Park Hills Dr  
Austin, TX 78746-5573

### **Sanjiv Bhatia, MD, FACS**

751 Calatrava Ave  
Coral Gables, FL 33143-6203

### **Karin Sabin Bierbrauer, MD**

Cincinnati Children's Med. Ctr.  
3333 Burnet Ave  
Cincinnati, OH 45229-3026

### **Peter M. Black, MD, PhD**

13 Louisburg Sq  
Boston, MA 02108-1202

### **Jeffrey P. Blount, MD, FAAP**

Children's Hospital of Alabama  
1600 7th Ave S Acc 400  
Birmingham, AL 35233-1711

### **John Scott Boggs, MD**

3 Shircliff Way Ste 104  
Jacksonville, FL 32204-4785



## SECTION MEMBERSHIP ROSTER

### **Frederick A. Boop, MD, FACS**

Semmes Murphey Clinic  
1211 Union Ave, Ste 200  
Memphis, TN 38104-6654

### **Robin M. Bowman, MD**

Children's Memorial Hosp.  
2300 Children's Plaza #28  
Chicago, IL 60614

### **William R. Boydston, MD**

Pediatric Neurosurgery Assoc.  
5455 Meridian Marks Rd NE, Ste 540  
Atlanta, GA 30342-4723

### **Ruth E. Bristol, MD**

Phoenix Children's Hospital  
1919 E Thomas Rd, Bldg B  
Phoenix, AZ 85016-7710

### **Douglas L. Brockmeyer, MD**

Primary Children's Med.L Ctr.  
100 Mario Capecchi Dr, #1475  
Salt Lake City, UT 84113-1103

### **Jeffrey A. Brown, MD, FACS**

600 Northern Blvd, Ste 118  
Great Neck, NY 11021-5200

### **Derek A. Bruce, MD**

2577 Township Rd  
Quakertown, PA 18951-3350

### **Michael James Burke, MD, FACS**

Neurosurgery Inst. of South Texas  
3643 S Staples St  
Corpus Christi, TX 78411-2456

### **George T. Burson, MD**

Neurosurgery Arkansas  
9601 Lile Dr, Ste 310  
Little Rock, AR 72205-6325

### **Leslie D. Cahan, MD**

16063 Royal Oak Rd  
Encino, CA 91436-3913

### **Jeffrey W. Campbell, MD**

A.I Dupont Hosp. For Children  
1600 Rockland Rd  
Wilmington, DE 19803-3607

### **Carolyn Marie Carey, MD, FACS**

601 5th St S, #511  
Saint Petersburg, FL 33701-4804

### **Peter W. Carmel, MD**

Umdnj-New Jersey Med. Sch.  
90 Bergen St, Ste 7300  
Newark, NJ 07103-2425

### **Benjamin Solomon Carson, MD**

Johns Hopkins Univ. Hosp.  
600 N. Wolfe St. Harvey 811  
Baltimore, MD 21287-0001

### **Oguz Cataltepe, MD**

Div. Of Neurosurgery  
55 Lake Ave N, Ste S2-848  
Worcester, MA 01655-0002

### **Jeffrey E. Catrambone, MD**

166 Ridge Rd  
Grosse Pointe Farms, MI 48236-3514

### **Juanita Marie Celix, MD**

Harborview Med. Ctr./Neurological Surg.  
325 9th Ave, #359924  
Seattle, WA 98104-2420

### **Michael J. Chaparro, MD, FACS**

Palm West Pediatric and  
Adult Neurosurgery  
12983 Southern Blvd, Ste 202  
Loxahatchee, FL 33470-9207

### **William R. Cheek, MD**

3009 Robinhood St  
Houston, TX 77005-2343

### **Joshua J. Chern, MD, PhD**

1600 7th Ave S, #Ac400  
Birmingham, AL 35233-1711

### **W. Bruce Cherny, MD**

100 E Idaho St, Ste 202  
Boise, ID 83712-6270

### **David A. Chesler, MD, PhD**

Univ. Of Maryland/Neurosurgery  
22 S Greene St, # S12  
Baltimore, MD 21201-1544

### **Maurice Choux, MD**

Residence Solvert/C  
14 Av. Pastre  
13009 Marseille  
France

### **Giuseppe Cinalli, MD**

Apt 21  
Naples 80132  
Italy

### **Samuel F. Ciricillo, MD, FACS**

5238 Fair Oaks Blvd  
Carmichael, CA 95608-5766

### **David Douglas Cochrane, MD**

Childrens & Womens Hlth. Ctr. of BC  
B2W 4500 Oak St.  
Vancouver, BC V6H-3N1  
Canada

### **Alan R. Cohen, MD, FACS**

Rainbow Babies & Children's Hosp.  
11100 Euclid Ave, Rm B501  
Cleveland, OH 44106-1716

### **John Jeffrey Collins, MD**

4759 Ridgetop Dr  
Morgantown, WV 26508-4407

### **Shlomo Constantini, MD, MSc**

Dana Children's Hospital/  
Tel Aviv Med. Center  
6 Weizman St./Ped. Neurosurg.  
Tel Aviv 64239  
Israel

### **Richard A. Coulon Jr., MD**

1600 Medical Center Dr, Ste G500  
Huntington, WV 25701-3659

### **Daniel Edward Couture, MD**

Medical Center Blvd.  
Wake Forest Univ./Baptist Med. Ctr.  
Winston Salem, NC 27157-0001

### **Kerry R. Crone, MD**

Childrens Hosp. Med. Ctr./Neurosurgery  
3333 Burnet Ave. MI 2016  
Cincinnati, OH 45229

### **Daniel J. Curry, MD**

6621 Fannin CCC 1230.00  
Houston, TX 77030

### **Moise Danielpour, MD**

Cedars-Sinai Health Systems  
8631 W 3rd St, Ste 800E  
Los Angeles, CA 90048-5929

### **Silvia Danu, MD**

Apt. 32  
42/2 Independency Str.  
Chisinau 2072  
Republic of Moldova

### **Robert C. Dauser, MD**

Texas Children's Hospital  
6621 Fannin St, Ste 950  
Houston, TX 77030-2303

### **Laurence Davidson, MD**

616 Kemp Mill Forest Dr  
Silver Spring, MD 20902-1565

### **Richard A. Day, MD**

Montana Neurosurgery Ctr.  
2835 Fort Missoula Rd, Ste 202  
Missoula, MT 59804-7424

### **Mark S. Dias, MD**

Pennsylvania State Med. Sch.  
500 University Dr  
Hershey, PA 17033-2360

## SECTION MEMBERSHIP ROSTER

### **Roberto Jose Diaz, MD**

29 Brenton St.  
Toronto, ON M4B-1E1  
Canada

### **John R. Dickerson, MD**

Abay Neuroscience Center  
3223 N Webb Rd Ste 1  
Wichita, KS 67226-8176

### **Michael DiLuna, MD**

611 Admirals Way  
Philadelphia, PA 19146-5222

### **Joseph F. Dilustro, MD**

Children's Hospital  
601 Childrens Ln Ste 5A  
Norfolk, VA 23507-1910

### **Arthur J. DiPatri Jr., MD**

Children's Mem. Hosp./Ped. Neuro.  
2300 Children's Plaza Box 28  
Chicago, IL 60614

### **Peter B. Dirks, MD**

Hospital for Sick Children  
555 University Ave.  
Toronto, ON M5G-1X8  
Canada

### **Concezio Di Rocco, MD**

Univ. Cattolica/Neurochirurgia  
Rome 00168  
Italy

### **David J. Donahue, MD**

Neurosurgery Services  
801 7th Ave Ste 120  
Fort Worth, TX 76104-2733

### **Agustin Dorantes, MD**

Mod 9 Depto 403  
Dr. Navarro #60  
Mexico City, BCN 06720  
Mexico

### **Michael Joseph Dorsi, MD**

1534 Greenfield Ave Apt 303  
Los Angeles, CA 90025-3986

### **James R. Doty, MD, FACS**

Stanford Neurosurgery Outreach  
Melchor Pavilion  
Mountain View, CA 94040-4117

### **James M. Drake, MD**

#1504  
555 University Ave.  
Toronto, ON M5G-1X8  
Canada

### **Bernt Johan Due-Tonnessen, MD**

Rikshospitalet Medical Center  
Dept. of Neurosurgery  
Oslo 0027  
Norway

### **Ann-Christine Duhaime, MD**

Massachusetts General/Pediatric Neuro-  
surgery  
15 Parkman St Bldg 331  
Boston, MA 02114-3117

### **John A. Duncan III, MD, PhD**

2021 Baker St  
San Francisco, CA 94115-1603

### **Charles Cecil Duncan, MD, FACS**

Yale Univ. Sch. of Med.  
333 Cedar St Tmp 419  
New Haven, CT 06510-3206

### **Mary E. Dunn, MD**

225 Smith Ave N Ste 200  
Saint Paul, MN 55102-2534

### **Duc H. Duong, MD, FACS**

1730 Voorhees Ave  
Manhattan Beach, CA 90266-7046

### **Susan R. Durham, MD**

Dartmouth-Hitchcock Mc/Neurosurgery  
1 Medical Center Dr  
Lebanon, NH 03756-1000

### **Michael S. B. Edwards, MD, FACS**

300 Pasteur Dr Rm R211  
Stanford, CA 94305-2200

### **Michael R. Egnor, MD**

Ny Spine & Brain Surgery Pc  
Neurosurgery/Hsc T12-080 Suny  
Stony Brook, NY 11794-0001

### **Stephanie L. Einhaus, MD**

Semmes-Murphey Clinic  
6325 Humphreys Blvd  
Memphis, TN 38120-2300

### **Howard M. Eisenberg, MD**

Univ. of Maryland Med. Ctr.  
22 S Greene St Ste S12D  
Baltimore, MD 21201-1544

### **Samer K. Elbabaa, MD**

SLU - Division of Pediatric Neurosurgery  
Cardinal Glennon Children's Medical Ctr.  
Saint Louis, MO 63104-1003

### **Mostafa A. El Khashab, MD, PhD**

20 Prospect Ave Ste 905  
Hackensack, NJ 07601-1974

### **Richard G. Ellenbogen, MD, FACS**

5706 63rd Ave NE  
Seattle, WA 98105-2040

### **Ibrahim M. El Nihum, MD, FACS**

Scott and White Neuroscience Institute  
2401 S. 31st Street  
Temple, TX 76508-0001

### **Scott W. Elton, MD**

1432 S Dobson Rd Ste 304  
Mesa, AZ 85202-4773

### **Mark D. Erasmus, MD**

1123 Las Lomas Rd NE  
Albuquerque, NM 87106-4524

### **Andrew J. Fabiano, MD**

Dept. of Neurology  
Carlton & Elm St.  
Buffalo, NY 14263-0001

### **Walter J. Faillace, MD, FACS**

10101 Grosvenor Pl Apt 616  
Rockville, MD 20852-4672

### **Neil Arthur Feldstein, MD, FACS**

New York Neurological Inst.  
710 W 168th St Rm 414  
New York, NY 10032-3726

### **Ann Marie Flannery, MD, FACS**

938 Chapel Oaks Rd  
Frontenac, MO 63131-2816

### **Eldon L. Foltz, MD, FACS**

2480 Monaco Dr  
Laguna Beach, CA 92651-1007

### **Arno H. Fried, MD, FACS**

Advanced Neurosurgical Assoc. Pc  
20 Prospect Ave Ste 905  
Hackensack, NJ 07601-1974

### **David M. Frim, MD, FACS**

University of Chicago  
5841 S Maryland Ave # Mc3026  
Chicago, IL 60637-1447

### **Herbert E. Fuchs, MD, PhD**

Duke University Medical Center  
Box 3272  
Durham, NC 27710-0001

### **Daniel H. Fulkerson, MD**

72 Clifden Pond Rd  
Zionsville, IN 46077-8370

### **John Murage Gachiani, MD**

2313 Saint Charles Ave Uppr  
New Orleans, LA 70130-5823

## SECTION MEMBERSHIP ROSTER

### **Joseph H. Galicich, MD**

PO Box 276  
Alpine, NJ 07620-0276

### **Clare Naomi Gallagher, MD**

Foothills Med. Ctr./Clinical Neurosciences  
1403 29th St. N.W.  
Calgary, AB T2N-2T9  
Canada

### **Hugh J. L. Garton, MD, MHSc**

Univ. of Michigan/Mott Children's Hosp.  
1500 E Medical Center Dr  
Ann Arbor, MI 48109-5000

### **Sarah J. Gaskill, MD, FACS**

9909 Emerald Links Dr  
Tampa, FL 33626-2551

### **Robert T. Geertman, MD, PhD**

2500 Metrohealth Dr H-910  
Cleveland, OH 44109-1900

### **Rosemaria Gennuso, MD**

4410 Medical Dr Ste 410  
San Antonio, TX 78229-3749

### **Timothy M. George, MD**

1301 Barbara Jordan Blvd Pediatric  
Center/Ste. 307  
Austin, TX 78723-3077

### **Steven S. Glazier, MD, FACS**

Medical Univ. South Carolina/Neurosurgery  
428Csb PO Box 250616  
Charleston, SC 29425-0001

### **P. Langham Gleason, MD**

1722 9th St  
Wichita Falls, TX 76301-5003

### **Roberta P. Glick, MD**

Mt. Sinai/Neurosurgery  
California at 15th  
Chicago, IL 60608

### **James T. Goodrich, MD, PhD**

Albert Einstein/Montefiore Med. Ctr.  
111 E 210th St  
Bronx, NY 10467-2401

### **Liliana C. Goumnerova, MD, FACS**

300 Longwood Ave Children's Hospital Hun-  
newell 2  
Boston, MA 02115-5724

### **Lance Shane Governale, MD**

72 Longwood Ave  
Brookline, MA 02446-6683

### **Paul A. Grabb, MD**

1725 E Boulder St Ste 104  
Colorado Springs, CO 80909-5740

### **John Andrew Grant, MBChB, FRCS**

Univ. Of Kansas Med. Ctr.  
3901 Rainbow Blvd. Ms 3021  
Kansas City, KS 66160-0001

### **Gerald A. Grant, MD**

Pediatric Neurosurgery  
Box 3272 Dumc  
Durham, NC 27710-0001

### **Patrick C. Graupman, MD**

Gillette Children's  
200 University Ave E  
Saint Paul, MN 55101-2507

### **Clarence S. Greene, MD, FACS**

Neurosurgery  
200 Henry Clay Ave  
New Orleans, LA 70118-5720

### **Stephanie Greene, MD**

Children's Hosp. of Pittsburgh  
45th & Penn/4th Fl. Faculty Pavilion  
Pittsburgh, PA 15201

### **Ronald Thomas Grondin, MD, MSc, FRCSC**

700 Childrens Dr  
Columbus, OH 43205-2664

### **Naina Lynn Gross, MD**

1000 N Lincoln Blvd Ste 400  
Oklahoma City, OK 73104-3252

### **David P. Gruber, MD**

105 W 8th Ave Ste 200  
Spokane, WA 99204-2318

### **Raymond W. Grundmeyer III, MD**

Abay Neuroscience Ctr.  
3223 N Webb Rd Ste 1  
Wichita, KS 67226-8176

### **Jorge H. Guajardo Torres, MD**

Angel Martinez V 2614  
Col. Lomas De Chepe Vera  
Monterrey, BCN 64030  
Mexico

### **Francisco J. Guerrero Jazo, MD**

San Geronimo 2  
Smza 523 Mza 33 Lote 30/Privada del Val-  
paraiso #30  
Cancun 77536  
Mexico

### **Laurance J. Guido, MD**

PO Box 752  
Siasconset, MA 02564-0752

### **Daniel James Guillaume, MD**

3303 SW Bond Ave Mc Ch8N  
Portland, OR 97239-4501

### **William C. Gump, MD**

210 E Gray St Ste 1102  
Louisville, KY 40202-3907

### **Nalin Gupta, MD, PhD**

UCSF-Box 0112  
505 Parnassus Ave. Rm. M779  
San Francisco, CA 94143-0001

### **Walter John Hader, MD**

University of Calgary/Neurosurgery  
1403 29th St. N.W.  
Calgary, AB T2N-2T9  
Canada

### **Yoon Sun Hahn, MD, FACS**

Univ. of Illinois-Chicago Coll. of Med.  
912 S. Wood St./Neurosurg. 4th Fl. N.  
Chicago, IL 60612

### **Stephen J. Haines, MD**

Univ. of Minnesota/Neurosurgery  
420 Delaware St SE Mmc 96  
Minneapolis, MN 55455-0341

### **Mark G. Hamilton, MD**

5028 Vanstone Cr. N.W.  
Calgary, AB T3A-0V9  
Canada

### **Michael Hillel Handler, MD, FACS**

The Children's Hospital  
13123 E 16th Ave  
Aurora, CO 80045-7106

### **William C. Hanigan, MD, PhD**

Univ. Of Mississippi Med. Ctr.  
2500 N State St  
Jackson, MS 39216-4500

### **Todd Cameron Hankinson, MD, MBA**

Children's Hospital Colorado  
Pediatric Neurosurgery  
Aurora, CO 80045-7106

### **Abilash Haridas, MD**

Mt. Sinai Sch. of Med./Neurosurgery  
1 Gustave L Levy Pl # 1136  
New York, NY 10029-6500

### **David Houston Harter, MD**

Nyu Pediatric Neurosurgery  
317 E 34th St  
New York, NY 10016-4974

### **Jason Scott Hauptman, MD**

Ucla/Div. Of Neurosurgery  
Box 957039  
Los Angeles, CA 90095-0001

### **Michael D. Heafner, MD**

Carolina Neurosurgery & Spine Assoc.  
225 Baldwin Ave  
Charlotte, NC 28204-3109

## SECTION MEMBERSHIP ROSTER

### **Michael A. Healy, MD**

Neurosurgical Network Inc.  
2222 Cherry St, Ste M200  
Toledo, OH 43608-2674

### **Ian M. Heger, MD**

836 Prudential Dr, Ste 1005  
Jacksonville, FL 32207-8337

### **Leslie Carl Hellbusch, MD**

Midwest Neurosurgery  
8005 Farnam Dr, Ste 305  
Omaha, NE 68114-3426

### **Robert W. Hendee Jr., MD**

10709 Rigsbee Ct  
Austin, TX 78739-2008

### **Martin M. Henegar, MD**

Carolina Neurosurgery & Spine Assoc.  
225 Baldwin Ave  
Charlotte, NC 28204-3109

### **Robert D. Hollenberg, MD**

4 Walnut Grove  
Dundas, ON L9H-3M4  
Canada

### **Gregory W. Hornig, MD**

Childrens Mercy Hosp./Neurosurgery  
2401 Gillham Rd  
Kansas City, MO 64108-4619

### **Roger J. Hudgins, MD**

Akron Childrens Hosp./  
Ped. Neurosurgery  
1 Perkins Sq  
Akron, OH 44308-1063

### **Robin P. Humphreys, MD, FRCSC F**

67 Lyndhurst Ave.  
Toronto, ON M5R 2Z8  
Canada

### **Namath Hussain, MD**

4284 Echo Rd  
Bloomfield Hills, MI 48302-1943

### **Sung Kyoo Hwang, MD**

Kyungpook Univ. Hosp./Neurosurgery  
50 Samdukdong Chungku  
Daegu 700721  
Republic of Korea

### **Steven W. Hwang, MD**

Dept. of Neurosurgery  
800 Washington St  
Boston, MA 02111-1552

### **Mark R. Iantosca, MD**

Penn State Hershey Med. Ctr./Neurosurgery  
30 Hope Dr, #Ec110  
Hershey, PA 17033-2036

### **David M. Ibrahimi, MD**

1212 Battery Ave  
Baltimore, MD 21230-4302

### **Bermans J. Iskandar, MD**

Univ. of Wisconsin - Madison  
600 Highland Ave., K4/832  
Madison, WI 53792-0001

### **Eric M. Jackson, MD**

2071 Ellington Rd  
Upper Arlington, OH 43221-4138

### **George I. Jallo, MD**

Johns Hopkins Hosp./Pediatric Neurosurg.  
600 N. Wolfe St. Harvey 811  
Baltimore, MD 21287-0001

### **Hector E. James, MD**

Wolfson Childrens Hospital  
836 Prudential Dr Pavilion Building  
Suite 1205  
Jacksonville, FL 32207-8334

### **John A. Jane, Sr. MD, PhD**

Univ. of Virginia Health System  
Box 800212/Neurosurgery  
Charlottesville, VA 22908-0001

### **Andrew H. Jea, MD**

6621 Fannin St Ccc 1230.01  
12th Fl  
Houston, TX 77030-2303

### **David F. Jimenez, MD, FACS**

University of Texas/Neurosurgery  
7703 Floyd Curl Dr # 7843  
San Antonio, TX 78229-3901

### **Rolando Jimenez, MD**

Cordillera Karakorum 572 Lomas 3a Seccion  
San Luis Potosi SLP, BCN 78210  
Mexico

### **John K. Johnson, MD, FACS**

223 Bouchillion Dr  
Greenville, SC 29615-6182

### **Dennis L. Johnson, MD**

4460 Richmond Rd  
Keswick, VA 22947-3117

### **Martin Johnson, MD**

31870 SW Country View Ln  
Wilsonville, OR 97070-7476

### **Mary Morris Johnson, MD, FACS**

3223 Chatham Rd NW  
Atlanta, GA 30305-1101

### **Keyne K. Johnson, MD**

Arnold Palmer Hospital  
83 Columbia St  
Orlando, FL 32806-1101

### **Robert Francis C. Jones, FRCS, FRACS**

Sydney Children's Hospital  
21 Norfolk St.  
Paddington 2021  
Australia

### **Allen S. Joseph, MD, FACS**

Ste. 200  
10101 Park Rowe  
Baton Rouge, LA 70810

### **Kristopher Thomas Kahle, MD, PhD**

110 Melville Ave, #2  
Dorchester Center, MA 02124-2127

### **John E. Kalsbeck, MD**

Riley Hospital For Children  
702 Barnhill Dr  
Indianapolis, IN 46202-5128

### **Paul M. Kanev, MD**

Ct Children's Med. Ctr./Neurosurgery  
282 Washington St  
Hartford, CT 06106-3322

### **Stuart S. Kaplan, MD**

3061 S Maryland Pkwy, Ste 200  
Las Vegas, NV 89109-6227

### **Hakan Karabagli, MD**

Candir Mah  
Candir Sok. Hazal Sitesi #24/C Meram  
Konya 42090  
Turkey

### **Ioannis Karamelas, MD**

Case Western Reserve Univ.  
11100 Euclid Ave  
Cleveland, OH 44106-1716

### **Bruce A. Kaufman, MD, FACS**

999 N 92nd St  
Milwaukee, WI 53226-4875

### **Christian Burnette Kaufman, MD**

Pediatric Neurosurgery Assoc.  
5455 Meridian Marks Rd NE, Ste 540  
Atlanta, GA 30342-4723

### **Colin John Kazina, MD**

GB124  
820 Sherbrook St.  
Winnipeg, MB R3A-1R9  
Canada

### **Robert F. Keating, MD**

Children's National Med. Ctr.  
111 Michigan Ave NW  
Washington, DC 20010-2916

### **Amy H. Kelly, CPNP**

Carolina Neurosurgery & Spine Assoc.  
225 Baldwin Ave  
Charlotte, NC 28204-3109



## SECTION MEMBERSHIP ROSTER

### **David L. Kelly Jr., MD**

Medical Center Dr.  
Wake Forest Univ./Neurosurgery  
Winston Salem, NC 27157-0001

### **Tyler James Kenning, MD**

Thomas Jefferson Univ. Hosp./Neurosurg.  
909 Walnut St, Fl 3  
Philadelphia, PA 19107-5211

### **John R. W. Kestle, MD**

Primary Children's Med. Ctr.  
100 N Medical Dr, Ste 1475  
Salt Lake City, UT 84113-1100

### **David M. Klein, MD**

258 Carolina Meadows Villa  
Chapel Hill, NC 27517-8526

### **Laurence I. Kleiner, MD**

Childrens Medical Center  
1 Childrens Plz  
Dayton, OH 45404-1898

### **Paul Klimo Jr., MD**

1515 Grove Meadow Ct  
Germantown, TN 38138-3332

### **Arnett Klugh, MD**

617 Via Porlezza  
Chula Vista, CA 91914-5303

### **David S. Knierim, MD**

1201 Colony Dr, Apt 40  
Zanesville, OH 43701-6475

### **Edward J. Kosnik, MD**

Columbus Children's Hospital  
700 Childrens Dr  
Columbus, OH 43205-2664

### **Karl F. Kothbauer, MD**

Kantonsspital Luzern/Div. of Neurosurgery  
Dept. of Surgery  
Luzern 6000  
Switzerland

### **Mark D. Krieger, MD**

1300 N Vermont Ave, Ste 1006  
Los Angeles, CA 90027-6005

### **Abhaya Vivek Kulkarni, MD, FRCS**

Hospital for Sick Children/Neurosurgery  
1504 555 University Ave.  
Toronto, ON M5G-1X8  
Canada

### **Cornelius H. Lam, MD**

Univ. of Minnesota  
420 Delaware St SE, #McC96  
Minneapolis, MN 55455-0341

### **Sandi K. Lam, MD**

University of Chicago  
5841 S Maryland Ave, Mc 3026 J341  
Chicago, IL 60637-1447

### **John A. Lancon, MD**

102 Woodmont Hl  
Ridgeland, MS 39157-8819

### **Sergey Nikolay Larionov, MD**

Irkutsk Child Hosp./Neurosurgical Dept.  
Gagarina 4  
Irkutsk 664024  
Russian Federation

### **Jorge A. Lazareff, MD**

Ucla/Neurosurgery  
Box 957039  
Los Angeles, CA 90095-0001

### **Mark Robert Lee, MD**

1301 Barbara Jordan Blvd, Ste 307  
Austin, TX 78723-3080

### **Amy Lee, MD**

1002 Allen Ave  
Saint Louis, MO 63104-3910

### **Jeffrey R. Leonard, MD**

Washington University/Neurosurgery  
660 S Euclid Ave, #8057  
Saint Louis, MO 63110-1010

### **Michael Lee Levy, MD, PhD, FACS**

8010 Frost St, Ste 502  
San Diego, CA 92123-4222

### **Sean M. Lew, MD**

Children's Hospital of Wisconsin  
999 N 92nd St, Ste 310  
Milwaukee, WI 53226-4875

### **Veetai Li, MD**

219 Bryant St  
Buffalo, NY 14222-2006

### **David Delmar Limbrick, MD, PhD**

1 Childrens Pl, 4S20  
Saint Louis, MO 63110-1002

### **Benjamin C. Ling, MD**

105 W 8th Ave, Ste 200  
Spokane, WA 99204-2318

### **Kenneth I. Lipow, MD**

Connecticut Neurosurgical Specialists  
267 Grant St  
Bridgeport, CT 06610-2805

### **Morris D. Loffman, MD**

17173 Strawberry Dr  
Encino, CA 91436-3865

### **Rafael Longo-Cordero, MD**

911 Calle Rochester Urb University Gdns  
San Juan, PR 00927-4812

### **Ralph C. Loomis, MD**

Mountain Neurosurgical & Spine Ctr. P.A.  
7 Vanderbilt Park Dr  
Asheville, NC 28803-1700

### **Jorge Alonso Lopez-Magana, MD**

55/403  
Crepúsculo  
Mexico City, BCN 04530  
Mexico

### **Kenneth M. Louis, MD, FACS**

3000 E Fletcher Ave Ste 340  
Tampa, FL 33613-4645

### **Mark G. Luciano, MD, PhD**

Cleveland Clinic Foundation  
9500 Euclid Ave., S60  
Cleveland, OH 44195-0001

### **Thomas G. Luerksen, MD**

Clinical Care Center  
6621 Fannin St Ccc 1230.10  
Houston, TX 77030-2303

### **Joseph R. Madsen, MD**

Children's Hosp./Brigham & Womens Hosp.  
300 Longwood Ave, Rm 312  
Boston, MA 02115-5724

### **Suresh N. Magge, MD**

1006 Paper Mill Ct NW  
Washington, DC 20007-3619

### **Gail A. Magid, MD**

PO Box 66  
Wilson, WY 83014-0066

### **Gary Magram, MD**

Children's Hosp. Central California/  
Neurosurgery  
9300 Valley Childrens Pl  
Madera, CA 93636-8761

### **Cormac O. Maher, MD**

1522 Newport Creek Dr  
Ann Arbor, MI 48103-2200

### **Kim Herbert Manwaring, MD**

### **Timothy B. Mapstone, MD**

Univ. Of Oklahoma Hsc/Neurosurgery  
1000 N Lincoln Blvd, Ste 400  
Oklahoma City, OK 73104-3252

### **Arthur E. Marlin, MD**

2 Tampa General Cir Fl 7  
Tampa, FL 33606-3603

## SECTION MEMBERSHIP ROSTER

### **Jonathan E. Martin, MD**

471 Deercliff Rd  
Avon, CT 06001-2822

### **Timothy Yefim Maryanov, MD**

Univ. of Nc-Chapel Hill/Neurosurgery  
2160 Bioinformatics Bldg., Box 7060  
Chapel Hill, NC 27599-0001

### **Gary W. Mathern, MD**

University of California—Los Angeles  
710 Westwood Plaza/Neurosurgery  
Los Angeles, CA 90095-0001

### **Todd A. Maugans, MD**

3333 Burnet Ave, McC 2016  
Cincinnati, OH 45229-3026

### **John R. Mawk, MD, JD**

788 Ashland Ave  
Saint Paul, MN 55104-7119

### **Catherine Anne Mazzola, MD**

958 Arapaho Trl  
Franklin Lakes, NJ 07417-2258

### **James P. (Pat) McAllister II, PhD**

Dept. of Neurosurgery  
175 N. Medical Dr. E.  
Salt Lake City, UT 84132-0001

### **David McAuley, MD**

Mill Cottage  
10 Mill Rd./Ballyknockan  
Newtownards  
BT236NG  
United Kingdom

### **Jack E. McCallum, MD**

1 Stevens Dr  
Benbrook, TX 76126-4407

### **J. Gordon McComb, MD**

Univ. Childrens Med. Group  
1300 N Vermont Ave, #1006  
Los Angeles, CA 90027-6005

### **C. Scott McLanahan, MD**

Carolina Neurosurgery & Spine Assoc.  
225 Baldwin Ave  
Charlotte, NC 28204-3109

### **Robert L. McLaurin, MD, JD**

2412 Ingleside Ave, Apt 5C  
Cincinnati, OH 45206-2185

### **David Gordon McLone, MD, PhD**

Children's Memorial Hospital  
2300 Children's Plaza, Ste. 28  
Chicago, IL 60614

### **Sean A. McNatt, MD**

1600 Eureka Rd Mob li  
Roseville, CA 95661-3027

### **P. Daniel McNeely, MD**

PO Box 9700  
5850 University Ave.  
Halifax, NS B3K 6R8  
Canada

### **John Mealey Jr., MD**

9315 Spring Forest Dr  
Indianapolis, IN 46260-1269

### **Michael Dean Medlock, MD**

4 Centennial Dr, Ste 204  
Peabody, MA 01960-7930

### **Joshua Eric Medow, MD**

University of Wisconsin - Madison  
600 Highland Ave./Neurosurgery  
Madison, WI 53792-0001

### **Hatem Salah Megahed, MD**

5114 Pine St  
Bellaire, TX 77401-4910

### **Vivek Mehta, MD, MSc**

Univ. of Alberta/Neurosurgery  
8440-112 St./2D1.02 MacKenzie HSC  
Edmonton, AB T6E-6S8  
Canada

### **Hal S. Meltzer, MD**

8010 Frost St, Ste 502  
San Diego, CA 92123-4222

### **Arnold H. Menezes, MD**

University of Iowa Hospitals  
200 Hawkins Dr  
Iowa City, IA 52242-1007

### **W. Jost Michelsen, MD**

3229 SE Braemar Way  
Port St Lucie, FL 34952-6035

### **Thomas H. Milhorat, MD**

North Shore University Hospital  
300 Community Dr  
Manhasset, NY 11030-3816

### **John I. Miller, MD, FACS**

143 Reade St, Apt 6A  
New York, NY 10013-3900

### **Sanjay N. Misra, MD**

PO Box 1129  
Frisco, CO 80443-1129

### **Mark A. Mittler, MD**

Long Island Neurosurgical Associates  
410 Lakeville Rd, Ste 204  
New Hyde Park, NY 11042-1103

### **Avinash Lalith Mohan, MD**

New York Medical College  
Munger Pavillion, Rm. 329 3rd Fl.  
Valhalla, NY 10595

### **Richard H. Moiel, MD**

3656 Ella Lee Ln  
Houston, TX 77027-4105

### **Jose L. Montes, MD**

Montreal Children's Hospital  
2300 Tupper St., Rm. C819  
Montreal, QC H3H-1P3  
Canada

### **Leon E. Moores, MD**

203 Kent Oaks Way  
Gaithersburg, MD 20878-5614

### **Thomas M. Moriarty, MD, PhD**

210 E Gray St, Ste 1102  
Louisville, KY 40202-3907

### **Michon Morita, MD**

1380 Lusitana St, Ste 712  
Honolulu, HI 96813-2443

### **Nobuhito Morota, MD**

Neurosurgery/NCCHD  
2-10-1 Ohkura/Setagaya  
Tokyo 1578535  
Japan

### **William Joseph Morris, MD**

915 6th Ave, Ste 2  
Tacoma, WA 98405-4682

### **Glenn Morrison, MD, FACS**

980 Lugo Ave  
Coral Gables, FL 33156-6323

### **Luis Rafael Moscote-Salazar, MD**

Apt. 301  
Cra 45 A No 134 A-40  
Bogota  
Colombia

### **S. David Moss, MD**

Cardon Children's Hospital  
1432 S Dobson Rd  
Mesa, AZ 85202-4768

### **Carrie Rebecca Muh, MD**

1675 Reserve Way  
Decatur, GA 30033-1542

### **Michael S. Muhlbauer, MD**

Semmes Murphey Clinic  
6325 Humphreys Blvd  
Memphis, TN 38120-2300

### **Michael G. Muhonen, MD**

1010 W La Veta Ave, Ste 710  
Orange, CA 92868-4306

### **Lorenzo F. Munoz, MD**

1725 W Harrison St, Ste 970  
Chicago, IL 60612-3828

## SECTION MEMBERSHIP ROSTER

### **Karin M. Muraszko, MD**

1500 E Medical Center Dr  
3470 Tc/Neurosurgery  
Ann Arbor, MI 48109-5000

### **John S. Myseros, MD, FACS**

Children's National Med. Ctr.  
111 Michigan Ave NW  
Washington, DC 20010-2916

### **Joseph M. Nadell, MD**

2920 Camp St  
New Orleans, LA 70115-2204

### **Mahmoud G. Nagib, MD**

800 E 28th St, 305 Piper Bldg.  
Minneapolis, MN 55407-3723

### **Prithvi Narayan, MD**

6 Scudder Ct  
Pennington, NJ 08534-2325

### **Tien Trong Nguyen, MD**

11190 Warner Ave, Ste 305  
Fountain Valley, CA 92708-4047

### **Michael F. Nido, PA-C**

Carolina Neurosurgery & Spine Assoc.  
225 Baldwin Ave  
Charlotte, NC 28204-3109

### **Dimitrios C. Nikas, MD**

323 W Concord Pl, Apt 5  
Chicago, IL 60614-5732

### **W. Jerry Oakes, MD**

Children's Hospital of Alabama  
1600 7th Ave S, Acc 400  
Birmingham, AL 35233-1711

### **Mark Stephen O'Brien, MD**

Arkansas Children's Hospital  
800 Marshall St, Lot 838  
Little Rock, AR 72202-3510

### **Eylem Ocal, MD**

21801 Flanders Ct  
Ashburn, VA 20147-6730

### **Jeffrey G. Ojemann, MD**

Children's Hosp. & Regional Med.  
4800 Sand Point Way NE, #W-7729  
Seattle, WA 98105-3901

### **Greg Olavarria, MD**

Pediatric Neurosurgery  
83 Columbia St  
Orlando, FL 32806-1101

### **Brent Randle O'Neill, MD**

13123 E 16th Ave, B 330  
Aurora, CO 80045-7106

### **Kaine Chamberlain Onwuzulike, MD, PhD**

3314 Berkshire Rd  
Cleveland Heights, OH 44118-2527

### **Renatta J. Osterdock, MD**

1601 E 19th Ave, Ste 5125  
Denver, CO 80218-1216

### **Larry Keith Page, MD**

13845 SW 73rd Ct  
Palmetto Bay, FL 33158-1213

### **Dachling Pang, MD**

Kaiser Permanente Hospital  
280 W Macarthur Blvd  
Oakland, CA 94611-5642

### **Andrew D. Parent, MD**

University of Mississippi Medical Center  
2500 N State St  
Jackson, MS 39216-4500

### **Tae Sung Park, MD**

6 Brentmoor Park  
Saint Louis, MO 63105-3002

### **Michael David Partington, MD**

Gillette Children's Specialty Healthcare  
200 University Ave E  
Saint Paul, MN 55101-2507

### **Jogi Venkata Pattisapu, MD**

80 Bonnie Loch Ct  
Orlando, FL 32806-2908

### **Jerry O. Penix, MD**

928 Holladay Pt  
Virginia Beach, VA 23451-3913

### **Joseph H. Piatt Jr., MD**

251 Linden Ln  
Merion Station, PA 19066-1711

### **Prem K. Pillay, MBBS, FACS**

Asian Brain-Spine-Nerve Center  
3 Mt. Elizabeth, #15-03  
Singapore 228510  
Singapore

### **David W. Pincus, MD, PhD**

University Of Florida—Gainesville  
Box 100265  
Gainesville, FL 32610-0001

### **Thomas Pittman, MD**

Univ. of Kentucky Med. Ctr.  
800 Rose St., Rm. Ms105-A  
Lexington, KY 40536-0001

### **Ian F. Pollack, MD**

Children's Hospital of Pittsburgh  
3705 5th Ave  
Pittsburgh, PA 15213-2584

### **Harold D. Portnoy, MD, FACS**

3100 W Long Lake Rd  
West Bloomfield, MI 48323-1839

### **Mark R. Proctor, MD**

Childrens Hospital  
300 Longwood Ave, Hunnewell 2  
Boston, MA 02115-5724

### **Mark J. Puccioni, MD**

Midwest Neurosurgery  
8005 Farnam Dr, Ste 305  
Omaha, NE 68114-3426

### **Patricia B. Quebada-Clerkin, MD**

566 W Enterprise Ave  
Clovis, CA 93619-8356

### **Joseph V. Queenan, MD**

2518 Delancey St  
Philadelphia, PA 19103-6457

### **Taophee Bamidele Rabiou, MD**

Division of Neurological Surgery  
Department of Surgery  
Ido-Ekiti 372001  
Nigeria

### **Corey Raffel, MD, PhD**

Nationwide Children's Hospital  
700 Childrens Dr  
Columbus, OH 43205-2664

### **John Ragheb, MD, FACS**

Ambulatory Care Bldg./Ped. Neuros.  
3215 S.W. 62nd Ave., Ste. 3109  
Miami, FL 33155

### **Nathan Joseph Ranalli, MD**

Loft 110  
1445 S 18th St  
Saint Louis, MO 63104-2560

### **Mahmoud Rashidi, MD**

4 Hawthorne Dr  
Bedford, NH 03110-6983

### **Donald H. Reigel, MD**

4222 Corton Ct  
Allison Park, PA 15101-2877

### **Harold Louis Rekate, MD**

865 Northern Blvd  
Great Neck, NY 11021-5335

### **Ann M. Ritter, MD**

Virginia Commonwealth University  
PO Box 980631  
Richmond, VA 23298-0631

### **Jay K. Riva-Cambrin, MD**

100 Mario Capecchi Dr, Ste 1475  
Salt Lake City, UT 84113-1103

## SECTION MEMBERSHIP ROSTER

### **Elias B. Rizk, MD**

517 Northstar Dr  
Harrisburg, PA 17112-8963

### **Shenandoah Robinson, MD**

Rainbow Babies & Children's Hosp.  
11100 Euclid Ave, Rbc B501  
Cleveland, OH 44106-1716

### **Walker L. Robinson, MD**

Carle Clinic & Foundation Hosp.  
602 W University Ave  
Urbana, IL 61801-2530

### **Brandon Rocque, MD**

Dept. of Neurosurgery  
600 Highland Ave., Rm. K4/822  
Madison, WI 53792-0001

### **Luis Alberto Rodriguez, MD**

Memorial Healthcare  
1150 N 35th Ave, Ste 300  
Hollywood, FL 33021-5428

### **Luis F. Rodriguez, MD**

All Children's Hospital  
601 5th St., Ste. 511  
St. Petersburg, FL 33701

### **Armando Romero-Perez, MD**

815 - A  
Kepler 2143  
Puebla, BCN 72190  
Mexico

### **Bruce R. Rosenblum, MD**

160 Avenue At The Cmn, Ste 2  
Shrewsbury, NJ 07702-4570

### **Alan D. Rosenthal, MD, FACS**

7840 Talavera Pl  
Delray Beach, FL 33446-4321

### **Allen S. Rothman, MD, FACS**

421 Huguenot St, Ste 36  
New Rochelle, NY 10801-7021

### **Curtis J. Rozzelle, MD**

1600 7th Ave S, Acc400  
Birmingham, AL 35233-1711

### **John R. Ruge, MD, FACS**

1409 Burr Oak Rd, Apt 404A  
Hinsdale, IL 60521-8617

### **James T. Rutka, MD, PhD**

Hospital for Sick Children  
555 University Ave., #1503  
Toronto, ON M5G-1X8  
Canada

### **Petr O. Ruzicka, MD**

Banner Children's Hosp/  
Pediatric Neurosurgery  
1432 S Dobson Rd, Ste 304  
Mesa, AZ 85202-4773

### **Rajeet Saluja, MD**

Montreal Neuro. Inst./Neurosurgery  
3801 University St., #109  
Montreal, QC H3A-2B4  
Canada

### **David I. Sandberg, MD**

441 Ridge Rd  
Coral Gables, FL 33143-6475

### **Amanda Muhs Saratsis, MD**

1320 N Veitch St, Unit 1533  
Arlington, VA 22201-6218

### **Osamu Sato, MD**

#404 Celeas Actia  
2-13-6 Utuskushigaoka  
Aoba Yokohama  
225-0002  
Japan

### **Steven J. Schiff, MD, PhD**

Pennsylvania State Univ.  
212 Earth-Engineering Sci. Bldg.  
University Park, PA 16802

### **Steven J. Schneider, MD, FACS**

Long Island Neurosurgical Associates  
410 Lakeville Rd, Ste 204  
New Hyde Park, NY 11042-1103

### **Luis Schut, MD**

### **R. Michael Scott, MD**

The Children's Hosp. Boston  
300 Longwood Ave, Hunnewell 2  
Boston, MA 02115-5724

### **Mehmet Selcuki, MD, PhD**

CB Univ. Sch. of Med./Neurosurgery  
1403 sk 5/8 Alsancak  
Izmir 35220  
Turkey

### **Nathan R. Selden, MD, PhD**

3303 SW Bond Ave  
Oregon Health & Science Univ. Ch8N  
Portland, OR 97239-4501

### **Wan Tew Seow, MD**

94 Greenwood Ave.  
Singapore 289300  
Singapore

### **Thomas J. Sernas, PA-C MS**

100 Madison Ave, #29  
Morristown, NJ 07960-6136

### **David H. Shafron, MD**

Dept. of Neurosurgery  
1919 E Thomas Rd  
Phoenix, AZ 85016-7710

### **Ronald F. Shallat, MD**

33 Evergreen Dr  
Orinda, CA 94563-3114

### **Haitham Handhal Shareef, MBChB, IBMS**

Al Hussein Teaching Hospital  
Nasiriyah  
Thi Qar 00000  
Iraq

### **John Shillito, MD**

102 Cedar Meadows Ln  
Chapel Hill, NC 27517-7218

### **Howard J. Silberstein, MD**

1445 Portland Ave, Ste 305  
Rochester, NY 14621-3044

### **James C. Simmons, MD**

177 N Highland St Apt 4209  
Memphis, TN 38111-4777

### **Gary Robert Simonds, MD**

2710 Wycliffe Ave SW  
Roanoke, VA 24014-2338

### **Robert J. Singer, MD**

416 Powder Mill Rd  
Nashville, TN 37205-3226

### **Ashutosh Singhal, MD, FRCSC**

Dept. of Neurosurgery K3-159  
4480 Oak St.  
Vancouver, BC V6H-3V4  
Canada

### **Stanley O. Skarli, MD, FACS, FAAP**

414 Plymouth Ave NE Ofc  
Grand Rapids, MI 49505-6038

### **Frederick H. Sklar, MD**

Neurosurgeons for Children  
1935 Medical District Dr  
Dallas, TX 75235-7701

### **Lenwood P. Smith Jr., MD**

University Specialty Clinics  
3 Medical Park Rd., Ste. 310  
Columbia, SC 29203

### **Jodi L. Smith, PhD, MD**

702 Barnhill Dr, Ste 1134  
Indianapolis, IN 46202-5128

### **Edward Robert Smith, MD**

Children's Hospital Boston/Neurosurgery  
300 Longwood Ave  
Boston, MA 02115-5724



## SECTION MEMBERSHIP ROSTER

### Harold P. Smith, MD

### Matthew D. Smyth, MD

St. Louis Children's Hospital  
1 Childrens Pl  
Saint Louis, MO 63110-1002

### Debbie K. Song, MD

Gillette Children's Specialty Healthcare  
200 University Ave E  
Saint Paul, MN 55101-2507

### Sandeep Sood, MD

Pediatric Neurosurgery Group Pc  
3901 Beaubien St, Fl 2  
Detroit, MI 48201-2119

### Mark M. Souweidane, MD

Dept. Neurological Surgery  
525 E 68th St, # 99  
New York, NY 10065-4870

### Sherman Charles Stein, MD

310 Spruce St  
Philadelphia, PA 19106-4201

### Paul Steinbok, MD

British Columbia Children's Hosp.  
4480 Oak St., Rm. K3-159  
Vancouver, BC V6H-3V4  
Canada

### Thomas C. Steineke, MD, PhD

New Jersey Neuroscience Inst.  
65 James St  
Edison, NJ 08820-3947

### Charles B. Stevenson, MD

3075 Victoria Ave  
Cincinnati, OH 45208-1505

### Bruce B. Storrs, MD, FACS

138 Diamond Tail Rd  
Placitas, NM 87043-8338

### Timothy Alexander Strait, MD

Neurosurgical Group of Chattanooga  
1010 E 3rd St, Ste 202  
Chattanooga, TN 37403-2174

### Douglas L. Stringer, MD

2011 Harrison Ave  
Panama City, FL 32405-4545

### Merle Preston Stringer, MD

2011 Harrison Ave  
Panama City, FL 32405-4545

### Peter P. Sun, MD

Children's Hospital of Oakland  
744 52nd St  
Oakland, CA 94609-1810

### Leslie N. Sutton, MD

Children's Hospital of Philadelphia  
34th & Civic Center Blvd.  
Philadelphia, PA 19104

### Dale M. Swift, MD

Neurosurgeons for Children  
1935 Motor St, Fl 3  
Dallas, TX 75235-7794

### Artur Szymczak, MD

633 Thistlewood Dr.  
London, ON N5X-4L9  
Canada

### Michael S. Taekman, MD

15 Oakmont Ct  
San Rafael, CA 94901-1235

### Muhammad Zubair Tahir, MD

Aga Khan Univ. Hosp./Neurosurgery,  
Stadium Rd.  
Karachi  
Pakistan

### Mandeep Singh Tamber, MD, PhD

Children's Hosp. of Pittsburgh  
4401 Penn Ave, Fl 4  
Pittsburgh, PA 15224-1334

### Izabela Tarasiewicz, MD

5 Fletcher Pl 111 Colchester Ave  
Burlington, VT 05401-1419

### Kimberly D. Terry, MD

7 Park Mtn  
San Antonio, TX 78255-2178

### Willard D. Thompson Jr., MD

Neurological Inst. Of Savannah  
4 E Jackson Blvd  
Savannah, GA 31405-5810

### Ashley Grosvenor Tian, MD

313 6th Ave  
Menlo Park, CA 94025-1838

### Michael E. Tobias, MD

New York Medical College  
Munger Pavillion  
Valhalla, NY 10595

### Tadanori Tomita, MD

Children's Memorial Hospital  
2300 Children's Plaza, Ste. 28  
Chicago, IL 60614

### Zulma Sarah Tovar-Spinoza, MD

Suny Upstate Med. Univ.  
750 E Adams St  
Syracuse, NY 13210-2342

### Eric R. Trumble, MD

615 E Princeton St, Ste 540  
Orlando, FL 32803-1424

### Gerald F. Tuite Jr., MD

601 5th St S, Ste 510  
Saint Petersburg, FL 33701-4804

### Noel Tulipan, MD

8533 McCrory Ln  
Nashville, TN 37221-5911

### Michael S. Turner, MD

Indianapolis Neurosurgical Group  
1801 Senate Blvd, Ste 610  
Indianapolis, IN 46202-1259

### Rachana Tyagi, MD

125 Paterson St, # 2100  
New Brunswick, NJ 08901-1962

### Gary William Tye, MD

Neurosurgery/McV Campus  
417 N 11th St, Fl 6  
Richmond, VA 23298-5002

### Elizabeth C. Tyler-Kabara, MD, PhD

Children's Hosp. of Pittsburgh  
4401 Penn Ave  
Pittsburgh, PA 15224-1334

### David D. Udehn, MD, FACS

800 Cooper Ave, Ste 8  
Saginaw, MI 48602-5373

### Ronald H. Uscinski, MD

5530 Wisconsin Ave, Ste 1147  
Chevy Chase, MD 20815-4330

### Shobhan H. Vachhrajani, MD

3001-736 Bay St.  
Toronto, ON M5G-2M4  
Canada

### Payman Vahedi, MD

Tabriz Univ. of Med. Sci.  
Imam Reza Hosp./Golgasht St.  
Tabriz 5166614756  
Iran (Islamic Republic of)

### Rene Vargas Pacheco, MD

16  
J Toorez, #790  
Mexico, BCN 08200  
Mexico

### Adan Agreda Vasquez, MD

Dr. Jimenez 340  
Col. Doctores  
Cuauhtemoc, BCN 06720  
Mexico

## SECTION MEMBERSHIP ROSTER

### **Michael Vassilyadi, MD**

Children's Hospital East Ontario  
401 Smyth Rd.  
Ottawa, ON K1H 8L1  
Canada

### **Dominic Venne, MD, MSc**

Shaikh Khalifa Medical City  
PO Box 51900  
Abu Dhabi  
United Arab Emirates

### **Enrique C. Ventureyra, MD**

Children's Hospital East Ontario  
401 Smyth Rd.  
Ottawa, ON K1H-8L1  
Canada

### **John Kenric Vries, MD**

Univ. of Pittsburgh Med. Ctr./Medical  
Archival Systems  
1370 Beulah Rd, Bldg 5  
Pittsburgh, PA 15235-5068

### **Margaret Rose Wacker, MD**

603 Harp Pl  
Redlands, CA 92373-5664

### **Brian P. Walcott, MD**

4 Emerson Pl, Apt 311  
Boston, MA 02114-2277

### **Steven L. Wald, MD**

469 White Horse Trl  
Palm Desert, CA 92211-8947

### **John B. Waldman, MD, FACS**

Albany Medical College  
47 New Scotland Ave. Mc-10 NE  
Albany, NY 12208

### **Marion L. Walker, MD**

Primary Children's Med. Ctr.  
100 Mario Capecchi Dr, # 1475  
Salt Lake City, UT 84113-1103

### **John Willson Walsh, PhD, MD**

Tulane Univ. Sch. Of Med.  
1430 Tulane Ave, # SI47  
New Orleans, LA 70112-2632

### **Kyu-Chang Wang, MD, PhD**

Div. of Pediatric Neurosurgery  
101 Daehang-no/Jongno-gu  
Seoul 110744  
Republic of Korea

### **John D. Ward, MD**

Medical College of Virginia  
PO Box 980631  
Richmond, VA 23298-0631

### **Daryl E. Warder, MD, PhD**

Bronson Neurological Services  
601 John St Ste M-124  
Kalamazoo, MI 49007-5377

### **Monica C. Wehby, MD**

5815 SW Orchid Dr  
Portland, OR 97219-9101

### **Howard L. Weiner, MD**

New York University Med. Ctr.  
317 E 34th St, # 1002  
New York, NY 10016-4974

### **Martin H. Weiss, MD, FACS**

Lac-Usc Medical Center  
1200 N State St, Ste 5045  
Los Angeles, CA 90033-1029

### **John C. Wellons III, MD**

Children's Hospital of Alabama  
1600 7th Ave S, Acc 400  
Birmingham, AL 35233-1711

### **Bradley E. Weprin, MD**

Neurosurgeons for Children  
1935 Motor St, Fl 3  
Dallas, TX 75235-7794

### **Nicholas M. Wetjen, MD**

Gonda 8  
200 First St., S.W.  
Rochester, MN 55905-0001

### **William E. Whitehead, MD, MPH**

Pediatric Neurosurgery  
6621 Fannin St, #Cc1230.01  
Houston, TX 77030-2303

### **Jean K. Wickersham, MD**

1535 Virginia Way  
La Jolla, CA 92037-3836

### **Ronald J. Wilson, MD**

Austin Brain & Spine  
801 W 38th St, Ste 400  
Austin, TX 78705-1103

### **James T. Wilson, MD**

Maine Medical Partners  
49 Spring St  
Scarborough, ME 04074-8926

### **Joel W. Winer, MD**

Wellspan Neurosurgery  
228 Saint Charles Way  
York, PA 17402-4644

### **Ken Rose Winston II, MD**

The Children's Hospital  
13123 E 16th Ave  
Aurora, CO 80045-7106

### **Jeffrey H. Wisoff, MD**

317 E 34th St Ste 1002  
New York, NY 10016-4974

### **Daniel Won, MD**

1127 21st St, Unit 2  
Santa Monica, CA 90403-5624

### **Meredith V. Woodward, MD**

Valley Children's Hospital  
9300 Valley Children's Pl.  
Madera, CA 93638

### **David Michael Wrubel, MD**

5455 Meridian Marks Rd NE, Ste 540  
Atlanta, GA 30342-4723

### **Shokei Yamada, MD**

5410 Via San Jacinto  
Riverside, CA 92506-3647

### **Esmiralda Yeremeyeva, MD**

410 W 10th Ave  
Columbus, OH 43210-1240

### **Juneyoung Yi, MD**

750 E Adams St  
Syracuse, NY 13210-2342

### **Karol Zakalik, MD, FACS**

William Beaumont Hospital  
3535 W 13 Mile Rd, Ste 636  
Royal Oak, MI 48073-6770

### **Ahmad Zakeri, MD**

4235 Secor Rd  
Toledo, OH 43623-4231

### **Edward J. Zampella, MD**

Atlantic Neurosurgical Specialists  
310 Madison Ave, Ste 200  
Morristown, NJ 07960-6967

### **Boris Zivny, MD**

Za Rybníkem 711  
Jesenice u Prahy CZ - 252 42  
Czech Republic

### **Alexander Zouros, MD**

Llunc/Neurosurgery  
11234 Anderson St, Rm 2562B  
Loma Linda, CA 92354-2804

### **John G. Zovickian, MD**

Permante Med. Group/Ped. Neuros.  
280 W Macarthur Blvd  
Oakland, CA 94611-5642

### **Marike Zwienenberg-Lee, MD**

Dept. of Neurosurgery  
4860 Y St, Ste 3740  
Sacramento, CA 95817-2307

## NOTES

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**41<sup>ST</sup> ANNUAL MEETING OF THE AANS/CNS  
SECTION ON PEDIATRIC NEUROLOGICAL SURGERY**

**November 27 – 30, 2012  
Marriott St. Louis  
St. Louis, MO**

**SAVE THE DATE**