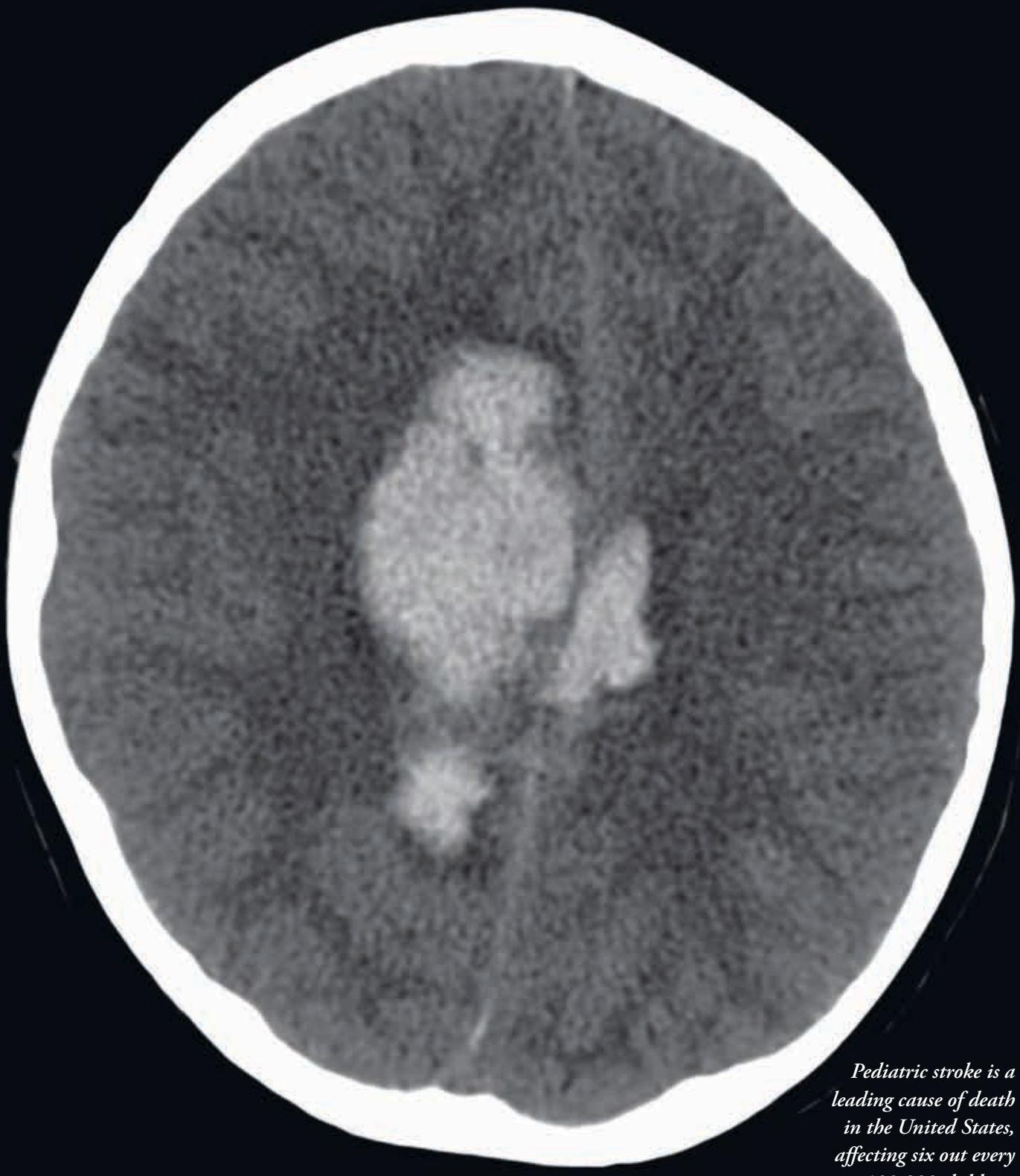
The best outcome means allowing each child to reach their fullest potential as human beings. Optimal treatment of their medical condition is important, but we also need to make certain that each patient and each family has the information and support they need to fully engage with life. Twenty years ago, our primary focus was on the child's therapy. Now we also look at how they function within society - a much more holistic perspective.

– E. Steve Roach, MD
Chief, Neurology

Neurosciences



Pediatric stroke is a leading cause of death in the United States, affecting six out every 100,000 children.

Researchers Develop Tool to Measure Long-Term Outcomes of Pediatric Stroke

A study of a new questionnaire developed by neurologists at Nationwide Children's Hospital suggests it could help researchers collect valuable data on outcomes of pediatric stroke that the existing assessment tool misses. The new tool makes it possible to collect information on patients' post-stroke functioning over the telephone instead of in person, which could expand scientists' understanding of the long-term impact of pediatric stroke, says **Warren D. Lo, MD**, director of the Stroke and Vascular Anomalies Clinic at Nationwide Children's, architect of the questionnaire and lead author of the study.

For years, the only tool available for measuring post-stroke functioning was the Pediatric Stroke Outcome Measure, which must be administered during patients' follow-up visits. Many stroke patients are unable to return for those follow ups, meaning that important data from those cases was lost. The new survey, called the Recurrence and Recovery Questionnaire (RRQ), includes 13 questions modeled after the existing assessment tool but designed to be delivered via a telephone interview.

To study the new survey's performance, Dr. Lo and colleagues administered both surveys to 232 children who had suffered a stroke and their caregivers. When they compared the results, the researchers found that the surveys resulted in similar patient outcomes data. While the new questionnaire wouldn't replace the existing assessment tool, the researchers say it provides a valid means for collecting data from patients that might otherwise be lost.

"A problem with collecting longitudinal outcome data is that patients may not show as scheduled for follow-up visits and that outcome information would normally be lost. The RRQ should enable investigators to fill in that missing information," says Dr. Lo, an attending pediatric neurologist at Nationwide Children's. "We have applied this tool in our own studies of pediatric stroke outcomes, and we have been able to capture information that would otherwise have been very difficult to acquire."

Lo WD, Ichord RN, Dowling MM, Rafay M, Templeton J, Halperin A, Smith SE, Licht DJ, Moharir M, Askalan R, deVerber G, International Pediatric Stroke Study (IPSS) Investigators. The Pediatric Stroke Recurrence and Recovery Questionnaire. *Neurology*. 2012 Aug 28, 79(9):864-70. Epub 2012 Aug 15. PMID: 22895580.

NEUROLOGY

The Section of Neurology at Nationwide Children's Hospital provides inpatient and outpatient care for children with a wide variety of neurological and neuromuscular diseases, along with state-of-the-art neurophysiologic testing and intraoperative monitoring. Through a combination of clinical expertise and outstanding research talent, the Neurology Division provides team-based diagnosis and treatment for children with neurological disorders.

FACULTY

E. Steve Roach, MD
Chief
Professor of Pediatrics and Neurology

Shawn C. Aylward, MD
Assistant Professor of Clinical Pediatrics
Emily C. De Los Reyes, MD
Associate Professor of Clinical Pediatrics and Neurology
Lorie D. Hamiwka, MD
Assistant Professor of Clinical Pediatrics
Geoffrey L. Heyer, MD
Assistant Professor of Clinical Pediatrics
Monica P. Islam, MD
Assistant Professor of Clinical Pediatrics
Charlotte T. Jones, MD, PhD
Assistant Professor of Pediatrics
A. Latif Khuhro, MD
Clinical Assistant Professor of Pediatrics
John T. Kissel, MD
Professor of Pediatrics and Neurology
Lenora M. Lehwald, MD
Assistant Professor of Clinical Pediatrics
Warren D. Lo, MD
Associate Professor of Pediatrics and Neurology
Jerry R. Mendell, MD
Professor of Pediatrics, Neurology, Pathology, and Physiology and Cell Biology
Bethanie N. Morgan-Followell
Assistant Professor of Pediatrics and Neurology
John Mytinger, MD
Assistant Professor of Clinical Pediatrics
Ann Pakalnis, MD
Professor of Clinical Pediatrics and Neurology
Anup D. Patel, MD
Assistant Professor of Clinical Pediatrics and Neurology
Zarife Sahenk, MD, PhD
Professor of Neurology and Pediatrics
Laurel A. Slaughter, MD
Assistant Professor of Clinical Pediatrics
Chang-Yong Tsao, MD
Professor of Clinical Pediatrics and Neurology
Jorge A. Vidaurre, MD
Assistant Professor of Clinical Pediatrics
Pedro Weisleder, MD, PhD
Associate Professor of Clinical Pediatrics
Khaled M. Zamel, MD
Assistant Professor of Pediatrics

CENTER FOR GENE THERAPY

Jerry R. Mendell, MD
Center Director
Professor of Pediatrics, Neurology, Pathology, and Physiology and Cell Biology

Louis G. Chicoine, MD
Assistant Professor of Pediatrics
K. Reed Clark, PhD
Associate Professor of Pediatrics
Kevin M. Flanigan, MD
Professor of Pediatrics
Scott Harper, PhD
Assistant Professor of Pediatrics
Brian K. Kaspar, PhD
Associate Professor of Pediatrics
Paul T. Martin, PhD
Professor of Pediatrics
Douglas M. McCarty, PhD
Associate Professor of Pediatrics
Federica Montanaro, PhD
Assistant Professor of Pediatrics

Louise Rodino-Klapac, MD
Assistant Professor of Pediatrics
Zarife Sahenk, MD, PhD
Professor of Neurology and Pediatrics

Sub-Specialty Neurology Services
The neurology and ophthalmology divisions at Nationwide Children's are home to the first specialty clinic for the care of children with pseudotumor cerebri, an increasingly recognized treatable cause of visual loss, headache, and other symptoms. This busy new clinic attracts patients from across the country.

Partnering with the Division of Genetics, the division provides specialized care for children with tuberous sclerosis complex and the formation of the country's first Center of Excellence for Batten Disease. The division offers a comprehensive program for children with epilepsy, including clinics for both medical and surgical epilepsy as well as a recently-developed clinic for the rapid assessment of children with new-onset seizures. A number of children are treated in the Ketogenic Diet Clinic. The epilepsy surgery program was expanded in 2009 and has provided successful surgical therapy to children with medically intractable epileptic seizures.

The Stroke and Vascular Anomalies Clinic at Nationwide Children's offers a comprehensive and multidisciplinary evaluation to all children with stroke or those who are at risk for stroke. The Neuromuscular Disease Clinic provides comprehensive clinical care and consultation for children with genetic or acquired nerve and muscle disease in conjunction with investigators in the Center for Gene Therapy, who are focusing on molecular and genetic therapies for these disorders.

The division's Neuromuscular Clinic provides care for children with a wide array of hereditary and acquired neuromuscular diseases. The division also offers a neonatal neurology program, providing specialized inpatient consultation services and outpatient follow-up of premature infants.

Education and Training
Nationwide Children's Child Neurology Residency Program, certified by the Accreditation Council for Graduate Medical Education (ACGME), continues to attract excellent residents. The Division of Neurology also offers fellowship training in clinical neurophysiology and neuromuscular disease. Our faculty continues to contribute to the field by publishing journal articles and textbooks, especially related to the management of stroke in children, neuromuscular disease, and pediatric epilepsy. Faculty members also continue to serve as leaders of societies dedicated to pediatric neurology.

Center for Gene Therapy
Physician-scientists and principal investigators in the Center for Gene Therapy at The Research Institute at Nationwide Children's employ molecular approaches, gene therapy, and cell-based therapeutics for prevention and treatment of neuromuscular and neurodegenerative diseases, lysosomal storage disorders, ischemia and reperfusion injury, neonatal hypertension, cancer, and infectious diseases. A primary focus of the Center for Gene Therapy is curing muscular dystrophies. Our faculty scientists are developing animal models of neuromuscular diseases, identifying gene-delivery strategies that cross the blood-brain barrier, and offering clinical trials, including the first human gene therapy trial for Duchenne muscular dystrophy, and a phase I clinical trial to target limb-girdle muscular dystrophy type 2D. The center is also leading the first national muscular dystrophy newborn screening study.

The Center for Gene Therapy's efforts led to a $7 million grant from the National Institutes of Health to designate Nationwide Children's Hospital as a Paul D. Wellstone Muscular Dystrophy Cooperative Research Center. Center Director Jerry R. Mendell, MD, is the chair of the Wellstone Steering Committee. The designation as a Wellstone Center helps our investigators identify the prevalence and mechanism of immunity to gene delivery in muscular dystrophy and develop strategies to bypass these and other challenges.

An on-site, certified Good Manufacturing Practices facility that expedites and strengthens translational neuromuscular research at Nationwide Children's allows investigators to create clinical-grade viral vectors for use in pediatric clinical trials.

Within the past five years, researchers in the Center for Gene Therapy have been awarded multimillion dollar grants from the National Institutes of Health, and published key articles in high-impact journals such as *Cell*, *Proceedings of the National Academy of Sciences*, *Annals of Neurology,* and *Nature*. The Muscular Dystrophy Association named Nationwide Children's Hospital to its Clinical Research Network in 2008.

RESEARCH FUNDING (OVER $50,000) AWARDED

July 2012 – June 2013

Chicoine, Louis
Local Intravascular Delivery of Follistatin Gene Therapy for Muscular Dystrophy
Industry Sponsor
National Institutes of Health (NIH)
$189,418

Flanigan, Kevin
Exon Skipping as a Treatment for Duplication Mutations in DMD
CureDuchenne
$201,450

MPS III Natural History
The Sanfilippo Research Foundation
$181,987

MPS III Natural History
Children's Medical Research Foundation, Inc.
$181,986

A Phase 3 Efficacy and Safety Study of Ataluren in Patients With Nonsense Mutation Industry Sponsor
$114,102

Harper, Scott
DUX4 and the P53 Pathway in FSHD Pathogenesis
National Institutes of Health (NIH)
National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)
$324,148

DUX4 Inhibition as a Therapeutic Strategy for FSHD
National Institutes of Health (NIH)
National Institute of Neurological Disorders and Stroke (NINDS)
$162,900

Development of an Inducible FSHD Model
Muscular Dystrophy Association
$99,222

Kaspar, Brian
Translating a CSF Delivered AAV9-SMN for Treatment of Spinal Muscular Atrophy
National Institutes of Health (NIH)
National Institute of Neurological Disorders and Stroke (NINDS)
$1,459,274

Role of Potent Trophic Factors on Glia and Motor Neurons in ALS
National Institutes of Health (NIH)
National Institute of Neurological Disorders and Stroke (NINDS)
$308,700

IND Enabling Studies for a CNS Delivered Gene Therapy for SMA
Families of SMA
$300,000

Screening of Candidate Targets for Astrocytic Toxicity in Motor Neurone Disease
University of Sheffield
Marie Curie Foundation
$170,665

Industry Study
Industry Sponsor
$100,000

Targeting Astrocytes as a Therapy for ALS: Testing The Effectiveness of AAV9 as a Therapeutic Vecot for Gene Delivery Across the Blood Brain Barrier
Ludwig Institute for Cancer Research-UC San Diego
Robert Packard Center for ALS Research at Johns Hopkins
$96,500

Lowes, Linda
Functional Outcomes Testing in Sporadic Inclusion Body Myositis: A Validation Study
Industry Sponsor
$222,762

Martin, Paul
A New DMD Model With a Humanized Glycome
National Institutes of Health (NIH)
National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)
$469,608

Translational Studies of GALGT2 Gene Therapy for Duchenne Muscular Dystrophy
Department of Defense
$353,126

A Myotube-Specific Deletion Model For Sarcopenia
National Institutes of Health (NIH)
National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)
$146,610

Protein-Based GALGT2 Therapies For Duchenne Muscular Dystrophy
Muscular Dystrophy Association
$132,000

McCarty, Douglas
Self-complementary rAAV9 Systemic Gene Delivery Treatment for MPS Type IIIA
National Institutes of Health (NIH)
National Institute of Neurological Disorders and Stroke (NINDS)
$218,250

Self-complementary rAAV9 Systemic Gene Delivery Treatment for MPS Type IIIA
National Institutes of Health (NIH)
National Institute of Neurological Disorders and Stroke (NINDS)
$163,688

Mendell, Jerry
Overcoming Immune Barriers to Gene Correction for Duchenne Muscular Dystrophy
National Institutes of Health (NIH)
National Institute of Child Health & Human Development (NICHD)
$1,580,238

Follistatin Gene Therapy to Improve Quadriceps Muscle Strength
Parent Project Muscular Dystrophy
$144,356

Pediatric Toxicity and Efficacy in Long-term Systemic Treatment With Anti-Sense: A Case Study of Personalized Medicine
Childrens Research Institute at Childrens National Medical Center
National Institutes of Health (NIH)
$76,229

Pediatric Toxicity and Efficacy in Long-Term Systemic Treatment With Anti-Sense: A Case Study of Personalized Medicine
Childrens Research Institute at Childrens National Medical Center
National Institutes of Health (NIH)
$74,249

Intracoronary Artery Gene Therapy in the MDX
The Ohio State University Office of Sponsored Programs
$50,000

Pakalnis, Ann
Study Drug in the Prevention of Childhood Migraine
Cincinnati Children's Hospital Medical Center
National Institutes of Health (NIH)
$86,576

Rodino-Klapac, Louise
β-Sarcoglycan Gene Transfer for Treatment of Limb Girdle Muscular Dystrophy Type 2E
Gonella Family
$1,322,500

AAV5.Dysferlin Gene Therapy as a Treatment for Dysferlinopathies
Jain Foundation, Inc.
$184,588

Vascular Delivery of AAV.Micro-Dystrophin Using Whole Limb Recirculation as a Therapy for DMD
Jesse's Journey
$98,740

Sahenk, Zarife
NT-3 Gene Therapy to Improve Peripheral Nerve Function Induced by Genetic Defect
National Institutes of Health (NIH)
National Institute of Neurological Disorders and Stroke (NINDS)
$838,587

Vidaurre, Jorge
Impact of Initial Therapy and Response on Long-term Outcome in Children With CAE
Cincinnati Children's Hospital Medical Center
National Institutes of Health (NIH)
$51,714

PUBLICATIONS

Alfano LN, Lowes LP, **Flanigan KM**, **Mendell JR**. "Correlation of knee strength to functional outcomes in Becker muscular dystrophy." *Muscle & Nerve*. 2013;Apr;47(4):550-554.

Allen HD, Thrush PT, Hoffman TM, **Flanigan KM**, **Mendell JR**. "Cardiac management in neuromuscular diseases." *Physical Medicine and Rehabilitation Clinics of North America*. 2012;Nov; 23(4):855-868.

Arnold WD, **Flanigan KM**. "A practical approach to molecular diagnostic testing in neuromuscular diseases." *Physical Medicine and Rehabilitation Clinics of North America.* 2012;Aug;23(3):589-608.

Arnold WD, Krishna VR, Freimer M, **Kissel JT**, Elsheikh B. "Prognosis of acute compressive radial neuropathy." *Muscle & Nerve.* 2012;45:893-895.

Aylward S. "Idiopathic intracranial hypertension." In: Weisleder P, ed. *Manual of Pediatric Neurology.* Singapore: World Scientific Publication Co. Ltd,. 2012:149-162.

Beunders G, Voorhoeve E, Golzio C, Pardo LM, Rosenfeld JA, Talkowski ME,Simonic I, Lionel AC, Vergult S, Pyatt RE, van de Kamp J, Nieuwint A, Weiss MM,Rizzu P, Verwer LE, van Spaendonk RM, Shen Y, Wu BL, Yu T, Yu Y, Chiang C,Gusella JF, Lindgren AM, Morton CC, van Binsbergen E, Bulk S, van Rossem E,Vanakker O, Armstrong R, Park SM, Greenhalgh L, Maye U, Neill NJ, Abbott KM, Sell S, Ladda R, Farber DM, Bader PI, Cushing T, Drautz JM, Konczal L, Nash P, **de Los Reyes E**, et al. "Exonic deletions in AUTS2 cause a syndromic form of intellectual disability and suggest a critical role for the C terminus." *American Journal of Human Genetics*. 2013;Feb 7;92(2):210-220.

Boster AL, Nicholas JA, Topalli I, Kisanuki YY, Pei W, **Morgan-Followell B**, Kirsch CF, Racke MK, Pitt D. "Lessons learned from fatal progressive multifocal leukoencephalopathy in a patient with multiple sclerosis treated with natalizumab." *JAMA Neurology.* 2013;Mar 1;70(3):398-402.

Brown LW, **Roach ES**. "Outgrowing the child neurologist: Facing the challenges of transition." *JAMA Neurology*. 2013;Apr;70(4):496-497.

Cano SJ, Mayhew A, Glanzman AM, **Kissel JT**, et al. "Rasch analysis of clinical outcome measures in spinal muscular atrophy." *Muscle & Nerve*. 2013;Jul 8. doi: 10.1002/mus.23937. [Epub ahead of print.]

Cataldi MP, **McCarty DM**. "Hairpin-end conformation of adeno-associated virus genome determines interactions with DNA-repair pathways." *Gene Therapy*. 2013;Jun;20(6):686-93.

Chen CY, **Lo WD**, Heathcock JC. "Neonatal stroke causes poor midline motor behaviors and poor fine and gross motor skills during early infancy." *Research Developmental Disabilities*. 2013;Mar;34(3):1011-1017.

Chikkannaiah M, **Lo WD**. "Childhood basilar artery occlusion: A report of 5 cases and review of the literature." *Journal of Child Neurology*. 2013;May 13. [Epub ahead of print.]

Collins MP, Arnold WD, **Kissel JT**. "The neuropathies of vasculitis." *Neurologic Clinics.* 2013;31:557-595.

Dimachkie MM, Muzyka IM, Katz JS, Jackson C, Wang Y, McVey AL, Dick A, Pasnoor M, Mozaffar MT, Xiao-Song Z, **Kissel JT**, et al. "Leg amyotrophic diplegia: Prevalence and pattern of weakness at US neuromuscular centers." *Journal Clinical Neuromuscular Disease.* 2013;15:7-12.

Rodino-Klapac LR, **Mendell JR**, **Sahenk Z**. "Update on the treatment of Duchenne muscular dystrophy." *Current Neurology and Neuroscience Report*. 2013;Mar;13(3):332.

Dowling MM, Hynan LS, **Lo W**, Licht DJ, McClure C, Yager JY, Dlamini N, Kirkham FJ, Deveber G, Pavlakis S; for the International Paediatric Stroke Study Group. "International paediatric stroke study: Stroke associated with cardiac disorders." *International Journal of Stroke*. 2012;Dec 11. [Epub ahead of print.]

Fedak EM, Zumberge NA, **Heyer GL**. "The diagnostic role for susceptibility-weighted MRI during sporadic hemiplegic migraine." *Cephalalgia*. 2013;June 13. [Epub ahead of print.]

Ferraiuolo L, Frakes A, **Kaspar BK**. "Neural stem cells as a therapeutic approach for amyotrophic lateral sclerosis." *Molecular Therapy*. 2013;Mar;21(3):503-505.

Ferraiuolo L, **Kaspar BK**. "Gene delivery improvement for treating the lysosomal storage disorder metachromatic leukodystrophy." *Human Gene Therapy*. 2012;Aug;23(8):793-795.

Findlay AR, Lewis S, **Sahenk Z**, **Flanigan KM**. "Camptocormia as a late presentation in a manifesting carrier of Duchenne muscular dystrophy." *Muscle & Nerve*. 2013;Jan;47(1):124-127.

Flanigan KM, Ceco E, Lamar KM, Kaminoh Y, Dunn DM, **Mendell JR**, King WM, Pestronk A, Florence JM, Mathews KD, Finkel RS, Swoboda KJ, Gappmaier E, Howard MT, Day JW, McDonald C, McNally EM, Weiss RB. "LTBP4 genotype predicts age of ambulatory loss in Duchenne muscular dystrophy." *Annals of Neurology*. 2012;Nov 26. doi: 10.1002/ana.23819. [Epub ahead of print.]

Flanigan KM, Wein N, Gurvich OL, Howard MT, Weiss RB. "Becker muscular dystrophy with widespread muscle hypertrophy and a non-sense mutation of exon 2." *Neuromuscular Disorders*. 2013;Feb;23(2):192.

Flanigan KM. "The muscular dystrophies." *Seminars in Neurology*. 2012;Jul;32(3):255-263.

Fonkem E, Skordilis MA, Binkley EM et al. "Ethambutol toxicity exacerbating the phenotype of CMT2A2." *Muscle & Nerve.* 2013;48:140-144.

Frasch HF, Dotson GS, Bunge AL, et al. "Analysis of finite dose dermal absorption data: Implications for dermal exposure assessment." *Journal Exposure Science Environmental Epidemiology.* 2013;doi: 10.1016/j.nmd.2012.11.012. [Epub 2013;Jan 29.]

Fu H, Bartz JD, Stephens RL Jr, **McCarty DM**. "Peripheral nervous system neuropathology and progressive sensory impairments in a mouse model of Mucopolysaccharidosis IIIB." *PLOS ONE*. 2012;7(9):e45992.

Giuliano F, Uckert S, Maggi M, Birder L, **Kissel J**, Viktrup L. "The mechanism of action of phosphodiesterase type 5 inhibitors in the treatment of lower urinary tract symptoms related to benign prostatic hyperplasia." *European Urololgy.* 2013;63:506-516.

Hajek CA, Yeates KO, Anderson V, Mackay M, Greenham M, Gomes A, **Lo W**. "Cognitive outcomes following arterial ischemic stroke in infants and children." *Journal of Child Neurology*. 2013;Jun 11. [Epub ahead of print.]

Heller KN, Montgomery CL, Janssen PM, Clark KR, **Mendell JR**, **Rodino-Klapac LR**. "AAV-mediated overexpression of human α7 integrin leads to histological and functional improvement in dystrophic mice." *Molecular Therapy*. 2013;Mar; 21(3):520-525.

Heyer GL, Fedak EM, LeGros AL. "Symptoms predictive of postural tachycardia syndrome (POTS) in the adolescent headache patient." *Headache*. 2013;Jun; 53(6):947-953.

Heyer GL, Mack KJ. "Do severe headaches portend greater stroke risk following CRT for childhood brain tumor?" *Neurology*. 2013;Apr 16;80(16):1448-1449.

Heyer GL, **Roach ES**. "Pediatric intracerebral hemorrhage, acute seizures, and epilepsy." *JAMA Neurology*. 2013;Apr; 70(4):437.

Howard JF, Jr., Barohn RJ, Cutter GR et al. "A randomized, double-blind, placebo-controlled phase II study of eculizumab in patients with refractory generalized myasthenia gravis." *Muscle & Nerve*. 2013;48:76-84.

Hsu SH, Wang B, Kota J, Yu J, Costinean S, Kutay H, Yu L, Bai S, La Perle K,Chivukula RR, Mao H, Wei M, Clark KR, **Mendell JR**, Caligiuri MA, Jacob ST, Mendell JT, Ghoshal K. "Essential metabolic, anti-inflammatory, and anti-tumorigenic functions of miR-122 in liver." *Journal of Clinical Investigation*. 2012;Aug 1;122(8):2871-2883.

Islam M, **Roach ES**. "Manual of Pediatric Neurology." In: Weisleder P, ed. *World Scientific*. Singapore:2012:137-147.

Islam M, **Roach ES**. "Bradley's Neurology in Clinical Practice." In: Daroff R, Fenichel G, Jankovic J, Mazziotta J, eds. *Neurological Disorders.*Vol. 2. 6th ed. Philadelphia: Elsevier; 2012:1508-33.

Jette N, Quan H, Tellez-Zenteno JF, Macrodimitris S, Hader WJ, Sherman EM, **Hamiwka LD**, et al. "Development of an online tool to determine appropriateness for an epilepsy surgery evaluation." *Neurology*. 2012;Sep 11;79(11):1084-1093.

Jin Y, Chen B, Calvert TJ, **Chicoine LG**, Liu Y, Nelin LD. "Chronic hypoxia decreases arterial and venous compliance in isolated perfused rat lungs: an effect that is reversed by exogenous L-arginine." *American Journal of Physiology – Heart and Circulatory Physiology*. 2013;Jan 15;304(2):H195-205.

Jones C, Kaffka J, et al. "Seizure occurrence following nonoptimal anticonvulsant medication management during the transition into the hospital." *Journal of Child Neurology*. 2012;Oct 3.

Jones C, Missanelli M, et al. "Anticonvulsant medication errors in children with epilepsy admitted for reasons other than seizures during the home-to-hospital transition." *Journal of Child Neurology.* 2013;28:314-320.

King AA, **Heyer GL**. "Moving from gene discovery to clinical trials in Hutchinson-Gilford progeria syndrome." *Neurology*. 2013;Jul 30;81(5):408-409.

King WM, **Kissel JT**, Visy D, Goel PK, Matkovic V. "Skeletal health in Duchenne dystrophy: Bone-size and subcranial DXA analyses." *Muscle & Nerve.* 2013.

Kissel JT, Elsheikh B, King WM, et al. "SMA valiant trial: A prospective, double-blind, placebo-controlled trial of valproic acid in ambulatory adults with spinal muscular atrophy." *Muscle & Nerve.* 2013.

Kopp BT, Kirkby S, Hayes D Jr, **Flanigan KM**. "Diabetic myonecrosis in a cystic fibrosis patient." *Respiratory Care*. 2013;Jan 29.

Lehwald LM, **Slaughter L**. "Neonatal Neurology." In: Weisleder P, ed. *Manual of Pediatric Neurology.* Hackensack, NJ: World Scientific LTD; 2012.

Lo, W. Chapter 14. "Pediatric stroke." In: Weisleder P, ed. *Manual of Pediatric Neurology*. Hackensack, NJ: World Scientific LTD; 2012:113-136.

Lo WD, Hajek C, Pappa C, Wang W, Zumberge N. "Outcomes in children with hemorrhagic stroke." *JAMA Neurology.* 2013;Jan;70(1):66-71.

Lo WD, Ichord RN, Dowling MM, Rafay M, Templeton J, Halperin A, Smith SE,Licht DJ, Moharir M, Askalan R, Deveber G; International Pediatric Stroke Study(IPSS) Investigators. "The pediatric stroke recurrence and recovery questionnaire: Validation in a prospective cohort." *Neurology*. 2012;Aug 28;79(9):864-870. [Epub 2012;Aug 15.]

Lowes LP, Alfano LN, Yetter BA, Worthen-Chaudhari L, Hinchman W, Savage J, Samona P, **Flanigan KM**, **Mendell JR**. "Proof of concept of the ability of the kinect to quantify upper extremity function in dystrophinopathy." *PLOS Currents*. 2013;Mar14;5.

Marshall JL, Holmberg J, Chou E, Ocampo AC, Oh J, Lee J, Peter AK, **Martin PT**, Crosbie-Watson RH. "Sarcospan-dependent Akt activation is required for utrophin expression and muscle regeneration." *Journal of Cell Biology*. 2012;Jun 25;197(7):1009-1027.

Medeiros MO, Behrend C, King W, Sanders J, **Kissel J**, Ciafaloni E. "Fat embolism syndrome in patients with Duchenne muscular dystrophy." *Neurology.* 2013;80:1350-1352.

Mendell JR, **Rodino-Klapac L**, **Sahenk Z**, Malik V, **Kaspar BK**, Walker CM, **Clark KR**. "Gene therapy for muscular dystrophy: Lessons learned and path forward." *Neuroscience Letters.* 2012;Oct 11;527(2):90-99.

Meyer K, Miranda CJ, **Kaspar BK**. "Transplantation of gene-corrected motor neurons as a therapeutic strategy for spinal muscular atrophy." *Molecular Therapy*. 2013;Mar;21(3):502-503.

Miranda CJ, Braun L, Jiang Y, Hester ME, Zhang L, Riolo M, Wang H, Rao M, Altura RA, **Kaspar BK**. "Aging brain microenvironment decreases hippocampal neurogenesis through Wnt-mediated survivin signaling." *Aging Cell*. 2012;Jun;11(3):542-552.

Morgan-Followell B, Reyes Ede L. "Child neurology: Diagnosis of Lambert-Eaton myasthenic syndrome in children." *Neurology*. 2013;May 21;80(21):e220-e222.

Mytinger JR, Joshi S. "The current evaluation and treatment of infantile spasms among members of the child neurology society." *Journal of Child Neurology*. 2012;Oct;27(10):1289-1294.

Mytinger JR, Joshi S. "Pediatric Epilepsy Research Consortium, Section on Infantile Spasms; The current evaluation and treatment of infantile spasms among members of the Child Neurology Society." *Journal of Child Neurology*. 2012;Oct;27(10):1289-1294. [Epub 2012;Aug 21.]

Ng YT, Conry J, Paolicchi J, Kernitsky L, Mitchell W, Drummond R, Isojarvi J, Lee D, Owen R; OV-1004 study investigators. "Long-term safety and efficacy of clobazam for Lennox-Gastaut syndrome: Interim results of an open-label extension study." *Epilepsy and Behavior.* 2012;Dec; 25(4):687-694.

Nicholas J, **Morgan-Followell B**, Pitt D, Racke MK, Boster A. "New and emerging disease-modifying therapies for relapsing-remitting multiple sclerosis: What is new and what is to come." *Journal Central Nervous System Disease*. 2012;4:81-103.

Pakalnis A, Kring D. "Chronic daily headache, medication overuse, and obesity in children and adolescents." *Journal of Child Neurology*. 2012:577-580.

Parikh S, Goldstein A, Koenig MK, Scaglia F, Enns GM, Saneto R, Anselm I,Collins A, Cohen BH, Debrosse SD, Dimmock D, Falk MJ, Ganesh J, Greene C, Gropman AL, Haas R, Kahler SG, Kamholz J, Kendall F, Korson MS, Mattman A, Milone M,Niyazov D, Pearl PL, Reimschisel T, Salvarinova-Zivkovic R, Sims K, Tarnopolsky M, **Tsao CY**, van Hove J, Walsh L, Wolfe LA. "Practice patterns of mitochondrial disease physicians in North America. Part 1: Diagnostic and clinical challenges." *Mitochondrion*. 2013;Jul 26. [Epub ahead of print.]

Patel AD, Vidaurre J. "Treatment of seizures and epilepsy syndromes." In: Weisleder P, ed. *Manual of Pediatric Neurology.* Hackensack, NJ: World Scientific Publishing Co.; 2012:23-31.

Patel A, **Viduarre J**. "Complex febrile sizaures: A practical guide to evaluation and treatment." *Journal of Child Neurology*. 2013;28:762-767.

Penton CM, Thomas-Ahner JM, Johnson EK, McAllister C, **Montanaro F**. "Muscle side population cells from dystrophic or injured muscle adopt a fibro-adipogenic fate." *PLOS ONE*. 2013;8(1):e54553.

Quinn CT, McKinstry RC, Dowling MM, Ball WS, Kraut MA, Casella JF, Dlamini N, Ichord RN, Jordan LC, Kirkham FJ, Noetzel MJ, **Roach ES**, Strouse JJ, Kwiatkowski JL, Hirtz D, DeBaun MR. "Acute silent cerebral ischemic events in children with sickle cell anemia." *JAMA Neurology*. 2013;Jan;70(1):58-65.

Ramachandran N, Munteanu I, Wang P, **Kissel JT**, et al. "VMA21 deficiency prevents vacuolar ATPase assembly and causes autophagic vacuolar myopathy." *Acta Neuropathologica*. 125:439-457.

Roach ES, **Lo W**, **Heyer GL**. *Pediatric Cerebrovascular Disorders.* 3rd ed. 2012. New York, NY: Demos Medical Publishing;2012.

Roach ES. "A new look for pediatric neurology." *Pediatric Neurology*. 2013;Aug;49(2):77-78.

Roach ES. "Mass hysteria and the media: Folie à Troupeau?" *Pediatric Neurology*. 2013;49(1):6-7.

Roach ES, Bodensteiner JB. "Obituary: Roger Alan Brumback, MD (1948-2013)." *Pediatric Neurology*. 2013;49(1):1-3.

Rosas LE, Grieves JL, Zaraspe K, La Perle KM, **Fu H**, **McCarty DM.** "Patterns of scAAV vector insertion associated with oncogenic events in a mouse model for genotoxicity." *Molecular Therapy*. 2012;Nov;20(11):2098-110.

Rosales XQ, **Tsao CY**. "The childhood-onset limb girdle muscular dystrophy." *Pediatric Neurology.* 2012;46:13-23.

Rosales XQ, Malik V, Sneh A, Chen L, Lewis S, Kota J, Gastier-Foster JM, Astbury C, Pyatt R, Reshmi S, **Rodino-Klapac LR**, **Clark KR**, **Mendell JR**, **Sahenk Z**. "Impaired regeneration in LGMD2A supported by increased PAX7-positive satellite cell content and muscle-specific microrna dysregulation." *Muscle & Nerve*. 2013;47(5):731-739.

Rose MR, Sadjadi R, Weinman J, Akhtar T, Pandya S, **Kissel JT**, Jackson CE**.** "Role of disease severity, illness perceptions, and mood on quality of life in muscle disease." *Muscle & Nerve.* 2012;46:351-359.

Rodino-Klapac LR, **Mendell JR, Sahenk Z**. "Update on the treatment of Duchenne muscular dystrophy." *Current Neurology and Neuroscience Report.* 2013;Mar;13(3):332.

Singhal N, Xu R, **Martin PT**. "Distinct contributions of Galgt1 and Galgt2 to carbohydrate expression and function at the mouse neuromuscular junction." *Molecular and Cellular Neurosciences*. 2012;Nov;51(3-4):112-126.

Slaughter LA, **Patel AD**, Slaughter JL. "Pharmacological treatment of neonatal seizures: A systematic review." *Journal of Child Neurology*. 2013;Mar; 28(3):351-364.

Srivastava AK, Renusch SR, Naiman NE, Gu S, Sneh A, Arnold WD, **Sahenk Z**, Kolb SJ. "Mutant HSPB1 overexpression in neurons is sufficient to cause age-related motor neuronopathy in mice." *Neurobiol Dis.* 2012;Aug;47(2):163-173.

Statland JM, McDermott MP, Heatwole C, Martens WB, Pandya S, van der Kooi EL, **Kissel JT**, Wagner KR. "Reevaluating measures of disease progression in facioscapulohumeral muscular dystrophy." *Neuromuscular Disorders.* 2013;23:306-312.

Tate ED, Pranzatelli MR, Verhulst SJ, Markwell SJ, Franz DN, Graf WD, Joseph SA, Khakoo YN, **Lo WD**, Mitchell WG, Sivaswamy L. "Active comparator-controlled, rater-blinded study of corticotropin-based immunotherapies for opsoclonus-myoclonus syndrome." *Journal of Child Neurology*. 2012;Jul;27(7):875-884.

Thévenot E, Jordão JF, O'Reilly MA, Markham K, Weng YQ, Foust KD, **Kaspar BK**, Hynynen K, Aubert I. "Targeted delivery of self-complementary adeno-associated virus serotype 9 to the brain, using magnetic resonance imaging-guided focused ultrasound." *Human Gene Therapy*. 2012;Nov;23(11):1144-55.

Thrush PT, Edward N, **Flanigan KM**, **Mendell JR**, Allen HD. "Precordial wave height does not correlate with echocardiographic findings in boys with Duchenne muscular dystrophy." *Congenital Heart Disease*. 2013;Mar 20. doi: 10.1111/chd.12049. [Epub ahead of print.]

Tremblay JP, Xiao X, Aartsma-Rus A, Barbas C, Blau HM, Bogdanove AJ, Boycott K, Braun S, Breakefield XO, Bueren JA, Buschmann M, Byrne BJ, Calos M, Cathomen T, Chamberlain J, Chuah M, Cornetta K, Davies KE, Dickson JG, Duchateau P, Flotte TR, Gaudet D, Gersbach CA, Gilbert R, Glorioso J, Herzog RW, High KA, Huang W, Huard J, Joung JK, Liu D, Liu D, Lochmüller H, Lustig L, Martens J, Massie B, Mavilio F, **Mendell JR**, et al. "Translating the genomics revolution: The need for an international gene therapy consortium for monogenic diseases." *Molecular Therapy*. 2013;Feb; 21(2):266-268.

Tsao CY. "GTP-cyclohydrolase 1-deficient dopa-responsive dystonia presenting as frequent falling in two children." *Journal of Child Neurology.* 2012;27:389-391.

Vidaurre J, Patel AD. "Diagnosis and classification of seizures and epilepsy syndromes." In: Weisleder P, ed. *Manual of Pediatric Neurology.* Hackensack, NJ: World Scientific Publishing Co.; 2012:1-21.

Vidaurre J, Patel AD. "Generalized convulsive status epilepticus." In: Weisleder P, ed. *Manual of Pediatric Neurology.* Hackensack, NJ: World Scientific Publishing Co.;2012:33-38.

Viollet L, Thrush PT, **Flanigan KM**, **Mendell JR**, Allen HD. "Effects of angiotensin-converting enzyme inhibitors and/or beta blockers on the cardiomyopathy in Duchenne muscular dystrophy." *American Journal of Cardiology*. 2012;Jul 1;110(1):98-102.

Wallace LM, Liu J, Domire JS, Garwick-Coppens SE, Guckes SM, **Mendell JR**, **Flanigan KM**, **Harper SQ**. "RNA interference inhibits DUX4-induced muscle toxicity in vivo: Implications for a targeted FSHD therapy." *Molecular Therapy*. 2012;Jul;20(7):1417-1423.

Weisleder P. ed. "Manual of Pediatric Neurology." Singapore:World Scientific;2012. ISBN:978-981-4324-19-9.

Weisleder P. "Hope is an evil." *Journal of Child Neurology*. 2012;27:1619-1620.

Weisleder P. "No such thing as a "blind culture."" *Journal of Child Neurology*. 2012;27:817-818.

Wirrell EC, Laux L, Franz DN, Sullivan J, Saneto RP, Morse RP, Devinsky O,Chugani H, Hernandez A, **Hamiwka L**, Mikati MA, Valencia I, Le Guern ME, Chancharme L, de Menezes MS. "Stiripentol in Dravet syndrome: Results of a retrospective U.S. study." *Epilepsia*. 2013;Jul 12.

Yoon JH, Johnson E, Xu R, Martin LT, **Martin PT**, **Montanaro F**. "Comparative proteomic profiling of dystroglycan-associated proteins in wild type, mdx, and Galgt2 transgenic mouse skeletal muscle." *Journal of Proteome Research*. 2012;Sep 7;11(9):4413-4424.

FAST FACTS

July 2012 – June 2013

Total Discharges: 1,193
- Inpatient Discharges: 1,038
- Observation and Outpatient-in-a-Bed Discharges: 155

Total Patient Days*: 2,333
- Average Length of Stay*: 2.2
- Average Daily Census*: 6.4

Inpatient Consults: 683

Total Clinic Visits: 13,848
- Dublin Neurology Clinic Visits: 3,304
- East Broad Neurology Clinic Visits: 389
- Ironton Neurology Clinic Visits: 131
- Mansfield Neurology Clinic Visits: 71
- Neurology Clinic Visits: 9,155
- Westerville Neurology Clinic Visits: 496
- Springfield Neurology Clinic Visits: 54
- Stroke Clinic Visits: 248

Neuromuscular

Total Clinic Visits: 1,447
- MDA Clinic Visits: 586
- Westerville Neuromuscular Disorders Clinic Visits: 613
- Neuromuscular Disorders Clinic Visits: 248

**Excludes Observation and Outpatient-in-a-Bed Cases.*

NEUROSURGERY

Ranked among the top programs in the country by *U.S. News & World Report*, the Division of Pediatric Neurosurgery at Nationwide Children's Hospital provides evaluation and treatment for problems of the central nervous system in patients from birth through 21 years of age and in selected adults with congenital neurological disorders. The staff works closely with members of the departments of anesthesia, hematology/oncology/BMT, neurology, physical medicine and rehabilitation, pediatric surgery, plastic and reconstructive surgery, and other pediatric disciplines.

STAFF PHYSICIANS AND FACULTY

FULL-TIME NCH FACULTY

Lance S. Governale, MD
Assistant Professor of Neurological Surgery
Ronald T. Grondin, MD
Assistant Professor of Neurological Surgery

OSU-AFFILIATE FACULTY

John M. McGregor, MD
Associate Professor of Clinical Neurological Surgery
Ehud U. Mendel, MD
Professor of Neurological Surgery
Ciaran J. Powers, MD, PhD
Assistant Professor of Neurological Surgery
Eric Sauvageau, MD
Associate Professor of Neurological Surgery

Conditions treated include aneurysms, arteriovenous malformations, Chiari malformations, brain and spine tumors, cavernous angiomas, congenital abnormalities, craniosynostosis and craniofacial abnormalities, hydrocephalus, neurological trauma, neurological birth defects, spina bifida, tethered spinal cord, complex spinal disorders, complex vascular disorders and stroke, surgical treatment of epilepsy, and the surgical treatment of spasticity.

The state-of-the-art neurosurgical operating rooms provide neurosurgeons with cutting-edge surgical facilities. Operating rooms include those that are equipped with intraoperative MRI, advanced neurosurgical microscope systems, and stereotactic intraoperative image guidance. These advanced technologies allow patients undergoing surgery for brain tumors and epilepsy to benefit from enhanced guidance for surgeons, including MRI studies performed during the operation, allowing the neurosurgeon to confirm complete resection of the abnormal tissue without the need for an additional operation at a later date.

Between July 2012 and June 2013, the Division of Pediatric Neurosurgery performed 542 surgical procedures and saw 3,157 clinic visits. A national search for a new chief of neurosurgery is underway. The division also consists of the following pediatric clinical neurosurgeons:

- Ronald Grondin, MD, received certification from the American Board of Pediatric Neurosurgery in June 2012. His clinical interests include the surgical treatment of epilepsy, advanced endoscopy for the management of hydrocephalus, craniosynostosis, and skull base tumors, as well as surgical management of spinal trauma and congenital cervical spinal deformity.
- Lance Governale, MD, whose clinical interests include minimally invasive neurosurgery (including endoscopic treatment of hydrocephalus, craniosynostosis, pituitary disease, and skull base disease), brain/spinal cord tumors, arachnoid cysts, and cavernous malformations.

In addition, the following surgeons, with primary appointments with The Ohio State University Department of Neurosurgery, provide specialized care for our pediatric neurosurgical patients:

- Ehud Mendel, MD, provides expertise in the areas of complex spinal surgery and the surgery for spinal tumors.
- Ciaran Powers, MD, specializes in the surgical and endovascular treatment of complex cerebrovascular disorders and stroke.
- Eric Sauvageau, MD, specializes in the surgical and endovascular treatment of complex cerebrovascular disorders and stroke.

PUBLICATIONS

Ammirati M, Lamki TT, Pillai P, **Powers C**. "Intra-tumoral ultrasonic aspirator delivery of H_2O_2-A novel approach to resecting highly vascularized intracranial tumors. Technical note and case report." *Clinical Neurology and Neurosurgery.* 2013;Jun 10.

Arnold M, Stallings-Archer K, Marlin E, **Grondin R**, Olshefski R, Biegel JA, Pierson CR. "Cribriform neuroepithelial tumor arising in the lateral ventricle." *Pediatric and Developmental Pathology*. 2013;Mar 15.

Christoforidis GA, Yang M, Abduljalil A, Chaudhury AR, Newton HB, **McGregor JM**, Epstein CR, Yuh WT, Watson S, Robitaille PM. "Tumoral pseudoblush identified within gliomas at high-spatial-resolution ultrahigh-field-strength gradient-echo MR imaging corresponds to microvascularity at stereotactic biopsy." *Radiology*. 2012;Jul;264(1):210-217.

Digiusto M, Bhalla T, **Grondin R**, Tobias JD. "Perioperative care of the pediatric patient for pial synangiosis surgery." *International Journal of Clinical and Experimental Medicine*. 2013;6(3):231-238.

Durden F, Wang D, **Mendel E**, Tiwari P. "Reconstruction of a large external hemipelvectomy defect after chordoma resection using a 5-component chimeric rotational flap." *Annals of Plastic Surgery*. 2013;Jun 28.

Feiz-Erfan I, Fox BD, Nader R, Suki D, Chakrabarti I, **Mendel E**, Gokaslan ZL, Rao G, Rhines LD. "Surgical treatment of sacral metastases: Indications and results." *Journal of Neurosurgery. Spine*. 2012;Oct;17(4):285-291.

Mattei TA, Higgins M, Joseph F, **Mendel E**. "Ectopic extramedullary hematopoiesis: Evaluation and treatment of a rare and benign paraspinal/epidural tumor." *Journal of Neurosurgery. Spine*. 2013;Mar;18(3):236-242.

Patel SN, **Sauvageau E**, Padhya TA. "Rare treatment of radiation induced carotid pseudoaneurysm and ensuing carotid blowout syndrome with placement of multiple contiguous endovascular stents: A case report." *American Journal of Otolaryngology*. 2013;May-Jun;34(3):219-222.

Ramos E, **Mendel E**. "Redefining tradition: The anterior cervical discectomy and fusion." *World Neurosurgery*. 2013;Feb 1.

Ramos E, **Mendel E**. "Treatment of synovial cysts: A matter of debate." *World Neurosurgery*. 2013;Feb;79(2):281-282.

Thongrong C, Kong N, Govindarajan B, Allen D, **Mendel E**, Bergese SD. "Current purpose and practice of hypertonic saline in neurosurgery: A review of the literature." *World Neurosurgery*. 2013;Feb 9.

Uribe AA, Baig MN, Puente EG, Viloria A, **Mendel E**, Bergese SD. "Current intraoperative devices to reduce visual loss after spine surgery." *Neurosurgical Focus*. 2012;Aug;33(2):E14.

FAST FACTS

July 2012 – June 2013

Total Discharges: 418
- Inpatient Discharges: 384
- Observation and Outpatient-in-a-Bed Discharges: 34

Total Patient Days*: 1,856
- Average Length of Stay*: 4.8
- Average Daily Census*: 5.1

Total Surgical Procedures: 579

Neurosurgery Clinic Visits: 3,157

** Excludes Observation and Outpatient-in-a-Bed Cases.*