The Fifth annual Highlights of the Resident and Fellow Section: 2012
A representative collection of previously published articles

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Meet the Resident & Fellow Editors of Neurology
And learn how you can contribute to the journal
Monday, April 23, 2012, 7:30-9:00 p.m.
ANNOUNCEMENT

Neurology® Resident and Fellow Section Writing Award

The winners of the 2012 Award are: Christina B. Pham, Johannes R. Kratz, Angie C. Jelin, and Amy Gelfand

Child Neurology: Brachial plexus birth injury: What every neurologist needs to know
Neurology August 16, 2011 77:695-697

The winners will be honored at the 2012 AAN awards luncheon. See page 16 of this Highlights booklet for the award-winning article.

The Neurology Resident and Fellow Section Writing Award is intended to recognize the extraordinary writing abilities of those currently in training in neurology. Eligible manuscripts will include any submitted to and published in the Neurology Resident and Fellow Section, whether online or in print. Submissions on any topic of interest to trainees and in any subcategory of the section will be eligible. The main criteria for selection will be educational value, novelty, depth of exposition, and clarity of writing. At least one author of the manuscript must be currently in a neurology residency program or in fellowship training in one of the neurological subspecialties. All authors will be considered equal recipients of the award in order to recognize and encourage collaborative work among trainees. The next award will be announced in early 2013 and will be awarded for a paper published in 2012.

No formal application process is required. All manuscripts submitted to the section will be considered. Manuscripts should be submitted online at www.neurology.org. Please direct any questions to kpieper@neurology.org.

To commemorate the fifth edition of the Resident & Fellow Highlights Booklet, the past winners are listed here:

2011 Award Winner
Amy Gelfand, MD for Right Brain: We were all once ‘fixed and dilated’. Neurology November 16, 2010;75:1851-1852.

2010 Award Winner

2009 Award Winner
Megan Alcauskas, MD and Rita Charon, MD, PhD for Right Brain: Reading, writing, and reflecting: Making a case for narrative medicine in neurology. Neurology March 11, 2008 70:891-894.
THE NEUROLOGY RESIDENT AND FELLOW SECTION: 2004-2012

Mitchell S.V. Elkind, MD, MS, FAAN; John J. Millichap, MD; Karen C. Johnston, MD, MSc

The Neurology® Resident and Fellow Page was launched in January 2004 with the intention of providing a forum for articles, written by trainees and others with a stake in neurology education, on topics relevant to residency and fellowship, including academic research projects, practice, ethics, teaching, historical topics, and international training experiences.1 During the past 8 years, the “page” has grown into a full-fledged section of the journal, with articles appearing weekly. Though most continue to be published on-line, several exceptional articles have also appeared in the parent print journal. The number of submissions to the section has increased dramatically (from 12 in 2004 to 345 in 2011), and the quality of published manuscripts has improved (represented by our current acceptance rate of about 26%; Figure). We published 134 manuscripts in 2011 (7 in the print journal), our highest number to date.

Neurology Resident and Fellow Section Submissions 2004-2011

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<th>Manuscripts Received</th>
<th>Manuscripts Accepted</th>
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<th>Manuscripts Published in Print</th>
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Neurology Resident and Fellow Section Submissions and Acceptances 2004-2011

The Resident and Fellow Section (R&FS) is trainee-run: a nationally representative team of 12 residents and fellows, each of whom serves 3 years, has responsibility for reviewing, editing, and publishing articles of interest to trainees. This provides an opportunity for these trainees to begin a process of lifelong learning about writing, reviewing, and identifying articles of importance to the field. Section members also write articles, but the vast majority of manuscripts are written by neurology trainees, program directors, and educators around the world. Photographs and brief biographies of the current Resident and Fellow Section Editorial Team, as well as comments from past team members, appear in this Fifth Anniversary Highlights issue.

The Section has several different subsections, and some are represented by the articles in this booklet. These include Emerging Subspecialties in Neurology, Clinical Reasoning, Right Brain, Child Neurology, Pearls and Oy-sters, International Issues, Education Research and Initiatives, Teaching Neuroimages (including both static images and videos), and Book Reviews. The descriptions of the subsections appear before each sample article.

Continued on page 2
The group has also initiated and developed numerous other unique projects since the inception of the Section, including a website, podcasts, weekly electronic communications, an annual writing award, Mystery Cases, Journal Club, Call for Authors, and other new subsection ideas. Podcasts related to articles published in the R&FS began in December 2007, for example, and weekly E-Pearls, now archived on our website, have been sent to residents nationwide since July 2008. The first annual R&FS writing award was awarded in April 2009, the first Mystery Case published in August 2009, our website launched in 2010, and the first Journal Club articles published in August 2011. In 2011, we also expanded our book review section to a new Media and Books Reviews Section to provide reviews of other forms of educational media in increasing use, including websites and apps. Our new Call for Authors program, in which trainees throughout the world have the opportunity to sign up to write articles on selected topics, was launched in January 2012.

The Section has been strongly supported by Neurology’s Editors-in-Chief during the past 8 years, beginning under Dr. Robert Griggs and continuing under Dr. John Noseworthy and Dr. Robert Gross. In addition, the Section has had tremendous help from the journal’s other Associate Editors, the journal staff, the American Academy of Neurology, and the publishers Lippincott Williams and Wilkins. In particular, Kathy Pieper and Sandi Moriarity in the home office have provided continual assistance and encouragement without which the Section could not have survived.

Neurology recognizes that the future of the journal, and the future of the field of neurology itself, depends on the interest and commitment of its readers and writers. This journal is one of the most important records of our profession, and current trainees are the profession’s most valuable resource. We anticipate further developments for the R&FS in the future, limited only by the imagination of the students, residents, fellows, and others who are interested in neurology education.

We welcome submission of manuscripts for the Resident and Fellow Section, and author instructions can be found at www.neurology.org. Papers submitted for this Section will undergo the same thorough peer review process as all Neurology submissions, and it is anticipated they will reflect the same high level of quality. It is further expected that manuscripts published in the Section will carry the same academic weight, whether on-line or in print, as papers published elsewhere in Neurology. We also continue to welcome input from our readers, including program directors and other educators, on features that will be most valuable. Questions and comments should be addressed to Mitchell Elkind or Kathy Pieper at kpieper@neurology.org.

Each year for the past five years we have published a highlights issue to be distributed at the American Academy of Neurology Annual Meeting. These issues have included representative examples of the finest articles written for the Section by neurology trainees and educators in the preceding year. In celebration of the fifth anniversary of these highlights issues, we have taken this opportunity to also look back over the past several years of the Section, and to provide updates on the experiences and progress of some of the section’s past editorial team members.

We hope you enjoy this special Fifth Anniversary issue of the Highlights of the Resident and Fellow Section of Neurology!

Mitchell S. V. Elkind, MD, MS, FAAN
Associate Editor, Resident and Fellow Section

John J. Millichap, MD
Deputy Associate Editor, Resident and Fellow Section

Karen C. Johnston, MD, MSc
Founding Editor, Resident and Fellow Section

References

Special Thanks
The R&F Editorial Team would like to thank team member Dr. Victoria Wong for her extensive work in organizing and gathering all of the material necessary for the 5th Annual Highlights Booklet, a milestone.
TOP 10 WAYS FOR PROGRAM DIRECTORS TO USE THE NEUROLOGY RESIDENT & FELLOW SECTION (R&FS)

Visit the Resident & Fellow Section website at http://neurology.org/site/feature/index.xhtml to access the features below.

1. The new Journal Club articles provide critical appraisals of articles published in *Neurology*®, ideal for guiding discussion at your local Journal Club meetings.

2. A one-hour resident conference can easily be filled by reviewing a Clinical Reasoning article, which is formatted for teaching, with questions for consideration.

3. The large bank of Teaching NeurolImages and E-Pearls provides opportunities for brief educational exercises.

4. As a starting point for residents who are applying for fellowship positions: The Career Choices section includes an article about the fellowship search, the Emerging Subspecialties in Neurology section discusses additional avenues for training, and the website provides a link to the AAN Fellowship Directory.

5. The Media and Book Reviews section may provide ideas for what to purchase with book funds. The R&FS has taken the “digital plunge” now, and will begin reviewing electronic media as well.

6. For other digital ways to access R&FS content, download the Neurology app onto your iPad, listen to the weekly Neurology podcast which includes the E-Pearl of the week, and join Neurology on Facebook and Twitter for updates.

7. The Right Brain subsection allows you to exercise your right brain by composing your neurological narratives and submitting them.

8. The Education Research section reports quality research on educational topics including surveys of program directors and residents, as well as studies about educational interventions and resident evaluation.

9. Scholarly activity among residents and fellows can be promoted by encouraging them to write for the R&FS. Current sections highlight educational cases, review educational topics, and showcase humanities in neurology. A new Call for Authors section provides opportunities to write about emerging issues, obstacles, and debates in neurology. All published articles are considered for the Resident & Fellow Writing Award.

10. Pick up a few more copies of this R&FS Highlights book and help to spread the word! Encourage your trainees to read the R&FS regularly, send us manuscript submissions, and apply for a position on our editorial team during our annual recruitment!
Megan Alcauskas, MD
I am now the Neurology Clerkship Director and an attending neurologist specializing in headaches at the Mount Sinai School of Medicine in New York City. I have continued to review for the Resident and Fellow Section of Neurology® as well as the main journal and am involved in WriteClick. Working on the Resident and Fellow Section inspired my interest in medical education and, in addition to being the clerkship director, I am also very involved in resident education. My vision for the Resident and Fellow Section is that it be the first stop educational resource for all neurology residents.

Beau Ances, MD, PhD
I fondly remember the thrill of being chosen to the first board of the Neurology Resident and Fellow Section. In its early stages this section quickly became a voice for younger member participation and has now expanded through multiple media outlets. Working for the Resident and Fellow Section allowed me to see the internal processes involved in the production of Neurology and cultivated my appreciation of the final product. Since stepping down from the Resident and Fellow Section, I have continued to pursue my research interests in neurodegenerative diseases (particularly HIV and Alzheimer disease) through cutting-edge neuroimaging modalities at Washington University in Saint Louis.

James Berry, MD
I am a neuromuscular physician and ALS clinical researcher at Massachusetts General Hospital (MGH). I see patients in the neuromuscular clinic and multidisciplinary ALS clinic where I supervise neurology residents and neuromuscular fellows. At the MGH Neurology Clinical Trials Unit, I lead ALS clinical trials and biobanking and biomarker discovery efforts. Since working on the Resident and Fellow Section, I have become an ad-hoc reviewer for numerous journals. My experience on the Resident and Fellow Section also provided me an understanding of the review and editing process for manuscripts, which has been incredibly valuable as I submit my own manuscripts for publication. I envision the Resident and Fellow Section as a resource for resident education, a forum for the development of methods for resident education, and a platform for residents to learn about medical writing, editing, and publication.

Rajani Ruth Caesar, MD
I received my BS in chemistry from Midwestern State University in Wichita Falls, Texas. I earned my MD from Erasmus University in Rotterdam, the Netherlands, and then conducted two years of research in traumatic brain injury at UTSW in Dallas, Texas. I also served as chief resident in both a transitional year program in Toledo, Ohio, and my neurology residency program at UTMB in Galveston, Texas. I am currently the director of the primary stroke center at Good Shepherd MC in Longview, Texas, and work in both the in and outpatient setting. More recently, I have joined the internal residency program faculty.

David Gill, MD
I am a now an assistant professor of neurology at Penn State Hershey where I am the residency program director and run the Penn State Hershey Memory and Cognitive Disorders Program. Working on the Resident and Fellow Section was a great experience for me. The opportunity to serve on the editorial board for the section helped me understand the process of peer review for journal articles and allowed me to improve the quality of my writing as well as the quality of my reviews of potential articles. I have been interested in resident education for some time and my time on the Section solidified this interest. I think the present state of the Section is excellent. The number and variety of articles has increased dramatically since my time on the section and I hope to see it continue to grow.

Fabio M. Iwamoto, MD
After completing my fellowship in neuro-oncology in 2008 at Memorial Sloan-Kettering Cancer Center, I joined the Neuro-Oncology Branch, a trans-institute branch of the National Cancer Institute and the National Institute of Neurological Disorders and Stroke, at the National Institutes of Health in Bethesda, MD, as an attending staff. I received an intramural National Cancer Institute’s Clinical Investigator Development Award and my research focus has been on early phase clinical trials and translational research in gliomas. My work at the Resident and Fellow Section has positively influenced my career, by improving my own writing and editing skills.

Shafali Jeste, MD
I am currently a senior Movement Disorders fellow at Columbia University spending 20 percent time in clinic and 80 percent time in the laboratory studying the mechanisms underlying Parkinson’s disease. I was fortunate to be a Neurology Resident and Fellow Section editorial team member for three years, and this experience dramatically improved my writing and editing skills. At the same time, I also got deeply involved in residents’ education by encouraging residents to submit articles to our sections. In addition, I also got to work with a group of exceptional residents,
fellows, and faculty members who guided me through the whole process. I envision that *Neurology* Resident and Fellow Section will continue to serve as a major driving force for the development of next generation academic neurologists.

**Irfan Lalani, MD**

I started my solo practice in general neurology and interventional pain medicine 3 years ago in Sugarland, TX. I am involved with organizing CME activities with the local hospital where I practice. I am not currently participating in teaching or supervising residents. The Resident and Fellow Section will hopefully play a useful role in informing trainees of future developments in healthcare delivery, practice environment, and career opportunities. I primarily worked on the Emerging Subspecialties of Neurology section.

**Farrah Mateen, MD**

During my time with the Resident and Fellow Section (2006-2009), I was able to start the “International Issues” theme. Since then, there have been many submissions to the Section and many publications from trainees around the world. Currently, I am in my third year of study towards a PhD in international health and am completing a fellowship in neurological infectious diseases and neuroimmunology, both at Johns Hopkins University. I continue to review for the Section and am the Chair of the American Academy of Neurology Ethics Section this year.

**Ryan Overman, MD**

I am serving the Indiana University School of Medicine as an Assistant Professor of Clinical Neurology. Working with the Resident and Fellow Section has taught me that writing and reviewing academic manuscripts can provide significant enrichment to one’s clinical career. Participating in editing and publishing activities lends amazing insight for those interested in an academic career path. I hope the Resident and Fellow Section is able to expand its online presence with an enhanced, interactive website that utilizes innovative electronic publishing and provides a comprehensive forum for trainees to interact.

**Sashank Prasad, MD**

I am currently a neuro-ophtalmologist at Brigham and Women’s Hospital and Assistant Professor of Neurology at Harvard Medical School. The majority of my time is spent in clinical care and teaching. Among my current research projects, I am interested in improving patient education and I am helping to develop a smartphone app that monitors symptoms in patients with multiple sclerosis. My experience as an editor of the Resident and Fellow Section was invaluable, and directly influenced my clinical and academic interests. I am very excited by the growing readership of the Resident and Fellow Section, and I have a special interest in seeing the Clinical Reasoning CPC pieces develop a more interactive format. Ideally this would allow better identification of important knowledge gaps that could then be targeted to suit the needs of the readership.

**Sarah Song, MD**

I’m in my second year of a post-doc stroke outcomes research fellowship with the American Heart Association at UCLA, and received a pilot project grant from the Resource Centers for Minority Aging Research to work with Korean seniors. I accepted an Assistant Professor position in the stroke department at Rush University, to start summer 2012. I’ve been serving as the Advocacy Web Editor for AAN.com since July 2011. Like the Resident and Fellow Section, the AAN website is about reading and reviewing content and coming up with new ideas, but also includes different components, such as usability and design. I still review and write articles for the Resident and Fellow Section; I just coauthored an article on public policy fellowships that was published October 2011.

**James Watson, MD**

I am an Assistant Professor of Neurology at the Mayo Clinic in Rochester, MN, with dual appointments in the Departments of Neurology and Anesthesiology, Pain Division. At Mayo, I have continued to work on improving resident education with my dedicated colleagues. I serve on our curriculum as well as education committees. I am course director for our 50-lecture Summer Lecture Series which brings first- and second-year neurology residents quickly up to speed in neurology clinical care. I am also part of the core teaching faculty in our clinical neurophysiology program for residents and serve as Director of the Neurophysiology Technology Program in the Mayo School of Health Sciences.

My vision for the Resident and Fellow Section is to continue to use technology in novel ways to provide information to residents with a focus on clinical practice. The sections on clinical approach and reasoning skills, clinical pearls, and teaching images have been very effective as quick, high-yield teaching opportunities. It is also the natural forum for discussion and commentary on pertinent issues to residency (I can’t believe work hours continue to be as big an issue now as they were as we implemented the first work hour requirements in 2004 and used that as the focus of our initial articles in the Resident and Fellow Section). I served on the first editorial team as we implemented the then new Resident and Fellow Section.

Past team members Christopher Nolte, MD, Shanna Patterson, MD, Keith Ridel, MD and Michele Yang, MD were also an integral part of the Resident & Fellow Team, contributing to its growth and success.
Mitchell S.V. Elkind, MD, MS, FAAN

Dr. Elkind graduated from Harvard Medical School in 1992, interned at Brigham and Women’s Hospital, and completed neurology residency at Massachusetts General Hospital. He then obtained a Masters degree in Epidemiology from Columbia University while doing his clinical stroke fellowship. Currently, Dr. Elkind is an Associate Professor of Neurology and Epidemiology at Columbia University in the Division of Stroke and the Associate Chair for Clinical Research and Training. His research is focused on inflammatory and infectious biomarkers in stroke risk prediction, as well as acute stroke therapy. Dr. Elkind is a Principal Investigator of 3 NINDS independent investigator awards. These include NeuSTART (Neuroprotection with Statin Therapy for Acute Recovery Trial), a clinical trial evaluating short-term high-dose statin therapy in acute stroke; Levels of Inflammatory Markers in the Treatment of Stroke (LIMITS), a multi-center blood biomarker study among lacunar stroke patients participating in the SPSP3 trial; and the Northern Manhattan Study, a prospective cohort study of stroke risk factors. He is the former Neurology Residency Program Director at Columbia University Medical Center, and is a fellow of the American Academy of Neurology and a member of the American Neurological Association and the Stroke Council of the American Heart Association. He has mentored several residents and fellows in neurology and clinical research.

Audrey Brumback, MD, PhD

Audrey Brumback is a Child Neurology fellow at the University of California, San Francisco. She earned her MD and PhD degrees at the University of Colorado School of Medicine, where she studied the role of chloride transporters in neonatal seizures. Her current research interests include mechanisms of inhibition and the function of ion transporters in normal and diseased brains.

Stacey Clardy, MD, PhD

Stacey Clardy is currently a neuroradiology resident at Penn State University in Hershey, PA. She is a graduate of Elizabethtown College and received her MD and PhD degrees from the Pennsylvania State University in Hershey, PA. Her research interests include the contribution of iron to neurological disease, especially in restless legs syndrome and amyotrophic lateral sclerosis. She is also interested in government policy as it applies to neurologic disease.

Amy Gelfand, MD

Amy Gelfand is a child neurology fellow at the University of California, San Francisco. She is a graduate of Harvard Medical School and Dartmouth College. Her academic interests include headaches in children and pediatric movement disorders. She also has an interest in issues related to parenting during residency.

Daniel Goldenholz, MD, PhD

Daniel Goldenholz completed his MD and PhD training at Boston University, where his thesis work focused on multimodal imaging techniques for brain mapping and epilepsy. He then completed a one year post-doctoral fellowship at the Harvard / MIT / MGH Martinos Imaging Center, studying techniques in functional MRI, diffusion tensor imaging, transcranial magnetic stimulation, and near-infrared spectroscopy. He completed his internal medicine internship at Alameda County Medical Center and is currently a neurology resident at UC Davis Medical Center.

Jennifer Fugate, DO

Jennifer Fugate is currently a fellow in Critical Care Neurology at Mayo Clinic in Rochester, MN. She studied molecular biology at Grove City College, completed medical school at the Philadelphia College of Osteopathic Medicine and completed her neurology residency at the Mayo Clinic in Rochester, MN. Her academic interests include critical care neurology, anoxia-ischemic encephalopathy, and posterior reversible encephalopathy syndrome.
FELLOW SECTION

Chafic Karam, MD

Chafic Karam completed his medical studies at Saint Joseph University in Beirut and is currently a neuromuscular fellow at Brigham and Women’s Hospital and Massachusetts General Hospital, Harvard Medical School. Starting July 2012, Chafic will be pursuing a peripheral nerve fellowship at the Mayo Clinic in Rochester, MN. His current research interest is focused on the role of vitamin D in ALS patients.

Dragos Nita, MD, PhD

Dragos Nita graduated from ‘Carol Davila’ University in Bucharest, Romania. He earned his PhD from Laval University in Quebec, Canada, where he studied the cellular and network mechanisms of post-traumatic epileptogenesis and the relationship between seizures and different states of vigilance under the supervision of Prof. Mircea Steriade. Since 2008, he has been a pediatric neurology resident at the University of Toronto and The Hospital for Sick Children in Toronto, Canada. His academic interests include epilepsy, neurophysiology, and pediatric neuro-intensive care and sleep medicine.

James H. Park, MD, PhD, MPhil

James H. Park is a resident at the Barrow Neurological Institute. He completed his MD PhD at Yale University with research focusing on Alzheimer’s disease. He received an MPhil in Biochemistry at Cambridge and AB in Chemistry at Harvard. His academic interests include neurodegeneration and neuroregeneration.

Peter Pressman, MD

Peter Pressman graduated from Oregon Health & Science University, and is now in his third year of residency at Northwestern Memorial Hospital in Chicago. He plans to pursue fellowship training in behavioral neurology at University of California, San Francisco. His academic interests include functional connectivity MRI, dementias, and medical education.

Roy E. Strowd, III, MD

Roy Strowd graduated from Duke University in 2001 where he studied attentional processing in the visual system. He completed his Doctor of Medicine at the Wake Forest University School of Medicine and has continued at Wake Forest where he is currently a PGY-III neurology resident. Current research interests include the use of process-oriented and other alternative preparation strategies in medical education, motor and non-motor side effects of deep brain stimulation and vaccination efficacy in neuro-oncology patients.

Christina Ulane, MD, PhD

Christina Ulane finished her residency in neurology at Columbia in June 2011, including as chief resident during her final year. She is currently pursuing fellowship training in electromyography and neuromuscular disorders, at Columbia. She has enjoyed participating in reviewing articles as a member of the Resident and Fellow Section editorial board. Her interest in resident and student education, and further writing activities, was reinforced by the time she spent as part of the team.

Victoria S. S. Wong, MD

Victoria Wong received her medical degree from the John A. Burns School of Medicine at the University of Hawaii, completed her neurology residency at the University of California, Davis, and is currently a clinical neurophysiology fellow at the University of Michigan. She enjoys electroencephalography. She also has an interest in the training of biomedical editors and peer reviewers.

Holly Yancy, DO

Holly Yancy is a PGY-3 neurology resident at the University of Arizona. She studied English, journalism, and photography as an undergraduate at the University of Arizona and completed medical school at Midwestern University in Phoenix. In between undergraduate school and medical school she spent several years editing children’s books and fitness publications.
Clinical Reasoning focuses on case presentations with the aim of developing clinical reasoning skills among trainees. Appropriate cases for publication would include uncommon presentations of common neurological disorders and also typical presentations of more exotic disorders. The emphasis of the case presentation should be on generating a sound, thorough differential diagnosis; logically arriving at the correct diagnosis; and thoughtfully discussing the teaching-points of the case. Cases discussed in the section should utilize data presented serially in two to four segments that could be opened sequentially by the reader, allowing them to challenge themselves by thinking through the differential diagnosis or treatment options at each step. The manuscript should indicate where each break would occur, with specific questions for the reader to consider as they work their way through the case. The final section should provide the experienced clinician’s discussion (or resident author’s literature review). Ideally the individual sections will also include visually presented data, such as radiology, EEG, EMG, or other studies.
Clinical Reasoning: 
An encephalopathic 3-day-old infant

SECTION 1
A full-term, 3-day-old infant presented to the emergency department with poor feeding, increased work of breathing, and encephalopathy 1 day after having been discharged from the hospital in good health.

Pregnancy and labor were uneventful, and birth was by spontaneous vaginal delivery. Apgar scores were 9 and 9 at 1 and 5 minutes, respectively. The infant's nursery course was unremarkable. On the evening after discharge, his parents noted he became sleepy and lost interest in feeding over the next 12 hours. The following morning, they noted his breathing was rapid, so they brought him to the emergency room. His general examination at presentation revealed suprasternal retractions, a flat anterior fontanelle, and an enlarged liver. Neurologic examination was notable for marked encephalopathy; he did not open his eyes or react to stimulation. His suck was weak and poorly coordinated and his gag reflex was absent. He lay in a frog-legged position; however, passive tone was increased in all 4 extremities. There were no spontaneous movements or motor response to noxious stimulation. Deep tendon reflexes were symmetrically brisk without ankle clonus.

Questions for consideration:
1. What is the differential diagnosis for an infant who is initially well but becomes encephalopathic at several days of life?
2. What are the initial steps to evaluate an encephalopathic neonate?

SECTION 2
The differential diagnosis for encephalopathy in a previously well 3-day-old full-term neonate includes infection (sepsis, meningitis, encephalitis), a vascular event such as a sinus venous thrombosis, nonaccidental trauma, epilepsy leading to nonconvulsive status, and metabolic disturbances secondary either to inborn errors of metabolism or exogenous causes (such as inaccurate preparation of infant formula).

A careful review of the history can help identify infectious risk factors, such as a maternal history of group B streptococcus colonization, prolonged rupture of membranes, or labor complicated by chorioamnionitis. Absence of herpetic lesions does not exclude the diagnosis of herpes simplex virus infection. A bulging fontanelle would suggest elevated intracranial pressure from either infection or intracranial hemorrhage.

Initial laboratory investigations to consider include serum electrolytes, complete blood count, arterial blood gas, lactate, pyruvate, ammonia, transaminases, total and direct bilirubin, coagulation studies, quantitative amino acids, carnitine levels, and acylcarnitine profile. Urine should be sent for routine urinalysis, urine organic acids, and orotic acid. A sepsis workup, including blood cultures, urine cultures, and CSF analysis, should be pursued. An urgent bedside head ultrasound can evaluate for cerebral hemorrhage. If there is concern for impending herniation or other neurological emergencies, CT can be performed; however, MRI is preferred in children if available and if the patient is stable.

This infant had a noncontrast head CT in the emergency room, which was notable for cerebral edema. Ammonia (venous sample) was markedly elevated at 770 μmol/L (reference <49 μmol/L). Arterial blood gas showed a mild respiratory alkalosis. Serum glucose and anion gap were normal.

Questions for consideration:
1. What are the neurologic consequences of hyperammonemia?
2. What is the differential diagnosis for neonatal hyperammonemia?
3. What are the initial treatment steps for neonatal hyperammonemia?
SECTION 3

Elevated ammonia levels are toxic to the brain. Acute hyperammonemia rapidly leads to encephalopathy, cerebral edema, and, if untreated, death.1 Cerebral edema is often apparent on neuroimaging and may result from accumulation of glutamine in astrocytes.1 Neonates typically fare the worst, but significant neurologic injury can occur after hyperammonemic crisis even in previously asymptomatic adults.1

In a neonate, the differential diagnosis for hyperammonemia includes both inherited (e.g., urea cycle defects) and acquired (e.g., valproate usage) etiologies (Table 1). In this infant, the combination of a highly elevated serum ammonia level, respiratory alkalosis, normal serum glucose, and normal anion gap suggested a urea cycle defect.

The acute management of hyperammonemic crisis involves 1) preventing further ammonia production by discontinuing protein intake and 2) urgent removal of accumulated ammonia via dialysis and administration of sodium benzoate and sodium phenylacetate.1 These medications may improve survival by providing an alternative pathway for ammonia precursors to be excreted in the urine.2 Generous fluid intake can also support urinary ammonia excretion. Encephalopathy makes seizures difficult to detect clinically and therefore continuous EEG is helpful. Consultation with a metabolic expert should be sought urgently to assist with management.

When this infant arrived at our tertiary care facility, EEG showed intermittent multifocal seizures. He was treated with phenobarbital. His ammonia peaked at >1,000 μmol/L. He was treated urgently with sodium benzoate, sodium phenylacetate, and hemodialysis. His metabolic labs revealed a low citrulline, high orotic acid, high glutamine and alanine, and normal arginine. This biochemical profile was diagnostic for ornithine transcarbamylase (OTC) deficiency, a urea cycle defect (Table 2). There was no maternal history of protein intolerance, nor was there a family history of recurrent miscarriages, sudden unexplained death, or parental consanguinity.

**Questions for consideration:**

1. What is the purpose of the urea cycle and how do neonates with a urea cycle defect present?
2. What are the predictors of survival and neurologic outcome after an episode of neonatal hyperammonemia?
3. What are the genetics of OTC deficiency?

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**Table 1**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Initial laboratory or clinical findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea cycle defect</td>
<td>Normal serum glucose and bicarbonate (no anion gap), respiratory alkalosis often present</td>
</tr>
<tr>
<td>Organic acidurias</td>
<td>Lactic acidosis</td>
</tr>
<tr>
<td>Disorder of pyruvate metabolism</td>
<td>Lactic acidosis</td>
</tr>
<tr>
<td>Disorder of fatty acid metabolism</td>
<td>Nonketotic hyperglycemia*</td>
</tr>
<tr>
<td>Transient hyperammonemia of the newborn</td>
<td>Premature infant with respiratory distress</td>
</tr>
<tr>
<td>Secondary or exogenous causes</td>
<td>Renal or hepatic failure (severe), valproate usage</td>
</tr>
</tbody>
</table>

* It is essential to draw serum glucose prior to starting dextrose containing fluids or this diagnosis can be missed.
SECTION 4
The urea cycle removes excess nitrogen by conversion into water-soluble urea for renal excretion. A deficiency in any one of the 6 enzymes involved can constitute a urea cycle defect. The inheritance pattern is autosomal recessive, except for OTC, which is X-linked. Alternatively, a patient may have a de novo mutation. Elevated ammonia is the hallmark of a urea cycle defect.

Presentation in the neonatal period suggests a complete enzyme deficiency, while patients with partial deficiencies may only come to attention in adulthood. Neonates present with encephalopathy, seizures, hypotonia, and poor feeding after protein intake in the form of milk or formula.

To diagnose the specific urea cycle defect, plasma amino acids, urine organic acids, and urine orotic acid should be ordered (table 2).

The survival rate for acute neonatal hyperammonemia due to a urea cycle defect is 73%, significantly lower than the 98% survival rate of older patients. Coma at admission is a negative prognostic indicator for survival, as is having a peak ammonia level >1,000 μmol/L.

In one study, neurodevelopmental deficit after the initial hyperammonemic crisis related to the peak ammonia concentration; those neonates with ammonia levels greater than 350 μmol/L had severe deficits or died. Only those whose peak ammonia level was <180 μmol/L did not develop neurocognitive impairment. In another study, long-term neurologic sequelae related to the duration of hyperammonemia but not the peak level.

OTC deficiency is the most common urea cycle defect, with an incidence of 1 in 14,000. Males typically present in the neonatal period and have a higher mortality. Female heterozygotes can become symptomatic, with severity and timing dependent on the pattern of hepatic lysis. Neonatal presentation is associated with poor neurologic outcome. Orthotopic liver transplant can be curative, but will not reverse neurologic injury already sustained.

Question for consideration:
1. What screening mechanisms are in place to prevent neonatal hyperammonemic crisis?
SECTION 5
Current extended newborn screening panels use tandem mass spectrometry to detect abnormal concentrations of analytes associated with 2 of the 6 urea cycle defects: argininosuccinic acid synthetase and argininosuccinic acid lyase deficiencies. Arginase deficiency, the most clinically subtle of the urea cycle defects, has also been detected by these methods, but newborn screening may not reliably detect partial defects. The tandem mass spectrometry used in newborn screening does not directly detect OTC, carbamoyl phosphate synthetase I, or N-acetylglutamate synthetase deficiencies; however, specific biochemical abnormalities on the newborn screen can point toward a diagnosis.

Newborn screening results can take several weeks to be reported. Because newborns are typically discharged from the hospital on the first or second day of life, symptoms usually do not develop until the infant is home. Thus, newborn screening may not detect a urea cycle defect early enough to prevent all neonatal hyperammonemic crises and, instead, clinicians must remain astute to the non-specific symptoms of hyperammonemia in a newborn.

If there is a known family history of a urea cycle disorder, prenatal testing is available. Infants with OTC deficiency may have a more favorable neurologic outcome if hyperammonemic crisis is prevented by early detection.

Newborn screening results in this infant were diagnostic for OTC deficiency. The patient was discharged home on day of life 39. At that time, he was seizure-free and his feeding was improving. His neurocognitive development will be followed closely. Molecular genetic testing and enzyme testing had not yet been sent. The mother plans to be tested to see if she is an OTC mutation carrier (vs a sporadic mutation in the infant), as this could have family planning or screening implications for multiple family members.

DISCUSSION
This case underscores the importance of considering hyperammonemia in the differential for a sick neonate. Diagnosis of a urea cycle defect is often delayed as these infants are frequently initially mistakenly assumed to be septic. The key diagnostic clue is that this breastfed infant deteriorated after starting to feed (and therefore ingesting protein), as maternal milk supply typically comes in on the second or third day postpartum.

In infants with acute hyperammonemia, immediate cessation of protein intake and implementation of ammonia-lowering therapy are critical, while further diagnostic testing is ongoing, as peak ammonia level and duration of hyperammonemia are correlated with neurologic outcome.

Neuroprotective strategies during hyperammonemic crises, such as therapeutic hypothermia, or the administration of medications that act at the NMDA receptor to block excitotoxicity, are under investigation.

AUTHOR CONTRIBUTIONS
Dr. Gelfand developed the study concept and analysis/interpretation of data and participated in drafting/revising the manuscript. A. Szwarc participated in drafting/revising the manuscript. Dr. Glass participated in drafting/revising the manuscript. Dr. Jenius participated in drafting/revising the manuscript. Dr. Sheer participated in drafting/revising the manuscript. Study concept or design, analysis or interpretation of data, and study supervision.

ACKNOWLEDGMENT
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DISCLOSURE
Dr. Gelfand is a member of the editorial board of the Resident & Fellow section of Neurology. A. Szwarc reports no disclosures. Dr. Glass serves on the editorial board of the Canadian Journal of Neurological Sciences and receives research support from the NIH (NINDS, NCRR) and the March of Dimes. Dr. Jenius reports no disclosures. Dr. Sheer receives research support from Pfizer Inc, the NIH/NINDS, the March of Dimes, Alcami Syndrome Foundation, Weston Havens Foundation, and the Simmons Foundation; holds stock/options in Sensorix, Inc., Daiichi Sankyo (Plexikon, Inc.), Inogenmax Systems, Inc. (this spouse is employed there), and ChemexGenyx, Inc. and has participated in medical-legal cases.

REFERENCES
CHILD NEUROLOGY SECTION

The Child Neurology Section in the Resident and Fellow Section of *Neurology* focuses on contemporary educational issues in child neurology. The goal of the section is to provide up-to-date reviews on important topics in child neurology that are relevant to all neurologists, both adult and child, particularly those still in their training. Examples include management of acute stroke in children, childhood demyelinating disease, neuroimaging in metabolic disorders, and the neurobiology of autism. Each piece will begin with a patient case, followed by a brief discussion about the differential diagnosis and a detailed discussion about the topic of focus. Submissions are welcome from residents and fellows in either child or adult neurology. Ideally, submissions will include the patient case as well as the discussion, but submission of timely review articles without an accompanying case will also be considered. In this situation, the editors of this section may supply an appropriate patient case.
Child Neurology: 
Brachial plexus birth injury
What every neurologist needs to know

ABSTRACT
While most often transient, brachial plexus birth injury can cause permanent neurologic injury. The major risk factors for brachial plexus birth injury are fetal macrosomia and shoulder dystocia. The degree of injury to the brachial plexus should be determined in the neonatal nursery, as those infants with the most severe injury—root avulsion—should be referred early for surgical evaluation so that microsurgical repair of the plexus can occur by 3 months of life. Microsurgical repair options include nerve grafts and nerve transfers. All children with brachial plexus birth injury require ongoing physical and occupational therapy and close follow-up to monitor progress. Neurology® 2011;77:695-697

CASE PART 1 A term male infant was delivered to a gravida 3 parity 0 mother after an uncomplicated pregnancy. Labor was uneventful; however, delivery was complicated by shoulder dystocia. An episiotomy was performed and the infant’s posterior shoulder (left) was grasped and delivered, followed by the anterior shoulder (right). The infant weighed 4,750 g, >97th percentile for age. In the delivery room he was noted to have a left upper extremity palsy, with an asymmetric Moro reflex.

Differential diagnosis. Brachial plexus injury is the most common etiology of a plegic arm in the neonatal period. Other considerations include a clavicular or humeral fracture, with pain limiting limb movement. Fractures can be diagnosed by feeling for “step-offs,” crepitus, or pain along the bone and obtaining plain films. Central causes, such as a focal cortical dysplasia selectively affecting the arm area of motor cortex, are rare. Poland syndrome, the absence or hypoplasia of the pectoralis muscles, can cause monomelic arm weakness; however, the structural abnormality is visibly apparent. A perinatal stroke typically does not cause hemiparesis in the neonatal period, but rather later in infancy.

CASE PART 2 On examination, there were no clavicular or humeral step-offs or crepitus, and a chest x-ray was normal. The parents were counseled that the brachial plexus injury would fully resolve. In pediatric follow-up at 2 months, however, the infant held the arm abducted and internally rotated at the shoulder. His forearm was pronated, his elbow extended, and his wrist and fingers were flexed in the “waiter’s tip” posture, consistent with injury affecting the C5-C7 root levels. There was no Horner syndrome. He was referred for neurologic and surgical evaluation.

Epidemiology. Brachial plexus birth injury occurs in 0.4 to 4 per 1,000 live births.1 It is most commonly associated with shoulder dystocia, an impaction of the infant’s anterior shoulder behind the maternal symphysis pubis. Lateral traction on the head, as part of the corrective maneuvers to deliver the infant, stretches the brachial plexus, leading to injury 4%–40% of the time.2

The strongest fetal risk factor for shoulder dystocia is macrosomia—birth weight greater than 4,000 g.3 Maternal risk factors for brachial plexus birth injury include diabetes or gestational diabetes, obesity, or a history of shoulder dystocia during a previous birth. A prolonged second stage of labor (pushing) and operative vaginal delivery also increase the risk.1,4 However, half of the cases have no identifiable risk factor.2

While the risk factors for shoulder dystocia are well recognized, they have poor predictive value.3,4 C-section decreases, but does not eliminate, the risk of brachial plexus injury, and introduces additional maternal morbidity.1,2
Neuroanatomy and prognosis. The ventral rami of the C5 through T1 spinal nerves form the roots of the brachial plexus. Children with brachial plexus birth palsy have traditionally been classified clinically into 4 groups. The largest group (50% of cases) involves C5-C6 injury, classic Erb palsy, and generally has the best prognosis. The next group (25%) involves C5-C7 injury and has an intermediate prognosis. Children in these 2 groups hold the arm in adduction and internal rotation at the shoulder due to relative sparing of the shoulder adductor and internal rotation muscles. The imbalance of push-pull muscular forces across the glenohumeral joint at the shoulder causes the joint itself to develop abnormally, with increasing deformity as the child grows. Involvement of C7 is suggested by the presence of a wrist drop.

The third and fourth groups (together 25%) involve injury to the entire plexus. The arm is held in a neutral position with little to no movement. The fourth group is the most severely affected and can be distinguished by the presence of an ipsilateral Horner syndrome (miosis, proptosis, and anhidrosis) due to concurrent injury to the sympathetic chain as it exits the spinal cord. Isolated lower root injury (C8-T1), Klumpke palsy, is extremely rare. Brachial plexus injuries can also be classified by the type of neuropathologic injury. The least severe is neuroapraxia, or stretch injury, causing conduction block, but no permanent structural damage to the nerve. Conduction block can last for hours to weeks, but ultimately fully recovers. Axonotmesis injury involves damage to axons, as well as supporting blood vessels and connective tissue, including perineurium and epineurium. If only the axons are disrupted, they regrow with full recovery. If the perineurium or epineurium are also disrupted, the likelihood of complete recovery decreases significantly. Neurotmesis injury indicates complete nerve rupture. Scar tissue forms between the proximal and distal ends of the nerve to become a neuroma. Recovery is limited because it is difficult for axons to regenerate through the neuroma. Root avulsion is the most severe injury, usually occurring at the nerve rootlets at or near the spinal cord. Avulsion injuries do not spontaneously recover so it is essential that these patients be identified for early intervention.

When examining the brachial plexus in a neonate, the emphasis should be on looking for signs of injury to proximal nerve structures as these are highly suggestive of avulsion. Given the proximity of the sympathetic chain to the spinal cord, the presence of Horner’s almost always implies a root avulsion injury. Additional signs of avulsion include winging of the scapula, indicating long thoracic nerve injury, and asymmetry in chest wall excursion, indicating phrenic nerve injury. In cases of complete plexus palsy, a chest x-ray should be performed to rule out hemidiaphragm paralysis.

Diagnostics. The diagnosis of brachial plexus birth injury and the assessment of severity are both made clinically based on history and examination findings. Some groups support the routine use of EMG/NCS or MRI for diagnosis early in the patient’s course to confirm the presence of avulsion-type injuries; however, as the decision to intervene surgically is exclusively based on whether there is adequate recovery on physical examination over time, these studies typically do not aid clinical decision-making.

Therapeutics. In the first few days of life, the patient’s arm can be temporarily immobilized via swaddling if there is pain from an accompanying fracture. Caregivers should be instructed in appropriate positioning to avoid contractures, pressure ulcers, and unnecessary traction. If the patient tolerates it, gentle range of motion exercises may be started either immediately or at latest by 7 to 10 days of life. Physical therapy should be continued until the child’s brachial plexus injury recovers. For cases that result in permanent functional deficit, therapy should be tailored to the patient’s age and developmental stage.

Ideally, infants with brachial plexus injuries should be referred to a multidisciplinary specialty clinic for treatment. Teams at these clinics include pediatric neurologists, orthopedic surgeons, neurosurgeons, physical and occupational therapists, and social workers. If this is not possible, the infant should be followed closely by a neurologist to monitor the pace and extent of neurologic recovery. If antigraft biopsies do not return before 6 weeks of age, a referral to surgery is appropriate, as a subset of these infants will require microsurgical reconstruction of the plexus. In cases of suspected avulsion or rupture injuries where spontaneous recovery is impossible or unlikely, it is generally agreed the infant should undergo microsurgical reconstruction by age 3 months for avulsions and by 6 months for nerve ruptures. Early surgery minimizes motor endplate loss and maximizes recovery time.

In less severe injuries, the indications for, and timing of, surgical interventions remain controversial. Most groups agree that lack of antigraft biopsies function by 3 to 6 months is an indication for surgical intervention, while others continue to observe and operate as late as 9 or 10 months of age.

Surgical intervention for brachial plexus palsy includes early microsurgical repair of the brachial plexus using nerve grafts or nerve transfers. In both
cases, the neuronal scar tissue (neuroma) is resected. For rupture injuries, a donor nerve, most often the sural nerve, is inserted into the area of discontinuity.6 Nerve transfers, in contrast, redirect an uninvolved healthy nerve, such as the spinal accessory nerve (CN XI), to the distal site of nerve injury and rely on neuroplasticity for adoption of functional control by the transferred nerve.1

Outcomes. Most children with brachial plexus birth palsy recover well. A recent prospective study demonstrated full recovery in 50% of patients by 3 months of age, and 82% by 18 months.11 However, roughly one in 5 affected infants have some degree of permanent nerve damage.12 While patients with permanent injury have lower functional scores than their peers, these children have equivalent rates of individual and team sports participation as their peers.13 Most children with persistent injury can manage their activities of daily living, albeit with varying degrees of difficulty.11

CASE PART 3 The infant regained gravity-assisted biceps function at 3 months of age and antigavity biceps function at 5 months. Now 18 months old, he is able to use his left hand and arm, though still with weakness and range of motion limitations. He continues with intensive physical and occupational therapy and his ultimate outcome is not yet determined.

DISCUSSION Brachial plexus birth injuries are usually transient, but can result in permanent functional deficits. Signs of nerve root avulsion, indicating severe injury that will not recover spontaneously, include a total plexopathy (complete arm paralysis), Horner syndrome, or phrenic nerve involvement. These infants should be referred for microsurgical evaluation immediately so that reconstruction of the plexus, if indicated, can be performed by 3 to 6 months. All infants with brachial plexus nerve injuries need close follow-up to monitor progress, and early and ongoing physical and occupational therapy to maintain range of motion, prevent glenohumeral joint deformity, and maximize function.

AUTHOR CONTRIBUTIONS
Dr. Plam $drafting/revising the manuscript$, study concept or design, analysis or interpretation of data. Dr. Kranz $drafting/revising the manuscript$, study concept or design, analysis or interpretation of data, acquisition of data. Dr. Jelin $drafting/revising the manuscript$. Dr. Gelfand $drafting/revising the manuscript$.;

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DISCLOSURE
Dr. Plam reports no disclosures. Dr. Kranz serves on the editorial board of the Journal of Thoracic Disease and has received research fellowship support from the American College of Surgeons. Dr. Jelin reports no disclosures. Dr. Gelfand is a member of the editorial team for the Resident & Fellow section of Neurology®.

REFERENCES
PEARLS AND OY-STERS

Pearls and Oy-sters focuses on fundamental clinical neurology. Each article should address a specific niche of neurologic disease and provide expertise in the form of clinical insights and tips, (i.e., “pearls”) as well as advice for avoiding mistakes, or (“oy-sters”). The author may choose to address a particular facet of the approach to neurologic disease, such as localization, elaboration of a differential diagnosis, evaluation, or treatment. The article should concentrate on what may be found in a textbook and/or provide what textbooks cannot, in the form of knowledge rendered from clinical experience. The target audience consists of those in training; however, the subject matter should be of interest to all in the world of clinical neurology.
Pears & Oy-sters:
Multiple ischemic strokes secondary to heparin-induced thrombocytopenia

PEARLS

- Neurologic complications of heparin-induced thrombocytopenia (HIT) are relatively rare, with ischemic stroke being the most common.
- HIT-associated strokes may be multifocal and can have arterial, venous, or cardioembolic etiologies.
- The risk for HIT-associated strokes persists 4–6 weeks after heparin use and may occur in the setting of normal platelets.

OY-STER

- Vitamin K antagonists should be used with caution in HIT until recovery of the platelet count.

CASE REPORT A 57-year-old right-handed woman developed sudden onset right-sided weakness and recurrent falls while on warfarin 13 days after being diagnosed with HIT. Three weeks prior, she had an elective hysterectomy and salpingo-oophorectomy for fibroids and menorrhagia complicated by postoperative pulmonary emboli. She had been treated with unfractionated heparin for 4 days, and then began low-molecular-weight heparin for 7 days. Her initial platelet count was within normal limits at 156 × 10^9 g/dL. The diagnosis of HIT was based on a platelet count of 67 × 10^9 g/dL with a nadir of 44 × 10^9 g/dL, positive platelet factor antibody-4 by ELISA, and abnormal heparin-induced platelet aggregation assay. Other causes of thrombocytopenia were ruled out. As her initial treatment for HIT, she received argatroban for 8 days and was discharged from the hospital on warfarin and fondaparinux with a platelet count of 75 × 10^9 g/dL. Fondaparinux was stopped 4 days later given an international normalized ratio (INR) = 3 while warfarin was continued.

Her past medical history was negative for stroke but significant for tobacco use and recent onset of hypertension. On admission examination, she had cognitive deficits including difficulty with naming and math ability, dysarthria, flattening of the right nasolabial fold, and a mild right hemiparesis. She did not have any headaches. MRI showed acute left parietal and scattered bilateral supratentorial foci of infarction (figure, A and B). Magnetic resonance angiography (MRA) and CT angiography (CTA) showed diffuse narrowing of the vessels of the anterior and posterior circulation (figure, C). Transcranial Doppler revealed mildly increased velocities in the anterior circulation and bilateral posterior cerebral arteries with normal pulsatility indices consistent with mild diffuse vessel narrowing. Bilateral carotid ultrasound did not show hemodynamically significant stenosis. Transthoracic echocardiogram with microcavitation study revealed atrial shunting at rest, but no cardiac thrombus. Ultrasonography of both lower extremities was negative for deep venous thrombosis. Cardiac monitoring and EKG during hospitalization did not reveal any arrhythmia. The platelet count at the time of neurologic symptoms was 186 × 10^9 g/dL, but INR was markedly elevated at 5.2. Warfarin was discontinued on admission and IV argatroban infusion was restarted once the INR dropped below 2 and continued for 13 days. Warfarin was reinitiated 8 days after restarting argatroban. Seven months later, the patient had recovered with the exception of mild cognitive impairment without recurrence of her symptoms. A follow-up MRA was performed and revealed resolution of the diffuse arterial stenotic lesions (figure, D).

DISCUSSION HIT is a prothrombotic disorder characterized by antibodies against heparin and platelet factor 4. It may present as unexplained thrombocytopenia or thrombocytopenia complicated by thrombosis after exposure to unfractionated heparin and less commonly to low-molecular-weight heparin. Thrombocytopenia could manifest either as an absolute drop in platelet count below the normal range or a relative decrease of 30%–50% from baseline counts. The magnitude of thrombocytopenia correlates with the risk for thrombotic complications, which occur in about 30%–60% of patients. Despite platelet count recovery, thrombotic risk in HIT remains high for 4–6 weeks after diagnosis.

Stroke occurred in 3.1% of patients in a study of 960 patients with HIT. In another retrospective study
of 120 patients with HIT, 11 patients (9.2%) presented with neurologic complications, including ischemic vascular events in 7 patients (5.8%) and cerebral venous thrombosis in 3 (2.5%). Mortality was higher in patients with HIT and neurologic complications as compared to those without neurologic complications (55% vs 11%, p < 0.01). In that study, one patient had a stroke 7 days after the initiation of treatment for HIT and 3 patients had a stroke in the setting of normal platelet counts, similar to our patient.

Strokes in patients with HIT may be secondary to arterial occlusion, cerebral venous thrombosis, or cardiac emboli, and can be multifocal. In our case, a cardioembolic etiology was unlikely in the presence of normal EKG, cardiac enzymes, and transthoracic echocardiogram. Even though cardiac shunting was present, there was no evidence of lower extremity deep venous thrombosis as a potential source for paradoxical embolism. Reversible vasoconstriction syndrome could explain the multiple strokes and the resolution of the arterial stenotic lesions on follow-up. Nonetheless, this possibility is unlikely given the coinciding HIT, the absence of headache, and the lack of precipitating factors such as the use of vasoactive medications. Vasculitis could also present similarly but is unlikely in our case given that the patient improved without steroids or other immunosuppressants. Our patient had arterial hypertension and smoking, which increased her risk for stroke in the setting of HIT by possibly causing underlying vascular injury. It is unlikely, however, that hypertension and smoking solely account for the multiple acute strokes, especially in the absence of hemodynamic instability. Other usual risk factors for hypercoagulability such as abnormalities of protein C, protein S, prothrombin gene mutation, or factor V Leiden have not been correlated with HIT-associated thrombosis and were not evaluated in our patient.

The multiple strokes and stenotic lesions detected on MRA and CTA in our case are likely due to partially thrombosed arteries secondary to HIT. Multiple arterial “white clover” consisting of platelet-rich thrombi have been previously reported in a brain autopsy of a patient with HIT-associated stroke and could potentially be the underlying mechanism of the lesions and strokes seen in our patient. The improvement of these lesions on follow-up rules out a progressive vasculopathy and is not surprising given the patient’s recovery from HIT. In our patient, warfarin was initiated prior to complete recovery of thrombocytopenia, which may have contributed to the observed thrombotic complications since vitamin K antagonists should not be used until the platelet count has substantially recovered.

Our patient was not a candidate for tissue plasminogen activator (tPA) since she presented outside the time window. IV tPA is contraindicated in ischemic stroke if the platelet count is less than 100,000/ mm³ but its safety in patients with a higher platelet count in HIT-associated stroke is uncertain given the lack of experience in this setting. Good outcomes following thrombolytic use have been reported in other HIT thrombotic complications. Cerebral angiograms and other intervention procedures may increase the risk of arterial thrombosis if using wires with heparin-included media or if the vessels are further traumatized by catheterization.

When the patient is on heparin treatment, HIT should be suspected if thrombocytopenia develops or if new thromboses including strokes occur regardless of the platelet count even after discontinuation of heparin. Clinicians should also be vigilant to the occurrence of HIT associated with heparin use in patients with stroke.

**DISCLOSURE**

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General Submission Instructions

The Resident and Fellow Section is a primarily online feature that serves the resident and fellow readership. Residents and fellows are expected to be the primary authors for most submissions, but those highly involved in graduate medical education (e.g., program directors) may also contribute submissions on appropriate topics. Submissions for all article categories should be no more than 1,500 words; permission for longer articles will be needed from the editors. The number of references should be 10 or less and one to two tables or figures may be incorporated. The topic must be mentioned in the cover letter of the submission. Potential article topics include: teaching, ethics, practice, career choices, residency training, editorial, international education, research, historical, opinion, book review, training videos, or teaching NeuroImages. Teaching NeuroImages has the same requirements as NeuroImages but is especially valuable to the trainee audience and will be published in the online Resident and Fellow Section. Queries and comments should be addressed to Mitchell Elkind, MD, MS, FAAN, or Kathy Pieper at kpieper@neurology.org.
EMERGING SUBSPECIALTIES IN NEUROLOGY

These manuscripts will review the history and development of emerging subspecialties in neurology, including fields such as Pain Medicine, Headache, Neurocritical Care, Interventional Neurology, and others. The focus should be on educating residents with a possible interest in this subspecialty. Those interested in writing these manuscripts should contact the Resident and Fellow Section Editor before submission to inquire about the need for an article on a particular topic.
Emerging Subspecialties in Neurology: Neurophysiologic intraoperative monitoring

Aatif M. Hussain, MD
Ronald G. Emerson, MD
Marc N. Nauwer, MD, PhD

In the last 30 years, neurophysiologic intraoperative monitoring (NIOM), also referred to as surgical or operative neurophysiology, has evolved from a part-time preoccupation of a few neurologists to a subspecialty in neurology with dynamic career opportunities. NIOM uses a variety of neurophysiologic signals to warn surgeons and anesthesiologists when the nervous system is at risk of injury during a surgical procedure. Several studies have shown that these warnings often lead to modification of the surgery and consequent reduction in surgical morbidity.1,3

HISTORY The use of intraoperative neurophysiologic techniques to aid surgery can be traced to Wilder Penfield and Herbert Jasper’s use of electrocorticography for resection of epileptogenic cortex in the 1930s.4 However, it was not until the 1970s that neurophysiologic techniques began to be used during surgeries to reduce the risk of injury to the nervous system.5 During the early years, NIOM equipment was “homemade” by neurophysiologists, who served the function of not only interpreting physician but also biomedical engineer and technologist.

By the 1980s and 1990s, research documented the clear utility of somatosensory and brainstem auditory evoked potentials (SEP, BAEP), EEG, and EMG in reducing morbidity of many types of surgeries.6,7 Commercial NIOM equipment became available, and academic hospitals started offering NIOM services. Technologists became available with specialized training and certification in NIOM through the American Board of Registration of Electroencephalographic and Evoked Potential Technologists. The technologists were able to help set up the monitoring and run the NIOM equipment.

Over the last decade, motor evoked potentials (MEP) monitoring has become available, has been shown to be safe, and has been shown to reduce morbidity in various types of procedures.7,8 Advances in information technology have improved the NIOM expert’s access to data from outside the operating suite in some situations.9 Now not only academic but also many community hospitals are able to offer NIOM services.

PRACTICE OPPORTUNITIES The growth of NIOM has created many types of practice opportunities for neurologists with expertise in NIOM. The traditional model has been for neurologists with expertise in central or peripheral clinical neurophysiology employed by university hospitals to perform NIOM. The technologist is typically part of a team which includes technologists and possibly other personnel involved with monitoring. In addition to NIOM, these neurologists are frequently involved with EEG, evoked potentials, and EMG interpretation.

While an academic practice remains popular, appropriately trained neurologists in private practice can also perform NIOM for surgeries done in hospitals in which they have privileges. The technologists may be employees of the hospital or contract workers. Neurologists in this type of practice are involved with other clinical neurology activities when not performing NIOM.

A third type of opportunity exists with private companies that perform NIOM at several hospitals. These companies employ both the neurologist and technologist. The neurologist is usually interpreting the data from a remote location and does not have other clinical responsibilities. Appropriate licensure and privileges should be obtained in the state and hospital in which the NIOM is being performed. The many types of practice opportunities available for NIOM have exposed a critical shortage of neurologists with expertise in NIOM.

TRAINING AND EDUCATIONAL OPPORTUNITIES Until about 10 years ago, few neurology fellowship programs offered subspecialty training in NIOM. Those individuals who wanted to practice NIOM learned from mentors outside of a formal

From the Department of Medicine (A.M.H.), Duke University Medical Center, Durham; Neuradiologic Center (A.M.H.), Veterans Administration Medical Center, Durham, NC; Department of Neurology (R.G.E.), Neurological Institute, Columbia University, College of Physicians and Surgeons, New York, NY; and Department of Neurology (M.N.N.), UCLA School of Medicine, Los Angeles, CA.

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training program. Often this training occurred after the termination of a formal fellowship. In part due to the increasing need, over the last decade many fellowships have started including NIOM training. Most such training programs are clinical neurophysiology (CNP), epilepsy, EEG, EMG, or neuromuscular medicine fellowships that offer electives in NIOM to those individuals who are interested.

NIOM is one of 4 tracks (others include EEG, EMG, and sleep medicine) of a CNP fellowship recognized by the Accreditation Council for Graduate Medical Education (ACGME). All CNP programs must offer training in at least 2 tracks (personal communication between MRN and ACGME). Fellowships offering varying lengths of NIOM training in the United States are listed in the table. Prospective trainees are encouraged to talk with program directors about the extent of training offered in the various programs listed in the table.

In addition to fellowships, several professional societies provide courses in NIOM. The American Academy of Neurology, the American Clinical Neurophysiology Society, and American Association of Neuromuscular and Electrodiagnostic Medicine offer courses ranging from a few hours to 2 days (see society Web sites). Other societies provide education to technologists and other providers. The last few years have also seen an increase in NIOM publications. In the last few years, several textbooks on NIOM have been published.12,13

Along with training and educational opportunities, NIOM certifying examinations are also available. The American Board of Clinical Neurophysiology (ABCN; www.abcn.org) offers a dedicated NIOM examination, whereas the American Board of Psychiatry and Neurology Subspecialty in Clinical Neurophysiology (www.abpn.com/cnp.htm) examination includes questions on NIOM. Board certification is often required by hospitals before privileges are afforded.

**RESEARCH** An advantage of an emerging specialty is the enormous research potential. Though the utility of some types of NIOM has been clearly established (such as SEP in scoliosis surgery, BAEP in
microvascular decompression surgery, and MEP in spinal cord surgery), many monitoring modalities require validation of their utility.1,4,5 There is a paucity of outcomes research in NIOM. Surgical procedures become progressively more complicated, and innovative monitoring techniques are needed to minimize the risk of injury to the nervous system. NIOM research is a lucrative area for career development.

NIOM research also presents unique challenges. Controlled studies are ethically and medicolegally difficult to perform. It is impossible to control for surgical technique and skill. Despite these limitations, well-designed studies can provide useful data.

DISCUSSION NIOM is an exciting emerging subspecialty of neurology. There are many practice opportunities. The number of fellowships offering NIOM training is increasing. Research opportunities are plentiful and offer a path for career development. Hospital administrators, department chairs, division chiefs, and senior partners appreciate the need for neurologists with expertise in NIOM.

DISCLOSURE
Dr. Husain has received speaker honoraria from UCB, Pfizer Inc, and Jazz Pharmaceuticals; serves on the editorial board of the Journal of Clinical Neurophysiology; receives publishing royalties for A Practical Approach to Neurophysiologic Intraoperative Monitoring (Deadstein Medical Publishing, 2008); serves on speakers’ bureaus for UCB and Jazz Pharmaceuticals; performs NIOM in his practice at Duke University Medical Center; has received research support from UCB, Pfizer Inc, the NIH, and the American Epilepsy Society; and has served as an expert witness in a medical-legal case. Dr. Pearson serves on the editorial board of the Journal of Clinical Neurophysiology; has filed patents re: Dynamic adjustable spatial grandeur for EEG display and systems and methods for measuring brain activity; serves as a consultant for Percept Development Corporation; performs intraoperative monitoring (60%-70% clinical effort); receives research support from BlackRock Microsystems, NYSCIRB, Columbia University, and Epilepsy Therapy Project, and owns stock in Angion, Johnson & Johnson, Forrest Laboratories, Inc., Eli Lilly and Company, and Neuropace, Inc. Dr. Nauer serves on a scientific advisory board for Corinca; serves on editorial advisory boards for Clinical Neurophysiology, Journal of Clinical Neurophysiology, Practical Neurology, and Medical Economics; serves as a consultant for Medtronic; serves as Local Medical Director for StealthMed-Digitace; receives research support from Bristol-Myers Squibb; holds stock in Corinca; and has provided depositions and expert testimony in medical-legal cases.

REFERENCES
INTERNATIONAL ISSUES

More than 85 percent of the world’s population lives in low- and middle-income countries, where the burden of neurologic disease is the largest. Relatively little is known, however, about patients and practitioners of neurology in most countries. This section aims to explore international issues in neurology education. We welcome manuscripts describing international educational exchanges, personal rotations and experiences in low- and middle-income countries, and work by neurology trainees from around the globe. Descriptions of notable differences in training between countries are of interest. Inclusion of practical information regarding how interested residents might get involved in international programs would also be of use.
Few people in the world today are rich; the vast majority, 86% of the global population, live in the developing world, in countries that are classified as low or middle income. The most recent data on extreme poverty suggest that nearly a billion people, spread over many continents, live on less than one dollar per day. It is in low and middle income (LAMI) countries where most cases of neurologic disease occur, including stroke, epilepsy, primary headache disorders, and Alzheimer disease, and in these countries neurologic disease is studied little if at all.

The public health challenges for neurologic disorders in LAMI countries are multiple. Among the poor, there is special consideration of the 1) overall burden of neurologic disease, 2) lack of access to essential medications, 3) paucity of epidemiologic research available, 4) reduced ratio of practitioners in LAMI countries, 5) double burden of communicable and noncommunicable disease, and 6) stigma. At every level of society, there is a need for more education, in rich countries as well as poor ones. Health care workers, students, governments, teachers, and members of the general public all have important roles to play.

THE OVERALL BURDEN OF NEUROLOGIC DISEASE Dementia and stroke are among the most common disabling diseases worldwide, and in some regions of the world, stroke accounts for more deaths than ischemic heart disease. Although often considered developed world diseases, 86% of all stroke mortality and 85% of all cases of epilepsy occur in the developing world. Overall, neurologic disorders now account for a greater burden of disease than HIV/AIDS.

LACK OF ACCESS TO ESSENTIAL MEDICATIONS Studies from LAMI countries reveal poor access to underprescribed and often unaffordable medications. In one recent analysis of four low and six middle income countries, just 71.5% of patients with cerebrovascular disease were taking aspirin. In sub-Saharan African nations, most medications are simply not available in public and private facilities, regardless of a patient’s wealth. The World Health Organization (WHO) estimates that 150 countries do not have adequate access to medications to treat pain.

Moreover, 50 to 90% of people in LAMI countries must pay for their medications entirely by themselves. In Chad, a 30-day supply of carbamazepine 200 mg twice daily costs the equivalent of 8.8 days of an unskilled government laborer’s wages, rendering treatment of a very treatable disease effectively unattainable. Thus, access to essential medications is a result of both availability and affordability. Although costs and wages are objectively measured, the health-care seeking behavior of the poor is largely unstudied.

PAUCITY OF EPIDEMIOLOGIC DATA AVAILABLE ON NEUROLOGIC DISEASE From a public health stance, there is a lack of research in neurologic disorders. In other medical specialties, high income countries produce more than 90% of the world’s research although they account for approximately 10% of the global population. This is the so-called 10–90 divide in medical publication. It is uncertain whether the 10–90 divide exists in the neurologic literature because it has not been formally studied except in the case of dementia.

Among the neurologic disorders, research in LAMI countries has been so limited that their prevalence is difficult to estimate. Unlike census reports and sophisticated database analyses available from high income countries, epidemiologic information from LAMI countries is often obtained via tedious door-to-door surveys and reported in non-indexed, low-impact journals. Many studies piggyback on cardiovascular disease research and lack an emphasis on neurologic disorders. Little, in fact, is known about the cognitive effects of neuroAIDS outside of industrialized nations.

The value of research publications in LAMI countries also differs. A publication in the devel-
oping world, even more so than in the developed world, may have little effect on real life practice. Thus, searches for “neurology,” “headache,” “dementia,” and other common diseases in popular medical databases reveal no articles on neurologic disease, at any point in time, from a number of LAMI countries, accounting for knowledge gaps that encompass millions of people over decades.

**REDUCED RATIO OF PRACTITIONERS IN LAMI COUNTRIES** Where neurologists are needed most, they are least likely to be found. Although the WHO estimates that one neurologist is needed for a population of 100,000 people, in Africa, there are an estimated 0.3 neurologists per million. Many countries see neurologic care provided, if at all, by health care workers with no formal training in neurology. Eleven African countries have no neurologists. Physicians practicing in countries with the greatest need of neurologic care lack resources, educational opportunities, and health care workers. Some physicians emigrate to countries that can provide these desired resources and opportunities. An estimated 20,000 physicians leave Africa each year, a region which exemplifies this problem. Compared to the number of physicians who leave, the number of high-income country physicians working in Africa is small.

**THE DOUBLE BURDEN OF DISEASE** LAMI countries may continue to deal with diseases that have been eradicated or are easily prevented in high-income nations, the so-called double burden of communicable and noncommunicable disease. For example, the last case of locally acquired poliomyelitis occurred in the United States in 1979. Yet needless suffering from poliomyelitis among the poor of Pakistan, Afghanistan, India, and Nepal persists, for both medical and cultural reasons, in a world that has largely moved on.

**STIGMA** The majority of people with epilepsy, approximately 40 million, do not receive treatment. It would be wrong to assume that this is simply a financial issue, easily corrected by free medications and more health care workers. Recognition of neurologic disorders, particularly neuropsychiatric manifestations, as disease is long overdue.

Adding insult to injury, neurologic disease, even in the richest nations, in the hallways of the wealthiest institutions, can be stigmatized as incurable or barely treatable. In the developed world, common neurologic disorders are both under-recognized and undertreated. Not only a matter of science, this is a failure of education as well. The situation is probably worse in LAMI countries. If such stigmata persist, neurologic disorders will remain distant from the priorities of public health and public policy worldwide.

Conceptually, neurologic disease and poverty are connected. The idea that poverty and its consequences—most notably, malnutrition—can lead to poor cognitive ability, poor school performance, and eventual school desertion has been explored for decades. More recently, data from these same countries demonstrate that secondary prevention of neurologic disease in adulthood, such as stroke, is positively influenced by a higher level of education.

Thus, when a neurologic problem is addressed scientifically, it next demands collective action for sustained population-wide health improvement. Although small in scope compared to the burden with which they are faced, a number of agencies, academic groups, and nonprofit organizations have begun the great deal of work required. Solutions occur at multiple levels. In February 2007, the World Health Organization (WHO) and World Federation of Neurology (WFN) addressed the European Parliament, launching Neurological Disorders, Public Health Challenges, a comprehensive summary of the public health knowledge of neurologic disorders to date. Widespread changes for success include the entrace of women into the health care workforce, a focus on neurology within existing health systems, and the need for better epidemiologic information on which to set future priorities. The WHO calls for a “paradigm shift beyond the current preoccupation with prevention and simple curative interventions to encompass long-term support and chronic disease management.”

Others have responded similarly in magnitude. Among them, the Global Campaign Against Epilepsy, the 10/66 Dementia Research Group, the Global Burden to Reduce the Campaign Against Headache, and the WFN have each made progress. The WFN features an online book, Where there is no neurologist, which is meant to act as a guide to paramedical professionals in the care of neurologic disease. Many universities actively organize, sponsor, and encourage their staff and students to train abroad for short periods of time. Most journals, including this one, are available to physicians in low-income countries at a reduced rate of subscription. Headache clinics and neurology training programs now exist where previously there have been none. In more
than 100 countries, neurologists and non-neurologists alike participate jointly in alleviating the global burden of neurologic disease.

In the current Resident & Fellow pages of Neurology®, two American physicians recount their experiences studying neurology abroad. Dr. Chad Heatwole, a neurology resident at the University of Rochester, relates his story teaching neurology at Jagiellonian University in Kraków, Poland. Dr. Porter provides an eye-opening account of the neurologic care in an impoverished Kenyan town. Together, their stories provide the humanitarian perspective, inarguably the most important reason of all, to aggressively tackle these challenges.

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RIGHT BRAIN

Right Brain is a feature devoted to the relationship between neurology and the medical humanities, with submissions either written by trainees or with a focus on the experience of the trainee. Appropriate submissions include articles, commentaries, and reflections on the interaction between neurology and history, literature, ethics, theology, sociology, anthropology, philosophy, poetry, theater, film, fine arts, or the media. Right Brain also will publish original works of fiction, poetry, and reflection written by residents and fellows relating to the practice of neurology or neurology training.
Right Brain:
The blind spot

"He's not moving his left arm."

No mother wants to hear that about her newborn in the delivery room. I was a fourth-year medical student; my husband was a surgical resident. We couldn’t contain the windstorm of scary diagnoses that came over us as we heard those words. Did he have a congenital syndrome? A stroke? Over the next few days, the pediatricians reassured us it was “just a brachial plexus palsy” and we had nothing to be concerned about. The comment that put my motherly fears to rest: “I’ve never seen a case that didn’t recover.”

My delivery was complicated by shoulder dystocia and my son, Andy, was born with a brachial plexus birth palsy, giving him a flaccid left arm that had the characteristic “waiter’s tip,” with some movement in his fingers, but none in his arm. My heart ached every time I swaddled him and felt no resistance from his left arm. “Is there anything special we should do for him?” we asked before we left the hospital. The answer was always a reassuring, “No—we treat these children normally because they all end up getting better.” Four different pediatricians, no special exercises, no extra precautions, no additional visits. We were so relieved. Andy was a normal baby.

Over the next few weeks, my husband and I watched our son’s arm, but we were not overly concerned, trusting what we’d been told. Sure, Andy’s left arm was cooler than his right—but that would improve. Sure, his arm was atrophied—but it would catch up. Sure, it still wasn’t moving—but in time it would. A few days before his 2-month appointment, we noticed that there was an unusual smell about Andy. To our horror, we found a pressure ulcer on his wrist. Because of weakness from his brachial plexus injury, his wrist was adducted and not moving, so it had remained in the same position for 2 months, other than for the occasional bath. We had been told specifically that Andy did not need special care. The guilt … the feeling that we’d somehow neglected our baby to the point that he’d get a pressure ulcer produced a lump in my throat that didn’t go away for weeks.

That was the beginning of a new awareness for us—the realization that there was something our doctors didn’t know about Andy’s situation. For if they did know, we would have received anticipatory guidance on avoiding something as simple as a pressure ulcer in a newborn. With this new understanding, we were finally able to see what we had been subconsciously denying: Andy’s condition had not improved.

The next day, we went to Andy’s well-baby check-up. The pediatrician took one look at his arm and immediately the tension in the room was tangible. We didn’t want to hear what our doctor was saying, but the words “permanent functional deficit” slammed through our ear drums. That phrase kept reverberating in our heads. We had suspected that our son was not recovering as fast as he was expected to, but “permanent functional deficit” threw this game into a whole different arena. My thoughts were racing: Would Andy ever climb a jungle gym? Would other children tease him at school? Over the next few minutes, our pediatrician outlined a flurry of steps: referrals to neurologists, physical therapy, and resource centers for the developmentally disabled. How, we wondered, in 1 hour, could we have gone from a well-baby visit to a referral to services for the disabled?

We were devastated, bewildered, disappointed. We were devastated by what we imagined could be the future for our son. We were bewildered by how we, as medically sophisticated as we were, could have been so blind that we didn’t see the reality of Andy’s situation. We were disappointed in ourselves that we didn’t actively ensure that Andy was getting the appropriate care for his condition. Nevertheless, we were also grateful. We were grateful for the wake-up call.

The question that has revisited us over and over again was how at such a preeminent medical center our son could have fallen through the cracks. Over 90% of cases of brachial plexus birth palsy spontaneously recover within the first 2 months of life.1 Andy’s physicians had seen cases of brachial plexus birth

From the School of Medicine, University of California, San Francisco.

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palsy before; most likely, all of their patients had recovered. Could our doctors have been lulled into the assumption that all these cases got better, given the benign nature of their prior experience? Why had they not discussed with us that 10% of patients with these injuries don’t fully recover? What was the reason the worst-case scenario—complete nerve detachment (avulsion)—was never even mentioned?

Eventually, we realized that situations like ours are more likely to occur when, as treating physicians, we don’t know that we don’t know. When we do know, we try to provide the best possible care. When we don’t know, we readily admit our lack of knowledge and either refer to the literature or to our colleagues. It is when our gaps of knowledge fall into our brain’s “blind spot” that we get into trouble. Throughout my training in medical school, there was always an emphasis on expanding our fund of knowledge in areas we weren’t familiar with, whether that was going to grand rounds on new topics or looking up new diagnoses our patients had. The focus was on trying to expand the limits of what we didn’t know.

Andy’s case reminds us that it is also necessary to explore the limits of what we do know—or more importantly, what we think we know. Whether it’s the repetitious element of becoming more experienced or the fact that what we learned at one point has become outdated, it is easy to slide into complacency. It is easy to think, “I have seen this diagnosis before; I know how to treat it.” This assessment would likely be accurate for most of the patients we see. The danger, however, is that complacency—and simply, the passage of time—widens our blind spot and makes us overlook things we either once knew or should now know. Perhaps what distinguishes the great clinician from the good one is the ability to maintain a fresh outlook with each patient and to wonder whether a given patient is different from the rest. For what if the patient in front of you is the 10%? What if he happens to be the worst-case scenario? What if your patient is a rare presentation of the common—as Andy was—or a common presentation of the rare?

Challenging ourselves to explore the limits of what we think we know may not change the treatment plan or outcome … most of the time. But then there are those critical moments when actively challenging the boundaries of our blind spot could mean the difference between a child being able to put his shirt on with both arms or putting it on with just one.

ACKNOWLEDGMENT
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REFERENCE
EDUCATION RESEARCH

As the central mission of *Neurology*, education is a top priority. This is a section for interventional educational studies, as well as more traditional educational research, such as surveys. This section will examine the way neurologists not only practice, but also the way we teach and approach education. Neurologists have traditionally been respected, perhaps above all other specialties, for their scholarship and teaching. Educational issues will therefore continue to be at the center of the mission of *Neurology*. 
Education Research:
Patient telephone calls in a movement disorders center
Lessons in physician-trainee education

O.R. Adam, MD
J.M. Ferrara, MD
L.G. Aguilar Tabora, MD
M.M. Neshatizadeh, MD
M. Negoiita, PhD
J. Jankovic, MD

ABSTRACT

Objective: Telephone medicine is part of clinical practice, but there are no published data on the volume, nature, and time allocation of patient-related telephone calls received in a movement disorders center. Such data might provide insights which augment patient care, and may be instructive regarding medical education, since patient-related telephone calls are often addressed by physicians-in-training.

Methods: Characteristics of patient-related calls to a movement disorders center were prospectively recorded during a 2-month period.

Results: A total of 633 calls were generated by 397 patients. The average time per call was 6.6 ± 4.7 minutes. Disease-related questions (35.1%), treatment-related questions (21.3%), and side effect reports (15.3%) represented the majority of calls. Patients with Parkinson disease, Tourette syndrome (TS), and atypical parkinsonism (AP) called more frequently, while patients with dystonia and tremor called less frequently.

Conclusion: Patient telephone calls contribute substantially to the patient care in a movement disorders center and is an important aspect of training, providing an opportunity for movement disorders fellows to develop independent decision-making skills and monitor effectiveness of their patient-patient counseling. Parkinson disease, Tourette syndrome (TS), and atypical parkinsonism (AP) contribute disproportionately to the total patient telephone volume, possibly due to coexisting obsessive-compulsive and impulse-control comorbidities in patients with TS, and complications or a change of diagnosis and prognosis in patients with AP. Emphasis on the management of these specific diagnostic groups early in fellowship training may be warranted. Neurology® 2009; 73:e50-e52

GLOSSARY

AP = atypical parkinsonism; ED = emergency department; ET = essential tremor; PD = Parkinson disease; PDCMDC = Parkinson's Disease Center and Movement Disorders Clinic; RLS = restless legs syndrome; TS = Tourette syndrome.

Medical care provided by physicians extends beyond a patient's office visit, and returning patient telephone calls in a timely manner is part of good clinical practice. Telephone medicine is also part of fellowship and residency training programs.1-4

The movement disorders fellows at the Parkinson's Disease Center and Movement Disorders Clinic (PDCMDC) at Baylor College of Medicine often serve as the primary contact for patients calling with questions after their clinic visit. Although the attending physicians are available for consultation, call-backs provide an opportunity for the fellows to practice independent decision making and develop confidence in patient management. Call-backs may also inform fellows regarding issues that warrant additional counseling in clinic and may provide a means of gauging the efficacy of such counseling. The primary objective of this study is to analyze the nature, volume, and time allocation of patient-related telephone calls in a movement disorders center.

METHODS Patient telephone calls that were received by 4 movement disorders fellows and 3 faculty physicians at the PDCMDC during office hours were recorded over a period of 2 months (August 6, 2007–October 6, 2007). The telephone calls that did not

From the Parkinson's Disease Center and Movement Disorders Clinic (O.R.A., J.M.F., L.G.A.T., M.M.N., J.J.J.), Department of Neurology, Baylor College of Medicine, Houston, TX; and Department of Sociology (M.N.), University of California at Davis.
involve a physician were excluded. For all telephone calls, the following characteristics were recorded and analyzed: date, time, caller, diagnosis, date of the last clinic visit, reason for calling, and outcome of the encounter. Only calls that were answered by the fellows were timed. The diagnoses were grouped in several diagnostic categories: Parkinson disease (PD), atypical parkinsonism (AP), multiple system atrophy, dementia with Lewy bodies, corticobasal degeneration, progressive supranuclear palsy, other parkinsonism (vascular parkinsonism, drug-induced parkinsonism, normal pressure hydrocephalus). Tourette syndrome (TS), dystonia, essential tremor (ET), chorea (majority: Huntington disease), myoclonus, akinesia, tardive syndromes, psychogenic movement disorders, restless legs syndrome (RLS), and other disorders. The reasons for calling were grouped as follows: disease-related questions (general inquires, complications, worsening of symptoms), treatment-related questions, side effects, test results, feedback call (following a visit or a previous telephone call), and others. Likewise, the call outcome was grouped into several categories: medication changes, earlier appointment, rescheduling, counseling, test result reporting, additional testing, emergency department (ED) referral, and others. The distribution of diagnoses in the patient callback sample was compared to the clinic patient population that was evaluated during the same period.

RESULTS During the 2-month period, 633 patient telephone calls were generated by 397 patients. Only the telephone calls answered by the fellows (73%) were timed, the average time per call being 6.6 ± 4.7 minutes (0–40 minutes). The average time/day spent by fellows answering patient telephone calls totaled 64.8 ± 27.9 minutes (7–141 minutes). Patients placed 51.8% of the calls, with the remaining made by their spouse (20.2%), parent (12.2%), child or sibling (9.3%), health care provider (3%), and other (6.2%). Disease-related (35.1%) and treatment-related (21.3%) questions and side effect reports (15.3%) constituted the main reasons for calling. Most calls resulted in medication changes (42.5%) or consisted of counseling (21%). Only a minority of calls resulted in rescheduling of an earlier appointment (2.5%) and ED referral (1.2%).

Compared with the clinic patient population evaluated during the same period, patients with PD and AP called more often, and patients with ET and dystonia called less often than their equivalent clinic visit frequency (table). There was a nonsignificant trend for patients with TS to call more often than their equivalent clinic visit frequency. The diagnosis changed from the initial evaluation to the last follow-up visit in 6.0% of patient callers, the most common confusion involving AP, which was misdiagnosed initially as PD.

DISCUSSION This study confirms that telephone communication with patients is a vital aspect of medical practice. In academic institutions, such management is often provided by residents and fellows. Fellows at the PDMDM spend on average nearly the equivalent of a continuity clinic every 3-week period providing patient care by telephone. The bias of such a “clinic” is that mostly patients with problems call, with only a small percentage (3%) of calls constituting “feedback.” The patient telephone call length by Baylor fellows is comparable to the call duration by other physicians-in-training (86% of calls by gastroenterology fellows lasted less than 10 minutes; the average call by family medicine residents is 4.6 minutes).3 There are very limited data that analyze whether training impacts the performance of telephone medicine.9 Certain specialties such as pediatrics3 and family practice9 put more emphasis on telemedicine training than others, such as internal medicine.4 Training in telephone medicine should be studied for its effectiveness, either through direct patient feedback in the form of surveys or through standardized patient encounters.

Almost half (42%) of the telephone calls were placed by a family member. The initiative was taken by the parent of patients with TS, given their age, and by the spouse or the child of the adult patients, probably because direct communication was hindered by motor, speech, or cognitive impairments. Accordingly, it seems advisable that our patient population be accompanied to the clinic by their family when feasible.

Counseling represented a sizable portion of our calls. There is evidence that effective physician-patient communication has been linked to improved patient understanding, adherence, symptom

Table 1

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Call-back patients</th>
<th>Clinic patients*</th>
<th>p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
<td>Number</td>
</tr>
<tr>
<td>Parkinson disease</td>
<td>191</td>
<td>48.1%</td>
<td>450</td>
</tr>
<tr>
<td>Atypical parkinsonism</td>
<td>21</td>
<td>5.3%</td>
<td>27</td>
</tr>
<tr>
<td>Tourette syndrome</td>
<td>50</td>
<td>12.6%</td>
<td>110</td>
</tr>
<tr>
<td>Dystonia</td>
<td>33</td>
<td>8.3%</td>
<td>243</td>
</tr>
<tr>
<td>Essential tremor</td>
<td>27</td>
<td>6.6%</td>
<td>126</td>
</tr>
<tr>
<td>Other parkinsonism</td>
<td>9</td>
<td>2.3%</td>
<td>25</td>
</tr>
<tr>
<td>Chorea</td>
<td>11</td>
<td>2.8%</td>
<td>39</td>
</tr>
<tr>
<td>Tardive syndrome</td>
<td>15</td>
<td>3.8%</td>
<td>37</td>
</tr>
<tr>
<td>Psychogenic</td>
<td>6</td>
<td>1.5%</td>
<td>5</td>
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<tr>
<td>Restless legs syndrome</td>
<td>11</td>
<td>2.8%</td>
<td>28</td>
</tr>
<tr>
<td>Other</td>
<td>23</td>
<td>5.8%</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>397</td>
<td>100%</td>
<td>1153</td>
</tr>
</tbody>
</table>

*Clinic patients were defined as any new or established patient evaluated at the Parkinson's Disease Center and Movement Disorders Clinic during the same 2-month period that callback data were obtained.

*Two-sample t test.
resolution, and satisfaction. The effectiveness of physician-patient communication, however, is difficult to quantify, especially outside the confines of a dedicated study. Monitoring the frequency and nature of patient callbacks may help physicians better identify deficiencies in patient counseling and provide physician trainees a means of quantifying improvements in interpersonal and communication skills.

Patients with PD, AP, and TS required more telephone management. These findings may be explained by the complexity of medical management in advanced PD. We suspect that the inadequacy of available treatments and accelerated decline in AP necessitated more calls. The high incidence of behavioral comorbidities in TS and the higher frequency of obsessive compulsive behaviors in the parents of patients with TS may explain the frequent calls in that population, as the majority was initiated by a parent.

Patients carrying a diagnosis of dystonia and ET had a tendency to place fewer calls, probably explained by the availability of effective treatments (e.g., botulinum toxin).

Side effects and disease-related and treatment-related complications were almost entirely amenable to telephone management; only a small percentage of calls resulted in referral to the ED or an earlier clinic appointment.

Our findings may not be generalizable to other clinics, as the Baylor PDCMDC is a tertiary referral center. The patients often have more severe and chronic degenerative conditions, are on multiple medications, and the emphasis is on symptomatic rather than curative treatment. Our study recorded patient telephone calls over only 2 consecutive months; therefore, it did not control for seasonal biases (for example, patients with TS and their parents have a tendency to generate more telephone calls before or at the beginning of the academic year). Other noncyclical biases include drug marketing or media events that may influence the volume and nature of the telephone calls received from a specific patient population. However, no such events were identified during the period recorded. A longer longitudinal study, capturing a larger sample, would have been more accurate, but for practical reasons we limited this exploratory study to 2 months.

DISCLOSURE

Dr. Adam, Dr. Ferrera, Dr. Aguilar-Tobiera, Dr. Nacazmiadeh, and Dr. Negi report no disclosures. Dr. Jankovic serves on advisory boards for Allergan, Inc.; Merz Pharmaceuticals; Teva, and WEMOVE; receives royalties from publishing Fahr S, Jankovic J. Principles and Practice of Movement Disorders (Elsevier, 2007); Bradley WG, Daroff RB, Fenichel GM, Jankovic J, eds. Neurology in Clinical Practice, 5th Edition (Elsevier, 2008); and Jankovic J, Tolosa E, eds. Parkinson's Disease and Movement Disorders, 5th edition (Wolters Kluwer Health, 2007); has received honoraria from Allergan, Inc.; Michael J. Fox Foundation for Parkinson Research, Lundbeck, Inc., Merz Pharmaceuticals, and Teva; and receives research support from Advanced Neuromodulation Systems, Allergan, Inc., Boehringer-Ingelheim, Caregene, Inc., Chiron International, Hels Foundation, Huntington's Disease Society of America, Impax Pharmaceuticals, Ispen Limited, Medtronic, Merz Pharmaceuticals, National Parkinson Foundation, Novartis, Ortho-McNeil, Teva, the Parkinson Study Group, and the Michael J. Fox Foundation for Parkinson Research.

REFERENCES

Lumbar puncture (LP) is one of the few procedures that neurologists routinely perform and one for which they usually take pride in their performance skills. Rare is the seasoned neurologist who needs fluoroscopy to perform an LP. However, for the neophyte, the successful performance of an LP can be difficult, especially in the uncooperative, immobilized, or large patient.

A common excuse for an unsuccessful LP in a large patient is that the standard (3.5-in) needle is too short. Although a number of articles discuss the technique of performing LPs, we could find no previous studies that actually measured the distance from the skin to the thecal sac.

The distance from the skin to the L3 to L4 intrathecal space was measured in 54 lumbar spine MRI scans that were performed at Palo Alto VA Medical Center for other reasons. Three scans were excluded owing to unknown height and weight information and two because of surgical scar tissue obscuring accurate measurement. The mean age of the cases was 57 years (range 25 to 86 years), and all were male. The distance from the skin to the L3 to L4 intrathecal space was plotted against body mass index (BMI).

The mean distance from the skin to the intrathecal space was 2.47 in (62.8 mm) and median distance 2.44 in (62 mm). The mean BMI was 29.8 kg/m2 (range 17.3 to 40.7 kg/m2) (figure). With exception of one scan in an individual with BMI of 40.6 kg/m2, no skin-to-intrathecal distance was >3.4 in.

A 3.5-in spinal needle is long enough to enter the lumbar space in almost all patients (97%) and, in our experience, all male patients with BMI of <40 kg/m2. Whether or not this guideline applies to females, potentially with a different adipose pattern, we have not yet determined.

Longer needles, usually 4 inches in length, can be used in exceptionally large patients, but there is greater risk of misplaced needle due to their tendency to bend.

We conclude that when the neurologist experiences difficulty in completing a successful LP, what is probably too short is not the needle but the experience of the clinician. We agree with the view that "if the physician fails to obtain any fluid at two different interspaces, sometimes another physician will be successful." Only very rarely will a needle longer than 3.5 in be necessary.

References
NEUROLOGY JOURNAL CLUB

*Neurology* Journal Club submissions are structured evaluations of recent *Neurology* research articles. The aim is to enhance the training of residents and fellows by instruction in the critical appraisal of medical literature. Residents or Fellows interested in submitting a *Neurology* Journal Club article should review the e-Publication Ahead of Print articles at www.neurology.org/content/early/recent for the most recently published material and email *Neurology* with their selection for prior approval. Selections will aim to represent the major categories of research methodology over the course of a 3 year residency cycle. Submissions should be timely and are requested no longer than 4 weeks following the original e-Publication date of the subject article. These Journal Club critiques, written by neurology residents and fellows with faculty supervision, should follow a specific outline and contain subtitles for background and significance, hypothesis and design, methods, results, and interpretation. Further formatting advice may be found in Dr. Millichap’s August 30, 2011 Editorial (included in this booklet). Rather than a critical correspondence or editorial, this feature will highlight methods for the critical appraisal of medical literature. This online feature could be used as an adjunct to traditional institutional journal clubs and promote discussion among neurologists, including trainees and those in practice.
ABSTRACT
The term "journal club" traditionally refers to a gathering of physicians for the critical review of current medical literature and discussion regarding the clinical application of the results. Since the formation of the first documented journal club over 130 years ago, the organization and purpose of this academic tool has gone through many changes. Despite the advent of "virtual" online journal clubs, most academic departments still employ a physical meeting between trainees and the faculty. The Neurology® Journal Club is a new subsection of the Resident & Fellow Section with the goal of enhancing the traditional journal club experience by publishing examples of structured critical appraisals of medical literature. The Journal Club critiques, written by neurology residents and fellows with faculty supervision, will examine each article for key features of hypothesis and design, methods, results, and interpretation. Neurology® 2011;77:915-917

Neurology® Journal Club is a new subsection of the Resident & Fellow Section for the publication of structured evaluations of research articles that recently appeared in Neurology. The aim is to enhance the training of residents and fellows by instruction in the critical appraisal of medical literature. This online feature should be an adjunct to the traditional journal club and promote academic discussion among neurologists, including trainees and those in practice, within their home institutions.

HISTORICAL BACKGROUND The modern concept of a medical journal club is a regularly scheduled gathering of physicians for the presentation and critical discussion of the clinical application of the results of current research. This traditional structure originated over 130 years ago and has evolved with the changes in medical education and expansion of scientific research. Today, the journal club can help fulfill a variety of core competencies, for instance medical knowledge, system-based practice, and practice-based learning, for resident training programs overseen by the Accreditation Council for Graduate Medical Education.5

Rather than a mandated meeting required for successful completion of medical training, early journal clubs were more likely social organizations for like-minded academics to meet and discuss the profession in a relaxed atmosphere. An early reference was written in the memoirs of Sir James Paget regarding the experience at St Bartholomew's Hospital in London from 1835 to 1854. Due to the small reading area at the library, some of the students found a space away from the hospital where they "could sit and read the journals and where some, in the evening, played cards." 6 The more formal journal club may have emerged out of necessity to acquire and process the growing number of medical publications in the 19th and 20th centuries.

The initial use of the term "journal club" appears in the biography of Sir William Osler written in 1926 by Harvey Cushing.7 In 1875, Osler organized a group of physicians in Montreal to collectively purchase medical periodicals that he could not afford as an individual. The recorded history of the medical journal club is sporadic over the next hundred years, but there is evidence of the growing popularity of this feature of medical education.8 Neurology journal clubs likely originated in response to the many new journals and neurology specialty societies that developed with the expansion of neurologic research and training programs in the years following World War II.9 The "Green Journal" Neurology was founded as the official journal of the American Academy of Neurology at this time.
THE MODERN JOURNAL CLUB The structure of the medical journal club varies between institutions and departments, but several studies have examined the characteristics that make the process successful. A search of the literature reveals articles pertaining to the journal club format for several different specialties, including medicine, radiology, critical care, and surgery. Interestingly, there is none that focuses specifically on neurology. These articles, taken together, provide a solid overview and a basic format of the journal club that may be applied to any medical specialty. One systematic review reports the findings from 12 relevant studies that rate the effectiveness of the health-related journal club. In addition, there are editorials that describe the experience with journal club in one specialty and at one institution. Questionnaire-based methods are most frequently utilized to examine the specific aspects of journal club organization. The investigators survey residents involved in the journal club at their institution, or the program directors or chief residents of all training programs within their specialty. One randomized controlled trial compares 2 different journal club formats at a single internal medicine residency program. The residents are randomly placed in a journal club led by either a general medicine faculty member or a chief resident with subspecialist guest faculty. Both formats are effective for instruction in methodology of medical literature. The authors point out an interesting finding that the respondents report a change in critical reading habits after attending journal clubs, but do not integrate this into their practice of medicine. Combination of traditional journal club formats with new methods of instruction, such as online medical journals, may increase the clinical application of knowledge that is vital for successful training and the practice of medicine.

Journal club is commonly utilized to help fulfill the criteria for the medical knowledge core competency required by the ACGME. Creative article selection may also introduce other aspects of medicine to trainees, such as health care delivery, ethics, or insurance criteria. In one article, the medical literature regarding effective journal clubs is systematically reviewed and the key characteristics described. The main topics include organization and article analysis. Members should have a common clinical specialty. One person should be designated as the leader with the duties of identification of appropriate articles and facilitating discussions. Attendance is improved by making the meeting mandatory, selecting an appropriate time of day, having a regular interval, and, most of all, providing food of some kind. The articles should be distributed to the club members with adequate time for review (approximately 1 week). The use of a structured analytical tool, such as a checklist or outline, provides clear expectations for preparation. Evaluation should include discussion of the methods and specifically the type of statistics used. The designated leader or faculty member should be familiar with statistics and epidemiology in order to effectively discuss the methods (and statistics) used in the specific articles chosen. At the conclusion of the meeting, the clinical application of the results should be emphasized.

NEUROLOGY JOURNAL CLUB The articles are selected from the main Neurology journal and a list of available topics will be available upon request from the editorial staff to trainees interested in making a submission. Selections will aim to represent the major categories of research methodology over the course of a 3-year residency cycle. The Journal Club critiques, written by neurology residents and fellows with faculty supervision, will examine each article for key features of hypothesis and design, methods, results, and interpretation (appendix). Submissions should follow the outline and contain subtitles. Questions are posed to guide the analysis. Rather than a criticism or editorial, this feature should highlight a method for the critical appraisal of medical literature.

DISCUSSION A journal club can be an effective component of the training program in neurology, a resident's introduction to research methods, and a source of recent advances in the field. The success of the journal club depends on many factors, particularly the timing, the convenience of the meeting place, and the interest and hospitality of the faculty.

AUTHOR CONTRIBUTIONS Dr. Millichap: drafting/revising the manuscript, study concept or design, analysis or interpretation of data. Dr. Goldstein: drafting/revising the manuscript, study concept or design, study supervision.

DISCLOSURE Dr. Millichap serves on the Neurology® Resident & Fellow Section editorial team and receives research support from the National Epilepsy Foundation. Dr. Goldstein reports no disclosures.

APPENDIX Outline for Neurology Journal Club submissions:

Background and significance
- What is already known on the subject? Provide a brief, 1–2 sentence summary of the background.
- How does this study add to the available literature? Provide a brief, 1–2 sentence, conclusion.

Hypothesis and design
- What is the research question?
- Is this question relevant? Briefly describe the context of the question.
- Is the hypothesis reasonable?
- What type of study was performed (e.g., randomized controlled, retrospective cohort, case control, or meta-analysis)?
- Is the type of study performed feasible to test the hypothesis?
Methods
- What methods were used?
- Why were these methods chosen?
- What population was studied?
- What was the intervention or exposure?
- What was the control?

Results
- What were the results? Summarize the results relating to the primary research question.
- Are the results valid? Focus on the methods and form of statistics used.

Interpretation
- Discuss the strengths and weaknesses.
- Do the results support the conclusions?
- Does this study change clinical practice?

REFERENCES

Neurology Resident and Fellow Website

Click on Residents & Fellows tab at www.neurology.org

Now offering:
- Neurology Resident & Fellow Editorial team information
- New! Call for Authors initiative
- “Search by subcategory” option
- E-Pearl of the Week
- Recent Mystery Cases
- RSS Feeds
- Direct links to Continuum®, Career Planning, and AAN Resident & Fellow pages
- Recently published Resident & Fellow articles
- Podcast descriptions
- Social media links for Neurology including Facebook and Twitter
Journal Club:
Estimating risk for developing epilepsy
A population-based study in Rochester, Minnesota

This initial Journal Club article looks at a study from
Hesdorffer and colleagues\(^1\) who have calculated
the lifetime risk of developing epilepsy. The study
provides an elegant example of proper epidemiologic
methods and results in data that have important im-
lications for public health.

When addressing public health aspects of epilepsy,
it is essential to obtain an unbiased estimate of the
lifetime risk of epilepsy. With this assessment, the
economic burden of epilepsy, including health care
expenditures, productivity loss, intangible costs such
as those associated with stigma, and additional costs
from medical comorbidities of epilepsy can be ex-
trapolated.\(^2\,3\) Similarly, the patient-perceived burden
of epilepsy, including associations between epilepsy
and poor health, unemployment, lower annual in-
comes, lower health-related quality of life, smoking,
and obesity, can be better evaluated.\(^4\) Given this
information and the proportion of the aging popula-
tion that is at risk for epilepsy, the limited number of
specialists able to care for epilepsy patients is a grow-
ing concern. Nearly 35% of adults with self-reported
active epilepsy reported not having seen a neurologist
or epileptologist in the previous year\(^5\) and the Workforce
Task Force of the American Academy of Neurology
predicts a shortfall of neurologists in the years to come.\(^6\)

With these broad consequences of epilepsy, the ques-
tions that Hesdorffer and colleagues pose in their study
are relevant to neurologic practice.

HYPOTHESIS AND DESIGN What is the risk of
developing epilepsy over the course of a lifetime?
How much does this risk increase with age? How
does the incidence of epilepsy differ among age
groups? To answer these critical epidemiologic ques-
tions, Hesdorffer and colleagues performed a popula-
tion-based retrospective cohort study using medical
records from Southeastern Minnesota. The study
population was limited to those who developed
epilepsy between January 1, 1960, and December
31, 1979, as documented through the Rochester Ep-

\(^1\) The Rochester Epidemiologic Project, a medical record linkage system
that provides access to nearly all medical records of the residents of Olmsted County, MN, for the pur-
pose of medical research.\(^6\) Using the data from these
medical records, the authors calculated the cumulative
incidence and lifetime risk of epilepsy.

There is a J-shaped incidence curve for epilepsy,
already described in the literature, that illustrates a
high incidence of new epilepsy cases occurring in in-
fants under 1 year of age, a relatively lower number
of new cases occurring throughout childhood and
adolescence, and the largest number of new cases oc-
curring after the age of 60.\(^7\) In diseases for which the
incidence is high in the older population, the calcula-
tion of cumulative incidence is biased by the compet-
ing risk of death. A competing risk is defined as "an
alternative outcome that is of equal or more signifi-
cant clinical importance than the primary outcome
and alters the probability of the outcome of interest."
In the present study, the data analysis takes the
competing risk of death into account in order to ob-
tain an accurate estimate of the lifetime risk of epi-
lepsy. More traditional methods of analysis such as
Kaplan-Meier estimates and Cox proportional haz-
ards regression that do not adjust for competing risks
would result in bias.\(^8\)

METHODS Using the medical records from the
Rochester Epidemiologic Project described above,
data from the study population were collected in-
cluding the age at epilepsy diagnosis, epilepsy etiol-
ology (progressive symptomatic, remote symptomatic,
or idiopathic/cryptogenic), and deaths in the general
population. Using this information, Hesdorffer and
colleagues first calculated the cumulative incidence,
then adjusted for the competing risk of death to cal-
culate the lifetime risk. Both calculations were done
in order to compare the 2 results.

Cumulative incidence is a proportion that mea-
sures the number of new cases of a disease relative to
the number of people in a population who may de-
velop the disease over a specific period of time. The
cumulative incidence makes an assumption that “individuals who die before they can be observed to have the disease are assumed to have developed the disease at the same rate as those who survive.” To calculate the cumulative incidence, the hazard ratio was first obtained by dividing the total number of epilepsy cases at each age by the total population at risk at that same age. This ratio was used to calculate a survival probability at each age and the age-specific incidence at each age. Cumulative incidence was calculated as the summation of all age-specific incidences. In this calculation, it is apparent that death is not taken into account as a competing risk.

Lifetime risk was then calculated in a similar fashion except with the use of an adjusted hazard ratio that did take into account the competing risk of death. With the lifetime risk calculation, members of the population who die are considered to have zero risk for developing epilepsy. In this case, an adjusted hazard ratio was calculated by adding the total number of epilepsy cases at each age to the number of deaths, then dividing by the total population at risk at that same age. This adjusted hazard ratio was then used to calculate an adjusted survival probability at each age and an adjusted age-specific incidence. The summation of the adjusted age-specific incidences resulted in the lifetime risk.

RESULTS The cumulative incidence of epilepsy was found to be 0.9% to age 20, 1.7% to age 50, and 3.4% to age 80. The lifetime risk of epilepsy was found to be 0.9% to age 20, 1.6% to age 50, and 3.0% to age 80. In other words, the cumulative risk of developing epilepsy by the age of 80 would be 3.0%. Most notable is the fact that at younger ages, the cumulative incidence and lifetime risk are similar, whereas beginning at approximately age 70, when mortality increases, the cumulative incidence is larger than the lifetime risk. By ages 80–84, the cumulative incidence was 17.8% higher than the lifetime risk. This occurs because death becomes a larger competing risk, and as a result, the cumulative incidence is an overestimate of lifetime risk.

INTERPRETATION Hesdorffer and colleagues have brought to attention the lifetime risk of developing epilepsy and some of the implications of this data. They also emphasize the importance of calculating lifetime risk rather than cumulative incidence in order to prevent bias from the competing risk of death.

The strength of the study is that the calculation of lifetime risk is valid based on the methodology used. This method of adjustment for the competing risk of death has been cited in numerous articles, most notably in the geriatric and oncology literature. For example, if one were calculating the incidence of a second hip fracture, the competing risk of mortality following the first hip fracture would be present. If this competing risk were not taken into account, then there would be an overestimated incidence of second hip fracture. When such a competing risk is present, the options are to analyze the event of interest while ignoring the competing risk, combine the events (e.g., epilepsy and death) as a single endpoint, or analyze the competing risk. The latter option has been done in this study to obtain the least biased lifetime risk value possible, and it was confirmed that the cumulative incidence was an overestimate of the lifetime risk.

Weaknesses of the study are as follows:

1. With the use of 30-year-old data, there are multiple issues of concern.
   a) While the clinical definitions of epilepsy as “2 or more unprovoked seizures” and unprovoked seizures as “seizures without an identified proximate precipitant” used in this study are still widely accepted, the study divided the etiology of epilepsy into categories of progressive symptomatic, remote symptomatic, or idiopathic/cryptogenic. These categories do not figure prominently in the analysis, with just a note that the incidence of progressive symptomatic epilepsy increased most among the elderly, but it is still notable that these data were collected before the current system for classification of seizures and syndromes was established.
   b) As the population of the United States has become more diverse over the past 30 years, the calculated lifetime risk of the Rochester, MN, population between 1960 and 1979 may not be generally applicable today. Although the data are limited, some US studies suggest a higher prevalence of epilepsy among African Americans as compared to whites. Increased immigration may also alter the distribution of epilepsy subtypes (e.g., an increase in symptomatic epilepsy from additional neurocysticercosis cases). In addition, life expectancy has changed over time, resulting in a larger elderly population, such that the calculated lifetime risk may be an underestimate.
   c) The potential causes of symptomatic epilepsy may change over time, with a notable example of HIV, a known risk factor for epilepsy that was not diagnosed 30 years ago.

2. The accuracy of the epilepsy diagnosis may be called into question when performing a broad medical record review. The authors reviewed medical records with a diagnosis of “seizure, convolution, epilepsy, or conditions known to be re-
lated to seizures.” Given that the term “epilepsy” may be used loosely as a chart diagnosis, particularly by non-neurologists, it is possible that other conditions, such as psychogenic nonepileptic attacks or syncope, could have been misdiagnosed as epilepsy.

Given these concerns, is the calculated lifetime risk still relevant to current neurologic practice? Although the population demographics and the etiologies of symptomatic epilepsy may have changed over time, the only way to establish a current estimate of epilepsy risk is to do a retrospective cohort study.12 As public health resources are limited, having an estimate of lifetime risk is important to determine the allocation of resources. An estimate of lifetime risk is also key knowledge for the practicing clinical neurologist, who should have an idea of the risk of epilepsy as patients age.

With their article, Hesdorffer and colleagues have emphasized the importance of using the appropriate methodology for obtaining the lifetime risk of epilepsy. Cumulative incidence is a commonly used measure of risk, yet this study shows that in a disease such as epilepsy, with a high incidence in the elderly population where mortality is a competing risk, the cumulative incidence largely overestimates the lifetime risk. At age 80, the cumulative incidence of epilepsy was calculated as 3.4%, which is 13% higher than the lifetime risk of 3.0%. Above age 80, the cumulative incidence was 17.8% higher than the lifetime risk. Although the absolute differences between cumulative incidence and lifetime risk appear small (i.e., 3.4% vs 3.0%), the overestimation of cumulative incidence is essential to take into consideration when interpreted on a larger scale in the context of public health. Beyond epilepsy, the article notes that lifetime risk has been measured for other diseases with high incidence in the elderly such as stroke and AD. With the current aging population and the associated disease burden, it is essential that future epidemiologic geriatric studies make adjustments for the competing risk of death to maximize the accuracy of such estimates.

AUTHOR CONTRIBUTIONS
Dr. Wong: drafting/revising the manuscript, analysis or interpretation of data. Dr. Baume: drafting/revising the manuscript, analysis or interpretation of data.

DISCLOSURE
Dr. Wong: serves on the Neurology® Resident & Fellow Section editorial team. Dr. Baume: has received research support from Citizens United for Research in Epilepsy (CURE) and Forsee Laboratories, Inc.

REFERENCES
MEDIA AND BOOK REVIEWS

The Neurology offices frequently receive newly published books, and residents and fellows are invited to review these. Reviewers will be allowed to keep the books. Reviews should be 250-500 words, and include the strengths and weaknesses of books for a trainee audience. Interested individuals should contact the journal (smorianity@neurology.org) for available books to review. We also welcome reviews of online, electronic, and other educational materials, and interested individuals should contact the journal to discuss their ideas.
INTRODUCTION: TAKING THE DIGITAL PLUNGE

When I was a medical student, residents would often say—always with an air of confidentiality—"trust me, you’ll need it." Then they would reveal a must-have medical book tucked into the pocket of their white coat. Even back then I shuddered at the idea of carrying all those books. There were so many of them! Even less did I want to use a magnifying glass to read the 2-point font such books typically employ. More than anything, I did not want to waste time searching for information. I wanted it ready at a moment’s notice.

Many physicians today are blending smartphones, PDAs, laptops, tablets, and e-readers with their clinical practice. Some of us have been doing this from the beginning of our careers, others are just now wondering what the fuss is all about, and some Luddites are stubbornly holding out (though today this requires a conscious decision).

So what is all the fuss about? Yes, font sizes are adjustable, 100 textbooks do fit in a shirt pocket, and information is indexed and searchable in seconds. Every day since I was a medical student, I have had at my fingertips a complete dictionary (Stedman’s), a drug reference (I started with Epocrates), a couple of internist manuals (Pocket Medicine: The MGH Handbook of Internal Medicine and Harrison’s Manual of Medicine), and a pediatric reference (Harriet Lane Handbook). I realized early on that my electronic reference library represented a different way of doing things because most people at that time were still squinting at tiny printed pages or waiting until after rounds to look for answers to questions that had arisen. And I still work with many attending who do not use any portable electronic reference device. Often I was the only one who could find answers to clinical questions on the spot, and they were updated answers.

But that’s old news. The fuss, the one worth talking about, is that not too long ago, the game changed. It changed in 3 ways. First, there is new content. Before we were just putting books into our pockets and then into our PDAs. Now we collect “media” rather than books, and this might include a blend of text, video, audio, Web links, computations, or interactive software. This broader definition puts a wider range of useful tools at our disposal. As a medical student, my PDA held a series of high-quality audio clips demonstrating the different cardiac and pulmonary sounds (provided on an audio CD by Littman with my stethoscope). When I thought I was hearing something abnormal, I would open my PDA and listen to an example, to see if there was a match. As an intern I had an iPhone app (Afib Educator) that played a short video demonstrating for patients what atrial fibrillation looked like on a 3-dimensional heart. Now I keep handy a medical calculator (MedCalc) for things like corrected phenytoin levels, creatinine clearance, and NIH Stroke Scale score. I also keep handy an app for interpreting arterial blood gases (Acid Plus).

The second change is that of timing. Staying up to the minute is not only possible but is now expected, and many media offer users the option to auto-update. Drug index apps (Epocrates, mobileMicromedex, Medscape, mobilePDR) do this routinely. I have a fun little app called Eponyms that currently has more than 1,700 entries of common and obscure medical eponyms (Have you heard of Gonda’s maneuver?) that get updated regularly and automatically. Such systems permit physicians instant access to the same information previously found only in the hands of experts.

Finally, the context of the game has changed. It used to be that pocket textbooks served as reminders of facts already known to the owner. It is no longer possible to be the renaissance physician. There are too many details, and the details are constantly changing. Today the goal is to have access to, sometimes for the first time ever, the most updated expert opinions on various subjects. My favorite example is Medscape, a free product available online and as an app. Medscape is continuously updated with peer-reviewed articles on seemingly everything. Whenever we have a clinical question on rounds that is outside the knowledge set of the team, my first move is to check Medscape. Invariably I find something rele-
General Submission Instructions

The Resident and Fellow Section is a primarily online feature that serves the resident and fellow readership. Residents and fellows are expected to be the primary authors for most submissions, but those highly involved in graduate medical education (e.g., program directors) may also contribute submissions on appropriate topics. Submissions for all article categories should be no more than 1,500 words; permission for longer articles will be needed from the editors. The number of references should be 10 or less and one to two tables or figures may be incorporated. The topic must be mentioned in the cover letter of the submission. Potential article topics include: teaching, ethics, practice, career choices, residency training, editorial, international education, research, historical, opinion, book review, training videos, or teaching NeuroImages. Teaching NeuroImages has the same requirements as NeuroImages but is especially valuable to the trainee audience and will be published in the online Resident and Fellow Section. Queries and comments should be addressed to Mitchell Elkind, MD, MS, FAAN, or Kathy Pieper at kpieper@neurology.org.
TEACHING NEUROIMAGES

Teaching NeuroImages are interesting, previously unpublished photomicrographs, patient photographs, neuroradiologic images, or other pictorial material. They should be particularly clear examples of established observations intended for the trainee audience. Educational videos may also be submitted under this category (Teaching Video NeuroImages.)
A tasteless lesion

J.A. Feldman, MD; S.L. Galetta, MD; R.R. Miselis, VMD, PhD; A.C. Rosenquist, PhD; and B.M. Ances, MD, PhD

A 45-year-old restaurant owner noted loss of taste over his entire left tongue during a two-week time period. Neurologic exam was otherwise normal including facial strength. Brain MRI revealed an enhancing lesion of the left dorsal pons (figure, A and B). The patient subsequently developed coordination difficulties and double vision. Repeat MRI confirmed a left superior cerebellar and a new frontal white matter lesion consistent with multiple sclerosis.

The anatomy of the secondary projection fibers conveying the sensation of taste in humans remains poorly understood. Recent mapping studies in monkeys suggest that the second order neuron projections from the nucleus of the solitary tract pass through the dorsalateral pons before ascending as the central tegmental tract. The lesion in our patient is just above the nucleus of the solitary tract and lies in the location of the second order neurons that project to the thalamus for taste.

We conclude that the ascending taste fibers from the nucleus solitarius travel within the dorsolateral pons just medial to the superior cerebellar peduncle. A lesion in this location may produce this isolated deficit.

References

Figure. (A) Axial fluid level attenuation recovery MRI above the level of the nucleus of the solitary tract and (B) T1 postcontrast coronal at the pontomesencephalon. In both images, arrow shows demyelinating lesion.

From the Departments of Neurology (J.A.F., S.L.G.), Veterinary Medicine (R.R.M.), and Neuroscience (A.C.R.), University of Pennsylvania, Philadelphia; and the Departments of Neuroscience and Radiology (B.M.A.), University of California San Diego.

Disclosure: The authors report no conflicts of interest.
Address correspondence and reprint requests to Dr. Jessica A. Feldman, Department of Neurology, 3 West Gates, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA; e-mail: jfeldma2000@hotmail.com
Teaching NeuroImages: Remote cerebellar hemorrhage following resection of a supratentorial tumor

Joyce Paul, MD
Miral D. Jhaveri, MD
Steven L. Lewis, MD

A 23-year-old man was admitted with blurred vision and headache. Ten years ago he was diagnosed with a left temporal pleomorphic xanthoastrocytoma; his last resection was 6 years ago. Current CT and MRI showed left temporal encephalomalacia; MRI also revealed incidental bilateral remote cerebellar hemorrhages (RCH) (figure). Called “remote” due to their distance from the surgical site, RCH are rare complications of supratentorial and spinal operations.1 Depending on extent, RCH may be symptomatic and diagnosed acutely on CT, or incidentally discovered as chronic hemosiderin on MRI. RCH are thought to be due to venous traction and rupture from postoperative CSF loss and brain shift.1,2

REFERENCES

MYSTERY CASE RESPONSES
The Mystery Case series was initiated by the Neurology® Resident & Fellow Section to develop the clinical reasoning skills of the trainees. Residency programs, medical student preceptors, and individuals were invited to use this Mystery Case as an education tool. Responses were solicited through a group e-mail sent to the AAN Consortium of Neurology Residents and Fellows and through social media.

From the Section of General Neurology, Department of Neurological Sciences (J.P., S.L.L.), and Section of Neuroradiology, Department of Radiology (M.D.L.), Rush University Medical Center, Chicago, IL.

Disclosure: Dr. Paul and Dr. Jhaveri report no disclosures. Dr. Lewis serves as a CME Section Editor for Neurology®, serves as Associate Editor of Continuum, Lifelong Learning in Neurology, and has received publishing royalties for Field Guide to the Neurologic Examination (Lippincott Williams & Wilkins, 2005) and Neurology for the Non-Neurologist (Lippincott Williams & Wilkins, 2010).
For this Mystery Case, we received 25 answers, all responses coming from individual residents rather than groups, and they were all well-reasoned and thoughtful. The majority of respondents (19) identified the hemosiderin deposition between cerebellar foliae on gradient echo MR images as due to venous rupture from postoperative CSF loss and/or brain shift. The second most favored diagnosis (3) was a vascular or leptomeningeal spread of the primary tumor associated with microbleeds.

This Mystery Case illustrates a rare complication of supratentorial and spinal surgery, sometimes called the zebra sign.

Dragos A. Nita, MD, PhD
The Hospital for Sick Children, Toronto

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Gates’ Rule of 4 of the Brainstem: A Simple Method to Demystify the Brainstem

November 28, 2011

According to Gates’ rule of 4, there are 4 structures in the midline of the brainstem beginning with M: motor pathway or cortical spinal tract, motor cranial nerves (3, 4, 6 and 12), medial lemniscus, and medial longitudinal fasciculus. There are 4 lateral structures beginning with “S” including the spinocerebellar pathways, sympathetic pathway, spinothalamic pathways and sensory nucleus of trigeminal nerve. There are 4 cranial nerves above the pons (1-4), 4 in the pons (5-8), and 4 in the medulla. Knowledge of the rule of 4 makes the teaching and diagnosis of brainstem syndromes less challenging.

Reference

Submitted by:
Tissa Wijeratne

Disclosures:
Dr. Wijeratne has nothing to disclose.

Striatal Hand and Foot

June 2, 2011

Striatal deformities of the hand and foot are typically painless, fixed contractures of the distal joints seen in 10 % of patients with advanced Parkinson’s disease. Originally described by Charcot and Purves-Stewart, the term striatal refers to the pathology located in the neostriatum (caudate and putamen). Unlike dystonia, they are present at rest and in sleep. Striatal toe is differentiated from Babinski sign by lack of toe fanning and flexion synergy of other muscles in the same leg. Response to treatment with antiparkinsonian has been reported, but is not predictable. Botulinum toxin and surgery are other options.

Reference

Submitted by:
Partha S Ghosh, MD

Disclosure:
Dr. Ghosh reports no disclosures.