RESIDENT & FELLOW SECTION

HOW CAN I CONTRIBUTE?

The Neurology® Resident & Fellow (R&F) Section provides countless opportunities for trainees to make a contribution to the field. We have over 10 categories of manuscripts, from Global and Community Health to Clinical Reasoning cases. Every year, the R&F team develops innovative submission opportunities and new ways to engage our readers and users.

EXPLORE THE R&F SITE
Access NPub.org/RF for the latest blogs, articles, e-Pearls, Mystery Cases, and other trainee resources. The print issue also features “Resident & Fellow Rounds”—a monthly summary of the R&F Section articles.

SUBMIT AN E-PEARL
These brief educational points are designed to highlight an important topic or clinical finding in neurology.

BECOME A PEER REVIEWER
Create an account at submit.neurology.org and include any expertise terms that interest you. After your profile is complete, contact the editorial office at rfsection@neurology.org and you will be added to the database of available reviewers.

FOLLOW NEUROLOGY ON SOCIAL MEDIA
Receive the R&F Section alerts including e-Pearls, Mystery Cases, and recently published article alerts.

SUBMIT TO THE JOURNAL CLUB
Have you led journal club at your program recently or read a good Neurology article? For this section, authors review a recently published Neurology article focusing on a key aspect of research methods that trainees can take away from the article.

ACCESS AUTHOR GUIDES
The R&F Author Center provides pictorial guides on writing Clinical Reasoning, Pearls & Oy-sters, and Teaching NeuroImages at NPub.org/rfsections.

HAVE MORE QUESTIONS? HAVE AN IDEA?
Contact the editorial office at rfsection@neurology.org.

SUBMIT AN EQUILIBRIUM COMMENTARY
We invite trainees to share "Equilibrium" reflections that are posted to our Invited Commentary area of the RFS website. These are brief reflections on wellness and balance during training. Equilibrium provides a space for students, residents, and fellows to express, reflect, and contemplate their physical, mental, or social well-being.
Central Pontine Myelinolysis in Diabetic Ketoacidosis

T2 fluid-attenuated inversion recovery (FLAIR) reveals symmetric hyperintensities centered in the pons (A) with restricted diffusion (B). T1 postcontrast with gadolinium demonstrated no enhancement (C). DWI = diffusion-weighted imaging; GAD = gadolinium.
The mission of the Resident & Fellow Section (RFS) is to keep our readers up to date on issues relevant to trainees, educators, and others interested in the training and practice of neurology. The RFS was launched in 2004 by Robert “Berch” Griggs, MD, FAAN, then the editor-in-chief of Neurology, and Karen C. Johnston, MD, MSc, associate editor. The RFS has since grown into a juggernaut of high-quality work for trainees and educators in neurology. The RFS is led by Roy E. Strowd, MD, MEd, MS, FAAN, the RFS associate editor, and Whitley W. Aamodt, MD, MPH, deputy section editor.

The RFS is supported by an editorial board that consists of more than 20 neurology residents and fellows responsible for reviewing, editing, and publishing articles. Residents are selected annually for a three-year term through a competitive process that attracts dozens of applicants from around the world. The current board includes a diverse cohort of trainees; 57 percent are women and 38 percent are international members from Italy, Philippines, Switzerland, Iran, Tunisia, Peru, and Canada. This highlights book includes photographs and biographies of the current RFS editorial team. Past editorial team members have gone on to other editorial activities at Neurology and elsewhere and found the RFS experience a formative part of their careers.

The RFS publishes primarily case-based manuscripts as well as other articles. The number of submissions has grown considerably from 481 submissions in 2013 to 852 in 2021 (Figure 1), a 77-percent increase. Case-based submissions include Clinical Reasoning, Pearls & Oy-sters, Child Neurology, Teaching NeuroImages, Video NeuroImages, and Mystery Cases. In addition, the RFS publishes Journal Club articles on research methodology; Global and Community Health articles on the practice of neurology in resource-limited settings; Future of Neurology and Technology articles that discuss the influence of new technology on resident training and practice, and Emerging Subspecialties articles that summarize new avenues for training. Training in Neurology is focused on innovative curricula for teaching and training in neurology. There are also avenues for publishing the humanities of neurology through the Right Brain subsection. Descriptions of these subsections appear in this highlights booklet and include the top representative articles published in the past year as selected by the RFS Editorial Team members.

Over the past two years, the RFS has expanded the RFS blog site to provide a forum for students, residents, and fellows to share dialogue on the COVID-19 pandemic as well as issues related to social justice, health equity, anti-racism, and virtual learning. The newly developed blog series “Equilibrium” provides a monthly outlet for residents to reflect on their well-being and the influence of training.

The RFS editorial team has initiated and developed a number of projects over the years, including podcasts (beginning in 2007), weekly e-Pearls (2008), an annual Writing Award (first given in 2009), a mentored peer review training program (2016), social media presence to disseminate journal content (2019), and the publication of two books, Clinical Reasoning and Child Neurology, with compilations of previously published cases that provide an educational resource for trainees and program directors. One of the greatest accomplishments of the RFS is the mentor-mentee program designed to pair new RFS team members with recent section graduates. This past year, the program expanded under the direction of former team member Ariel M. Lyons-Warren, MD, PhD, to serve as a structured model for bringing new, young peer reviewers into the process, even outside the RFS itself. The RFS webpage includes features such as the blog series, e-Pearls, listings of the latest RFS articles, and an online survey platform for the Mystery Cases. There are also links to other resident and fellow resources on Neurology.org and AAN.com.

The team publishes at least one RFS article in every print issue of Neurology, and a monthly summary for the “Resident and Fellow Rounds” commentary written by the RFS section editors. The RFS editorial team members are proud of the additional exposure through print distribution and expect this will encourage continued submission of high-quality manuscripts. Recognizing the role of social media in medicine and daily life, the RFS delivers regular Instagram, Twitter, and Facebook posts and is involved in the Neurology Minute™ daily briefing as well.

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
2022 Resident & Fellow Section Writing Award

Child Neurology: Late-onset Vitamin B6–Dependent Epilepsy Identified by Rapid Genome Sequencing

Chris Espinoza, Melissa A. Wright, Meghan S. Candee, Cristina Trandafir and Gary R. Nelson

*Neurology* 2021;96(19):911-914; DOI: 10.1212/WNL.0000000000011891

The *Neurology* Resident & Fellow Section Writing Award recognizes the extraordinary writing abilities of those currently in training in neurology. Eligible manuscripts include any published in the *Neurology* Resident & Fellow Section, whether online or in print. Submissions on any topic of interest to trainees and in any subcategory of the section are eligible. The main criteria for selection are educational value, novelty, depth of exposition, and clarity of writing. At least one author of the manuscript must be a resident or fellow in one of the neurologic subspecialties. All authors are considered equal recipients of the award in order to recognize and encourage collaborative work among trainees. The award is announced in early 2022 and awarded for a paper published in 2021. No formal application process is required. All manuscripts submitted to the section will be considered. Manuscripts should be submitted online at [NPub.org /submit](http://NPub.org /submit). Please direct any questions to rfsection@neurology.org.

On behalf of the full team, we hope you enjoy this year’s edition!

2022 Education Research

**Effect of the COVID-19 pandemic on neurology trainees in Italy: A resident-driven survey**

Elena Abati, Gianluca Costamagna

*Nurology* 2020;95:1061-1066

2020 Right Brain

**Art and the restoration of identity in dementia**

Bryan J. Neth, MD, PhD

*Nurology* 2019; 93:719-721

2019 Emerging Subspecialties in Neurology

**Pain medicine**

Nathaniel M. Schuster, MD

Jacob R. Hascalovici, MD, PhD

*Nurology* 2018;91:1025-1028

2018 Clinical Reasoning

**An 82-year-old man with worsening gait**

Sheena Chew, MD

Ivana Vodopivec, MD, PhD

Aaron L. Berkowitz, MD, PhD

*Nurology* November 21, 2018, 89;21e246-e252

2017 Pearls & Oy-sters

**Episodic ataxia type 2: Case report and review of the literature**

Elan L. Guterman, MD

Brian Yurgionas, MD, MS

Alexandra B. Nelson, MD, PhD

*Nurology* June 7, 2016, 86:23 e239-e241

2016 Emerging Subspecialties in Neurology

**Telestroke and teleneurology**

Sunil A. Mutgi, MD

Alicia M. Zha, MD

Reza Behrouz, DO

*Nurology* June 2, 2015, 84:22 e191-e193

2015 Clinical Reasoning

**An unusual cause of transverse myelitis?**

Pavan Bhargava, MD

Rodger J. Eible, MD, PhD

*Nurology* February 11, 2014, 82: e46-e50

2014 Right Brain

**A reading specialist with alexia without agraphia: Teacher interrupted**

Jason Cuomo, MA

Murray Flaster, MD, PhD

José Biller, MD

*Nurology* January 7, 2014, 82:e5-e7
Team Members

Shashank Agarwal, MD

Agarwal is a neurovascular fellow at NYU Langone Health. He graduated from the neuroscience residency program at NYU Langone Health–Brooklyn and received his medical degree from Kasturba Medical College, Manipal University in India. During residency, Agarwal developed interest in caring for neurovascular and neuro-critical care patients. He has been actively engaged in research projects involving the mechanism and treatments of stroke. Agarwal is passionate about medical education and enjoys teaching medical students and residents. Outside of medicine, Agarwal loves drone photography, cooking, and spending time with family.

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Raphael Bernard-Valnet, MD, PhD

Bernard-Valnet is an adult neurology resident at Lausanne University Hospital (Centre Hospitalier Universitaire Vaudois), Switzerland. In 2010, he entered the French Institute of Health–Brooklyn and completed his neurology residency at Johns Hopkins completing the clinical and research neuro-epidemiology fellowship program as well as a Master’s in Education. Strowd has clinical research interests in drug development and response assessment in neuro-epidemiology as well as medical education interests in exploring optimal approaches for teaching healthcare professionals at multiple levels of training. Strowd is active in medical education, academic scholarship, and scientific research at both the local and national levels and truly enjoys each opportunity to mentor residents and fellows throughout neurology.

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Mehdi Bouslama, MD

Bouslama is an adult neurology resident at Emory University. Originally from Tunisia, he completed medical school at Faculté de Médecine de Tunis. After graduation, he spent two years working as a clinical research fellow at Grady Memorial Hospital in Atlanta investigating ways to enlarge the scope of stroke endovascular therapies and developing new imaging paradigms and tools to improve stroke care systems, under the mentorship of Dr. Raul Nogueira. His research interests include “big data AI, and machine learning in neuroimaging. After residency, Bouslama will pursue stroke and neurovascular fellowships. In his spare time, he enjoys playing the “oud,” tennis, exploring the Atlanta food scene, and spending time with his wife and son.

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Sarah Brooker, MD, PhD

Brooker is an adult neurology resident at Northwestern Memorial Hospital of Northwestern University. She is originally from Minnesota and completed her undergraduate education at Yale University in 2010. She then joined the Medical Scientist Training Program at Northwestern where she earned her medical and doctoral degrees. Her PhD research focused on signaling pathways modulating adult hippocampal neurogenesis. Her current research interests include investigating genetic and environmental mechanisms of neurological movement disorders. Outside of medicine she enjoys figure skating, spending time with family, and exploring the Chicago food scene.

Gianluca Costamagna, MD

Costamagna is a neurology resident at the University of Milan, Dapèdè Maggiore Policlinico, Italy. During medical school, he studied for one year in Bonn, Germany, while completing his medical degree at the University of Pavia, Italy. Prior to neurology residency, he was awarded the Armerise Harvard Summer Fellowship and worked at Weiner’s Lab, Harvard Medical School, and Brigham and Women’s Hospital, investigating the role of microbiota in modulating multiple sclerosis in mice. Costamagna truly enjoys medical education, having served as a microbiology, tropical medicine, and human physiology teaching assistant in medical school. As a neurology resident, he has broad research interests within the fields of neurodegenerative disorders, with emphasis on motor neuron diseases and stem cell-based 3D models of amyotrophic lateral sclerosis. Outside of neurology, Costamagna loves running, exploring Italian boroughs, and hiking in the Alps.

Isabella Ferando, MD, PhD

Ferando is an adult neurology resident at University of Miami. Originally from Mantova, Italy, she obtained her medical degree at the University of Bologna with a research thesis on localizing semioptic signs in focal epilepsies. She later moved to Los Angeles, where she obtained a doctorate in neurophysiology at UCLA. Her research focused on the role of neurosteroids on GABA-A receptors in mouse models of diseases. She later completed two postdocs with research focused first on epilepsy and later on migraines, during which time she was awarded the prestigious Epilepsy Foundation postdoctoral fellowship. She has published several peer-reviewed papers in journals such as Nature Neuroscience, Annals of Neurology and the Journal of Neuroscience, and throughout the years she has served as peer reviewer for journals like The Journal of Neuroscience and Frontiers. Ferando is passionate about women’s health and translational research, and in promoting those fields through scientific communication and educational outreach. During her free time, Ferando enjoys spending time with her family, cooking Italian meals, and traveling.

Katherine Fu, MD

Fu is a movement disorders fellow at the University of California, Los Angeles. She graduated with degrees in neuroscience and biological sciences from the University of Southern California and obtained her medical degree from the Keck School of Medicine of the University of Southern California. Her research interests include investigating neuromodulating biomarkers of neurodegenerative diseases, and she is interested in learning more about deep brain stimulation and neuromodulation during fellowship as well. She also has an interest in medical education, having completed the Certificate Program in Innovations in Curriculum Design and Evaluation, and now participating in the Fellowship in Medical Education Scholarship offered by the UCLA. She is also a co-neurology clerkship site director at the West LA VA Medical Center and one of the leaders of the UCLA Neurology Residency Education Track. Her hobbies include creative writing, shao-lin kung fu, and playing viola and ukulele.

Galina Gheihman, MD

Gheihman is an adult neurology resident in the Massachusetts General Brigham Neurology Program in Boston. Originally from Toronto, Ontario, Galina attended the University of Toronto for her undergraduate studies, majoring in neuroscience and psychology. She moved to Boston in 2014 and earned her medical degree at Harvard Medical School. Gheihman has wide clinical, research, and educational interests including quality improvement and patient safety, leadership, and resilience in medicine, and designing, implementing, and evaluating medical education interventions. She loves to mentor, teach, and share her enthusiasm for medicine and neurology with others. When not at the hospital, Gheihman’s favorite place to be is anywhere outdoors. She enjoys hiking in the mountains, running, dancing, and traveling around the world. She can often be found listening to a podcast or audiobook while on a long walk, or when on the train or plane heading to her next adventure!

Katrina Ignacio, MD

Ignacio is an adult neurology resident at the Philippine General Hospital. She received her medical degree from the University of the Philippines College of Medicine. Before entering residency, she had been involved in research projects that aimed to update health policies for public health insurance in the Philippines. She is currently the assistant chief resident for the Department of Neurosciences at the Philippine General Hospital. Her clinical interests include vascular neurology and neurophysiology. Outside medicine, she enjoys practicing yoga and going wakeboarding.

Deputy Editor

Whitley W. Aamodt, MD, MPH

Aamodt is a clinical instructor and postdoctoral research fellow in the Movement Disorders Division at the University of Pennsylvania. She graduated with a degree in neuroscience from the College of William and Mary and completed dual degrees in medicine and public health at the University of Texas School of Medicine at San Antonio. She also completed her adult neurology residency and Edmond J. Safra Fellowship in Movement Disorders at the University of Pennsylvania. Aamodt is currently the recipient of an NIH T32 grant in neuroepidemiology and will complete a master’s degree program in clinical epidemiology (MSCE) in 2022. She is passionate about medical education, global health, and the practice of neurology in resource-limited settings. Her research interests also include topics in health care disparities, outcomes, and palliative and end-of-life care for patients with Parkinson’s disease and related disorders.
Saba Jafarpour, MD  
Jafarpour is a child neurology resident at Children’s Hospital of Los Angeles. She received her medical degree with honors from Tehran University of Medical Sciences. She then completed a research fellowship at Boston Children’s Hospital, Harvard Medical School, and residency in pediatrics at Mayo Clinic in Rochester, MN. She has been actively engaged in research and scholarly activities in pediatric epilepsy, neuroimmunology and neuroinflammatory disorders. She also serves as a member of Residents and Fellows Board of Journal of Child Neurology/Child Neurology Open. In her free time, she enjoys drawing/painting, Persian calligraphy, and biking. 
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Alexandria Melendez-Zaidi, MD, PhD  
Melendez-Zaidi is a child neurology resident at Texas Children’s Hospital and Baylor College of Medicine. Melendez-Zaidi studied applied mathematics and microbiology at the University of Texas at El Paso before moving to Chicago as a part of Northwestern’s Medical Scientist Training Program where she earned medical and doctoral degrees. In graduate school, she studied microcytosis and synaptic plasticity within the basal ganglia, with particular interest in interneurons of the striatum and manifestations of diseases of this nucleus. Her current research interests are broad and include chameleomics in genetic epilepsy syndromes and neuroplasticity/rehabilitation in children after brain injury. Outside of medicine, she spends time moving (blancng, running, soccer), reading, being outside, and practicing her pediatrics exam skills on her two children. She is enthusiastic about communicating with the neurology population at large, grateful for the privilege to take care of patients and families, and for her own health.

Nara Michaelson, MD, MS  
Nara Miriam Michaelson is an adult neurology resident at New York Presbyterian/Weill Cornell in New York City. Originally from Oklahoma City, OK, she moved to the east coast to attend the Massachusetts Institute of Technology and major in brain and cognitive sciences. After her undergraduate degree, she did research at Brigham and Women’s Hospital, studying the role of T regulatory cells in multiple sclerosis. She attended Dartmouth Medical School, where she was president of the AAN’s Student Interest Group in Neurology (SIGN) chapter. Michaelson is passionate about teaching and studying all aspects of neurology, with specific interests in multiple sclerosis and other inflammatory conditions of the central nervous system. Currently, she is researching imaging biomarkers to further explore the biological mechanisms underlying inflammatory lesions. Her other interests include advancing the role of women in neurology as well as promoting the use of narrative medicine. She has published several short stories and created podcasts for the Journal of Academic Medicine and has written poetry for the Harvard Review of Psychiatry. 
Twitter: @Narologist

Alisa Mo, MD, PhD  
Mo is a child neurology resident at Boston Children’s Hospital. She graduated from Cornell University with a bachelor’s degree biology and mathematics. She then completed her medical and doctoral degrees from Johns Hopkins University School of Medicine. Her doctoral research focused on identifying genome-wide differences in behavior, motivation, and chromatin modifications across subtypes of cortical neurons. Her clinical and research interests are in neuropsychiatrics. Outside of medicine, Mo enjoys hiking, cooking, and board games.

Jodie Roberts, MD, MSc  
Roberts is an adult neurology resident at the University of British Columbia. She is an alumnus of the Leaders in Medicine program at the University of Calgary and the University of Melbourne. Her research interests include analytics of real-world data to assess the long-term outcomes of MS relapse management strategies. She has a special interest on the impact of health-related behaviors (particular exercise) on MS outcomes. Outside of medicine, she enjoys cycling, cross-country skiing and trail running in the beautiful Rocky Mountains.

Russ is in the Department of Pediatrics, Division of Neurology, at Duke University. He graduated in 2008 with a bachelor’s degree in the Biological Basis of Behavior from the University of Pennsylvania. He then entered the Wellcome Trust/NIH training program at the University of California, San Francisco, where he earned a doctoral degree in neuroscience in the laboratory of Dr. Julia Katschmann at Sloan Kettering. He studied how interneuron development is affected by intrinsic transcription factor expression and extrinsic circadian perturbations, such as perinatal stroke. Russ graduated with his medical and doctoral degrees in 2016. He then completed pediatric training at the University of California-San Francisco, and is currently completing his child neurology fellowship. His research and clinical interests include early neurodevelopment and circuit formation. He has authored multiple research papers, editorials, and essays. He is highly committed to teaching and mentoring upcoming neurology and neuroscience trainees.

Eric Lee Stulberg, MD, MPH  
Stulberg is an adult neurology resident at the University of Michigan. His research interests include translating causal inference methods into clinical neurology research, as well as studying how socioenvironmental factors influence neurologic health and healthcare delivery. He also has a growing interest in critical appraisal education in medical training. His clinical interests within neurology are broad. Outside of medicine, he enjoys playing tennis and taking advantage of the surrounding mountains by camping, hiking, and skiing.

Joaquin A. Vizcarra, MD  
Vizcarra is an adult neurology resident at Emory University in Atlanta, GA. He received his medical degree from the Universidad Peruana Cayetano Heredia in Lima, Peru. After completing his residency, he was awarded the Louise and Raymond Koeing fellowship in neurodegenerative disorders conducting clinical research in movement disorders at the University of Cincinnati under the mentorship of Dr. Alberto J. Espay. After residency, he plans to pursue a movement disorders fellowship. His research interests are broad, with an emphasis on the integration of patient-centered outcomes and technology measures. Outside of medicine, he enjoys playing guitar, piano, and tennis, as well as exploring the Atlanta food scene with his wife.

Aida Wise, MD  
Wise is an adult neurology resident at Mount Sinai Beth Israel in New York. As an undergraduate, she studied comparative literature and philosophy at NYU, where she went on to obtain a master’s degree in creative writing and psychology. She completed post-baccalaureate studies at Columbia University and earned her medical degree from Sidney Kimmel Medical College at Thomas Jefferson University. Wise is passionate about medical education; she has spearheaded curriculum design and trainee wellness initiatives throughout medical school and residency and has published several essays and editorials about medical training and the practice of modern medicine. In 2018, she attended the Harvard Macy Program for Future Academic Clinician-Educators and currently serves on Mount Sinai’s Graduate Medical Education Subcommittee. Her research interests include Parkinson disease, dystonia, and the genetic epidemiology of neurological illness. After residency, she plans to pursue a fellowship in movement disorders with an emphasis on neuroimmunology and neurogenetics. 
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Denise Xu, MD  
Xu is an adult neurology resident at the University of Pennsylvania in Philadelphia. She graduated from Harvard University in 2011 with a bachelor’s degree in neurobiology and completed her medical degree at the University of Pennsylvania. She is passionate about medical education and has been involved in direct teaching and curriculum development efforts since college. Clinically, she is interested in neurohospitalist medicine. In her spare time, she enjoys persuading estate/garage sales and used bookstores, hiking, and accumulating new hobbies. The latest: keeping an ever-growing collection of houseplants alive despite all odds.
Top 10 Ways Program Directors Can Use the Neurology Resident & Fellow Section

By Denise Xu, MD

1. Send clinical pearls to your trainees. Residency and fellowship can be busy, but education remains the foundation of training. Our e-Pearls provide essential insight into a neurologic topic in fewer than 85 words. Incorporate information from these weekly submissions into daily rounds or include e-Pearls in your email announcements to trainees. Pearls & Oysters manuscripts feature longer case vignettes that begin with a list of clinical pearls and can’t-miss red flag “oy-sters” great for an email, Tweet, or communication to your trainees.

2. Encourage your trainees to join our editorial team. Are your trainees interested in the editorial process? Encourage them to join the RFS editorial board. Annually, we offer three-year positions to adult and pediatric neurology residents from around the world. Team members peer review manuscripts, assist in writing and editing blogs, implement new projects for the section, and participate in monthly conference calls. Keep an eye out for our call for applications in May or June. If trainees would like to get involved with less of a time commitment, they can apply to become reviewers for the section.

3. Challenge your trainees with our social media quizzes. In addition to the AAN’s Neurology Question of the Day app and monthly Trainee Trivia, the RFS provides opportunities for trainees to test their neurologic knowledge. Check out our Twitter account (@GreenJournal) each week for quizzes featuring recent cases and topics from the Clinical Reasoning and Teaching NeuroImages subsections and the Cortical Careers series. Can your trainees keep an answer streak going?

4. Encourage your trainees to submit a blog. The RFS aims to share trainees’ ideas and experiences with peers and educators around the world. Our blog publishes commentaries from trainees on a range of topics, from recently published articles to lessons learned during the ongoing COVID-19 pandemic. A highlight of the year: the new Equilibrium series provides an outlet for trainees to discuss personal challenges and explore themes of balance and well-being. To submit an inquiry for your trainees, email rfssection@neurology.org with a description of the topic you’d like to discuss.

5. Learn and share new educational initiatives. The RFS publishes new educational innovations and programs that you may want to implement in your own program. Training in Neurology is an article type that showcases topics related to training neurologists at all stages of their careers and in various settings. This subsection provides a range of neurologic education, from novel adaptations to workflow borne out of the COVID-19 pandemic to creative reinventions of staples such as morning report. It also emphasizes how lessons and ideas can be translated to other institutions. Learn from these initiatives and share your own. Find submission guidelines on Neurology.org.

6. Demonstrate exam and neuroimaging findings (virtually!). Expand your trainees’ repertoire of bedside clinical and exam skills. Teaching NeuroImages and Teaching Video NeuroImages are brief case reports with an associated image or video. Cases feature classic presentations of uncommon disorders and rare manifestations of common conditions. In comparison to text-based instruction, these graphics allow learners to make their own observations and independently describe deficits before developing interpretations and differentials. Cases are easily accessible in PowerPoint.

7. Learn about new career paths in neurology. The field of neurology is expanding at a vertiginous rate with several new and exciting subspecialties. Our subsection, Emerging Subspecialties in Neurology, delves into these new options and provides guidance to trainees. The “Cortical Careers” series explores career pathways outside of formal subspecialties, picking the brains of senior leaders and compiling expertise and advice for trainees interested in similar paths. A recent highlight includes a discussion around the different approaches to becoming an editor-in-chief.

8. Discuss a teaching case. The RFS publishes instructive cases of patients seen around the world. The Clinical Reasoning and Child Neurology subsections feature cases with significant teaching value that offer trainees the opportunity to reinforce their skills in critical thinking. Discuss these manuscripts with your trainees, and parse out the presentations, differential diagnoses, and management of challenging patients. Explore our two free PDF book collections of Clinical Reasoning and Child Neurology cases, linked in the right-hand sidebar on the RFS website.

9. Write up a case with your trainees. The RFS publishes educational case reports in several different formats, offering trainees an opportunity to engage with academic writing. Explore our visual author guides (Neurology.org/rf/author_guides) to quickly learn how to structure submissions, avoid common pitfalls in writing, and increase the chance of publication. The Author Center includes in-depth explanation of the requirements and expectations for each subsection. After submission, our team of trainee and faculty reviewers provides detailed feedback to authors.

10. Follow and engage with us on social media. To keep up-to-date on the latest publications, follow us on Twitter (@GreenJournal), Instagram (@aanbrain), and Facebook (@AANResidentsandFellows). Here we link to articles and studies from the RFS, as well as news and resources about the field of neurology. Share our posts using #NeurologyRF. If you’re more of an auditory learner, listen to the Neurology Minute, a concise review of timely topics in the field, which is perfect for a morning commute and easily shareable with interested trainees.
Child Neurology

The Child Neurology section in the Resident & 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.
Malformations of cortical development represent an important cause of developmental disability and neurologic morbidity and mortality. Advances in genetic methodology, particularly the widespread implementation of next-generation DNA sequencing technology (e.g., multigene panels and whole exome sequencing [WES]), have significantly improved diagnostic yield in neurogenetic disease. The current yield for a range of conditions, including brain malformations, epilepsy, global developmental delay, and movement disorders, is approximately 50%.

Despite these advances, there are many individuals with suspected genetic disease who remain genetically unresolved. There are likely multiple explanations for this, with one important contributor being pathogenic variants in the noncoding genome that affect RNA processing and transcript expression. Whole transcriptome analysis, as accomplished using RNA sequencing (RNA-seq), is an emerging technology suitable for uncovering RNA processing mutations, as has been successfully demonstrated in particular for neuromuscular diseases.

In this study, we used RNA-seq to aid in the diagnosis of an individual with classical (type I) lissencephaly and a reportedly normal brain malformation multigene panel. Transcriptome analysis uncovered a splice altering variant, subsequently verified by DNA sequencing, in the LIS1 gene. We conclude that RNA-seq represents an effective diagnostic tool for genetically undefined cases of cortical malformation that can greatly improve the current diagnostic rate.

Case Report

A 3-year-old boy was born at term to nonconsanguineous Portuguese parents after an uneventful pregnancy and delivery. First medical concerns were at age 6 months when he presented with infantile spasms (epileptic spasms plus EEG with hypsarrhythmia). Currently, he has developmental delay with superimposed developmental regression in the context of medically refractory epilepsy. His physical examination was notable for microcephaly 45.5 cm (−2 SD), dysmorphisms including hypertelorism and a depressed nasal bridge, axial hypotonia, and exaggerated deep tendon reflexes. Brain MRI (performed at 6 months) is consistent with classical (type I) lissencephaly with a posterior-to-anterior gradient (Figure, A).

On the basis of these features, there was high clinical suspicion for an underlying genetic condition, specifically a defect in the LIS1 (or PAFAH1B1) gene. Commercial genetic testing was performed, and included an epilepsy multigene panel (471 genes including LIS1; Courtagen) and multiplex ligation dependent probe amplification–based analysis for deletion/duplication of LIS1 (University of Chicago). No causative abnormality was discovered through these approaches.
**Methods**

**RNA-seq**

Fibroblasts were derived from dorsal palmar skin biopsy, expanded through at least 2–3 passages, and then prepared for RNA extraction. RNA was extracted using Qiagen RNAeasy mini kit. Libraries for RNA-seq were prepared using poly-A selection (Illumina TruSeq) at The Centre for Applied Genomics (TCAG; SickKids), and paired-end 126 + 126 bp sequencing was subsequently performed with Illumina HiSeq 2000 instruments at TCAG. RNA-seq data generation and analysis were carried out as described.6

**Sequence Alignment, Expression, Variant Calling, and Splicing**

Alignment, variant calling, and quality controls steps were carried out using the RNA-seq workflow from the bcbio-nextgen bioinformatics framework (version 1.1.0). Raw reads were aligned to the GRCh37 (hg19) version of the human reference genome using the splice-aware aligner STAR. Expression was calculated using the R-bioconductor package edgeR and variants were called using GATK best practices. Finally, novel and outlier splice junctions were identified using the rules and filters outlined previously.6 The resulting BAM was viewed using Integrative Genomics Viewer to generate sashimi plots and identify aberrant splicing changes.

**Heat Map Generation**

We used the GTEx multigene query portal (GTEx Portal) to generate a gene expression heatmap. For the 42 brain malformation genes (listed in the Figure, C, identified from the GeneDx panel), we selected tissues of interest (all brain tissues, fibroblasts, whole-blood, skeletal muscle, and skin) and

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**Glossary**

RNA-seq = RNA sequencing; TCAG = The Centre for Applied Genomics; WES = whole exome sequencing; WGS = whole genome sequencing.

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**Figure** Three-Year-Old Boy With Posterior-Anterior Gradient Lissencephaly

(A) Sagittal T2 MRI shows Dobyns grade 3 lissencephaly more prominent in the parietooccipital region with posterior-anterior gradient and normal midline structure. (B) Axial T2 MRI at the level of the thalamus shows agyria/pachygyria in the parietooccipital region. (C) Heatmap coverage of common brain malformation genes in fibroblast vs blood vs brain tissue. Expression (in transcript per million (TPM)) of 42 brain malformation genes in each tissue is represented as a heatmap with colors ranging from yellow (0 TPM) to black (6.7e + 3 TPM). Most of the 42 genes are expressed at higher levels in fibroblasts (column 3) compared to whole blood (column 1). In addition, the expression in fibroblast is more consistent with expression in brain tissues. (D) Sashimi plot shows transcript change with exon4 skipping. We show expression of exons 3, 4, and 5 of LIS1 in the proband (case) and 2 unrelated controls. The coverage across each exon is plotted as a bar graph, arcs represent splice junctions connecting exons, and the number in the arc shows the number of reads split across the junction. The arrow points to the 20 reads connecting exons 3 and 5 (skipping exon 4) in the proband that are not found in either of the control samples.
exported svg (scalable vector graphics) of the resulting heat-map. The image was used to generate the Figure, C, where we highlight LIS1 (the gene of interest).

Results

Based on the negative DNA testing, we pursued RNA sequencing through a research ethics board–approved research protocol. Because source material is a critical consideration for RNA-seq, and no brain tissue was available in this case, we wanted to understand which easily accessed tissues best mirrored the brain transcriptome. We focused on blood and skin fibroblasts, using transcriptome data from our in-house database and from GTex. While neither had profiles that fully matched the brain, fibroblasts much more closely resembled cortex in terms of number of genes expressed and expression levels (Figure, C). In particular, we reviewed tissue expression of LIS1 and other known brain malformation genes, and found they have substantially higher expression in fibroblasts, with levels nearly equivalent to cortical brain tissue.

We thus performed a skin biopsy, derived fibroblast cultures, and performed RNA-seq. The resulting total transcriptome analysis revealed reduced expression and allele imbalance of LIS1, with approximately 20 reads coming from 1 allele vs >500 from the other. Within the allele with reduced expression, we observed multiple splicing disruptions, including exon 4 skipping, although the low overall read count presented difficulty for the definitive interpretation of specific splicing alterations. Overall, the RNA-seq data were consistent with reduced expression of 1 LIS1 allele, supporting a haploinsufficiency mechanism, the most common mutational consequence associated with LIS1 mutation.

We repeated DNA sequence analysis with Sanger-based sequencing of LIS1 gene on a clinical basis. This demonstrated a pathogenic variant in exon 4 of LIS1 gene with a sequence change at c.164 G>A. This variant is predicted to create a premature stop codon at amino acid residue 55, p.Trp55*, with subsequent nonsense-mediated decay. Our transcriptome data support the reduction of expression from this allele, and suggest the variant promotes splicing changes in addition to nonsense-mediated decay. Given that heterozygous loss of expression/function variants in LIS1 are the known genetic pattern for LIS1-related lissencephaly, we concluded that this heterozygous stop variant is the cause of disease in our patient.

Discussion

Our study demonstrates the suitability of RNA-seq for identifying novel mutations and for providing functional evidence of mutation consequence. Using RNA-seq, we were able to accurately identify a variant in LIS1, and show that the resulting nonsense mutation promoted allele-specific loss of expression and abnormal RNA processing. Importantly, while our RNA-seq analysis ultimately pointed to a pathogenic variant in LIS1, because we captured the total transcriptome, we were potentially able to identify an abnormality in any gene expressed in the sample. For fibroblast transcriptome analysis, this includes essentially all genes associated with cortical malformations, as well as most genes associated with neurogenetic conditions. Overall, therefore, this technology is applicable for the investigation of any case not fully clarified or solved by multigene panel or WES.

In terms of RNA-seq as a diagnostic modality, our study reinforces the importance of using suitable source material for transcriptome analysis, and provides first proof of concept for using skin fibroblasts for the study of brain malformation genetics. This is particularly useful for clinical practice, given that brain tissue is often not available, and skin biopsies are an efficient and noninvasive bedside procedure that can assist in revealing an underlying genetic diagnosis. Of note, we show that the expression of genes associated with brain malformations is superior in fibroblasts as compared to blood, both in terms of number of genes expressed and overall levels of expression. This is important because only genes expressed at suitable levels (typically >1 transcript per million for expression and at least 5 reads for identifying splicing aberrations) can be meaningfully analyzed. Another potential source material for diseases of the CNS are lymphoblastoid cell lines, which have recently been shown to express a broad range of genes associated with neurodevelopmental disorders, and which have been successfully used to identify or clarify pathogenic variants that cause Cornelia de Lange syndrome.

In addition, this case points to an important limitation of some genetic testing platforms, as the LIS1 variant in this case was missed in the initial analysis of patient DNA. The reasons why the variant was not detected are not clear, as overall mean read depth of the gene in the panel was >500×. One possibility is that the specific coverage of exon 4 was low, a likely hypothesis given that exon 4 is known to be challenging to capture at sufficient depth by next-generation sequencing. Overall, this illustrates the critical need to understand strengths and limitations of different genetic diagnostic technologies, and to not fully exclude causes until a definitive diagnosis has been established.

A final consideration is when to utilize RNA-seq in the diagnostic pathway. Multigene panel or WES remain first-line testing methodologies for mutation identification across the spectrum of neurogenetic disorders. However, these technologies do not provide information related to the noncoding genome, and in addition often identify variants that are of uncertain significance. RNA-seq is therefore an ideal next step modality in panel or WES-negative cases or cases with variants that are of uncertain significance, as it provides data on variants (coding or noncoding) that affect RNA levels and processing. Moving forward, with the emergence of whole genome sequencing (WGS) as a powerful and comprehensive
technology for detection of pathogenic variants; RNA-seq is also well positioned to provide functional annotation and interpretation when paired with WGS.

**Acknowledgment**
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**Disclosure**
H. Qashqari, A. Ramani, and H. Gonorazky report no disclosures relevant to the manuscript. K. Amburgey is an employee at Deep Genomics. M.M. Ghahramani Seno reports no disclosures relevant to the manuscript. K. Amburgey is an employee at Gene42 Inc. S. Naumenko, S. Das, and J.J. Dowling report no disclosures relevant to the manuscript. Go to Neurology.org/N for full disclosures.

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### References

Clinical Reasoning

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. See published samples as examples.
Clinical Reasoning: A 36-Year-Old Woman Presenting With Headache Postpartum

Ahmad Nehme, MD, Laurent Létourneau-Guillon, MD, Céline Odier, MD, and Alexandre Y. Poppe, MD, CM

Neurology® 2021;96:e1585-e1589. doi:10.1212/WNL.0000000000011318

Section 1

A 36-year-old healthy G2P2 woman presented on postpartum day 10 with severe headache, progressing over several hours. She had no history of migraines and used neither medications nor drugs. The headache was not postural. She reported no associated neurologic symptoms or trauma. She described chest pain radiating to the thoracic spine, without visual changes, abdominal pain, or lower limb edema. Blood pressure (BP) was 166/94 mm Hg. She was afebrile. Mental status was normal. Examination revealed mild neck stiffness, without papilledema or focal neurologic deficits. Deep tendon reflexes were symmetrically brisk. Investigations showed no anemia, thrombocytopenia, liver dysfunction, or proteinuria. ECG and thoracic CT angiogram (CTA) were normal.

The patient underwent a C-section 4 years earlier due to fetal bradycardia during labor. She received prophylactic aspirin up to week 36 of her most recent pregnancy, as she had 2 moderate risk factors for preeclampsia (age ≥35 and Afro-Caribbean origin).1 BP was normal throughout pregnancy. At week 39, an uncomplicated L2–L3 epidural anesthesia and an elective C-section were performed.

Question for Consideration:
1. What is the differential diagnosis of postpartum headache?
Section 2

Postpartum headaches are more often secondary than primary among women for whom acute neurologic consultation is performed. Postpartum hypertensive disorders of pregnancy (preeclampsia and eclampsia) manifest with new-onset BP >140/90 mm Hg and organ dysfunction, which includes symptoms of neurologic origin and moderate to severe headache that does not respond to simple analgesia. Neurovascular diseases—such as ischemic stroke, intracranial hemorrhage, cervicocephalic artery dissection, cerebral venous thrombosis, reversible cerebral vasoconstriction syndrome (RCVS), and posterior reversible encephalopathy syndrome (PRES)—develop more often in the postpartum period. Improvement of headache in the supine position suggests postdural puncture intracranial hypotension. Lymphocytic hypophysitis and Sheehan syndrome can present with visual loss and pituitary gland failure. Primary etiologies (migraine, tension) also occur, in part because of stress and sleep deprivation.

Due to new-onset hypertension and brisk reflexes, the patient was initially diagnosed with postpartum preeclampsia. IV labetalol and IV magnesium were initiated, and she transferred to our institution. Chest pain resolved, but headache persisted, and nuchal rigidity suggested an alternative etiology. Head CT the following day demonstrated bilateral parieto-occipital subarachnoid hemorrhage (SAH) (figure 1A). Head CTA revealed dissections of the right extracranial and left intracranial and extracranial vertebral arteries, with no evidence of fibromuscular dysplasia (figure 1B). The patient reported no neck pain before postpartum day 10. The left intracranial vertebral dissection led to a 70% stenosis of the artery. The remaining intracranial arteries were normal. Brain MRI with T1 fat suppression confirmed intramural hematomas at the dissection sites and excluded cerebral infarction (figure 1C).

Questions for Consideration:
1. What could explain the SAH?
2. How would you treat the intracranial vertebral artery dissection?

Figure 1 Subarachnoid Hemorrhage and Cervicocephalic Artery Dissections

(A) Axial noncontrast head CT reveals bilateral parietal cortical subarachnoid hemorrhage. (B) Coronal head CT angiogram demonstrates fusiform ectasia followed by narrowing of the intradural left vertebral artery, consistent with a dissection. Additional bilateral extracranial vertebral artery dissections were also identified (not shown). (C) Coronal brain MRI with T1 fat suppression identifies hyperintensities that correspond to intramural hematomas, which confirms dissections of the left intracranial and extracranial vertebral arteries. The right extracranial vertebral intramural hematoma is not shown.
Section 3

Intracranial arteries have a well-developed internal but no external elastic lamina, which makes them susceptible to subadventitial dissection and secondary SAH. RCVS can initially present with convexity SAH, and vasospasm can be absent if imaging is performed in the first week after headache onset. Cervicocephalic artery dissection more often coexists with PRES or RCVS in postpartum vs non-postpartum women. Intracranial aneurysms, vascular malformations, and cerebral venous thrombosis should also be considered.

In our patient, the left intracranial vertebral artery dissection was the most likely cause of SAH. As the risk of rebleeding after SAH due to intracranial dissection approaches 40%, surgical or endovascular treatment is usually considered. Medical treatment—often antiplatelet agents—is preferred when patients present only with pain or cerebral ischemia, as the risk of subsequent SAH is considered low.

In our case, there was concern that, if we occluded the left vertebral artery, progression of the right vertebral dissection might lead to bilateral vertebral occlusion. On angiography, the right extracranial vertebral dissection was stable and nonstenotic. Injection of the right vertebral artery showed retrograde filling of the left vertebral artery. Both posterior communicating nonstenotic arteries were patent, and no vasospasm was seen. Consequently, to prevent recurrent SAH, we performed endovascular occlusion of the left intracranial vertebral artery. We initiated aspirin to prevent thrombus formation at the remaining extracranial dissection sites.

On postpartum day 16, transcranial Doppler revealed increased systolic velocities and prompted a head CTA that showed diffuse post-SAH vasospasm, which we treated with oral nimodipine (figure 2A). Blood workup for systemic causes of vasculitis was negative.

The next day, the patient reported lower limb paresthesias, without weakness or sensory level on examination. Since admission, she had required urinary catheterization.

Question for Consideration:
1. What is the next step in the investigation?

Figure 2 CT Angiogram and Spinal Imaging

(A) Follow-up axial head CT angiogram, on postpartum day 16, shows diffuse segmental narrowing of intracranial arteries compatible with vasospasm. (B) Sagittal T1 image on MRI at the T3 level demonstrates a heterogenous intradural-extradural lesion, associated with cord compression, in keeping with an intradural hematoma. (C) Left T7 arteriogram reveals an aneurysm of the radiculomedullary artery of Adamkiewicz. (D) Sagittal T2 image on MRI obtained at the T3 level at 3 months shows adhesive arachnoiditis with distortion of the spinal cord and secondary intramedullary signal changes.
Section 4

Sphincter dysfunction and bilateral lower limbs paresthesias suggest a spinal cord lesion. Spine MRI revealed a T1-hyperintense, T2-hypointense, nonenhancing intradural extramedullary lesion at the T3 level, suggestive of a hematoma. This was associated with a dependent blood-CSF level at the thecal sac and compatible with spinal SAH (figure 2B). Epidural anesthesia was performed several levels lower and could not explain the hematoma. Spinal angiography identified 2 fusiform aneurysms on left radicular branches of T3 and T7 (figure 2C).

Spinal aneurysms can develop with diseases that increase blood flow to the spinal circulation (arteriovenous malformation) or that compromise the vessel wall (connective tissue disorders, vasculitis). They may also result from arterial dissection.

While there was no direct evidence of radicular artery dissection in our case, the co-occurrence of vertebral dissections supports this hypothesis. The initial episode of chest pain was perhaps secondary to dissection of a radicular artery and subsequent spinal SAH. In retrospect, the parieto-occipital SAH may have represented redistribution of spinal SAH, or may have resulted from intracranial vertebral artery dissection, as we initially hypothesized. Rebleed rates and optimal management of spinal aneurysms are unknown. We elected for a conservative approach and discontinued aspirin. We did not perform a lumbar puncture due to the risk of downward spinal coning when a compressive cord lesion is present.

Headache resolved 1 week later. We prescribed calcium channel blockers for 3 months to address the vasospasm. The patient was discharged home postpartum day 22 but readmitted 3 months later for gait difficulties, progressing over several weeks. Urinary retention had resolved. Examination of the lower limbs revealed increased tone, symmetrically decreased strength (4/5), and bilaterally diminished pinprick sensation up to T8.

**Question for Consideration:**
1. What could explain the delayed-onset gait difficulties?
Spastic paraparesis and a sensory level suggest a spinal cord lesion. Rebleed from spinal aneurysms would likely lead to a more abrupt onset of symptoms. Following spinal SAH, altered CSF dynamics predispose to syringomyelia. Chronic subarachnoid bleeding can cause superficial siderosis, with hemosiderin accumulation around the spinal cord. Subarachnoid blood can trigger a chronic inflammatory reaction of the arachnoid membrane. This spinal arachnoiditis may deform the spinal cord, resulting in compressive myelopathy.

Spine MRI revealed T2 hypersignal and distortion of the cord at the T3 level, as well as multiple sites of adhesions, suggestive of arachnoiditis (figure 2D). There were no residual aneurysms on spinal angiography. Head CTA demonstrated resolution of the vasospasm and normalization of the initially dissected segments of both extracranial vertebral arteries. The patient underwent surgical lysis of adherences and was discharged to rehabilitation.

At 6-month follow-up, she required a walking aid due to moderate spastic paraparesis. A multigene connective tissue disease panel was normal.

Discussion

Numerous reports highlight the association between the postpartum period and RCVS, PRES, and cervicocerebral artery dissection. Postpartum angiopathy historically referred to postpartum RCVS. Postpartum arteriopathies can develop with or without preeclampsia, which suggests that both share common pathophysiologic mechanisms.

In the Cervical Artery Dissection and Ischemic Stroke Patients registry, multiple cervical dissections occurred in 15% of cases and were associated with fibromuscular dysplasia and recent infections, both absent in our case. Another study found no underlying arteriopathy in patients with triple and quadruple cervical dissections. Dissection of multiple cervical arteries is not associated with a family history of dissection, which may be a surrogate marker for genetic connective tissue disorders. A recent case–control analysis identified pregnancy as a risk factor for cervical artery dissection, specifically in the postpartum period. Cases were diagnosed on average 21 days after labor, which suggests that the postpartum period may transiently predispose arteries to dissection. The effect of trauma during labor on this association is unknown, as the authors did not stratify cases by mode of delivery.

A ruptured spinal aneurysm during pregnancy has, to our knowledge, only been reported once postmortem. In our case, the spinal aneurysms likely resulted from the same fulminating arteriopathy that affected the cervicocerebral arteries. While impossible to prove, these were likely dissecting aneurysms, as they co-occurred with cervicocerebral artery dissections and resolved on follow-up vascular imaging.

A secondary etiology should always be ruled out in patients presenting with a new-onset postpartum headache. Spinal dissecting aneurysms may complicate cases of postpartum cervicocerebral artery dissection. Spinal SAH, though rare, should always be considered when unexplained cerebral SAH, back pain, or symptoms of spinal cord dysfunction are present. Clinicians should not systematically attribute spinal SAH to epidural anesthesia in postpartum women and spinal angiography may be a useful diagnostic test.

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References

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: A Qualitative Study on Student Perceptions of Neurology and Psychiatry Clerkship Integration

Justin J. Mowchun, MD, MScEd, Julia R. Frew, MD, and Glenda Hostetter Shoop, PhD


**Abstract**

**Objective**

To explore student perceptions of the feasibility of neurology and psychiatry clerkship integration, including clinical education and competency evaluation, as there has been a call to improve undergraduate medical education integration of the disciplines to better develop physicians that can address nervous system disorders.

**Method**

Via a constructivist grounded theory approach, we carried out 5 focus groups in 2016–2017 with 28 medical students who completed both independent clerkships. Investigator triangulation was used with iterative interpretation comparisons, and themes were identified using constant comparative analysis.

**Results**

Three major themes arose: (1) combining the clerkships was not favorable as students need sufficient time to delve deeper into each discipline; (2) students did not observe an integrated clinical approach by faculty; (3) there is positive value to making links between neurology and psychiatry for effective patient care.

**Conclusions**

Students emphasized the importance of making stronger links between the 2 disciplines for their learning and to improve patient care; however, they did not observe this clinical approach in the workplace. Students perceived that integration of neurology and psychiatry clerkships should occur via increased affinity of the complementary discipline by trainees and faculty in each specialty.
There has been a recent call to improve undergraduate medical education integration of neurology and psychiatry, to better develop physicians who can address the multidimensional manifestations of nervous system disorders.7 Closing the divide between neurologic and psychiatric patient care remains elusive, even as our emerging neurobiological knowledge reveals that many brain disorders are not due to detectable lesions, but originate from dysfunction across complex multidirectional neural networks.2,3

Curriculum integration has a theoretical foundation to promote skill acquisition while learners build deeper connections across medical disciplines.4,5 The evidence to support clerkship integration originates from longitudinal integrated clerkships.8 However, the vast majority of medical schools utilize specialty-specific clerkship blocks that reflect the dominant workplace setting of clinical teams.7 In an attempt to improve integration, some medical schools have combined their neurology and psychiatry clerkships or linked them sequentially.8 However, there are no reports in the literature of student perceptions of integrating neurology and psychiatry clinical education and competency evaluation. It is essential for an integrated curriculum to be perceived as relevant and timely by students.10 According to sociocultural perspectives, clerkship student learning also depends on student observations and their interactive experiences with the cultural practices, specific language, and tools of their preceptors.11 Our qualitative study aimed to explore student perceptions of psychiatry and neurology clerkship integration. We sought a better understanding of how we can improve education integration of the 2 disciplines, but also patient care for those with nervous system disorders.

Method

Ethical Considerations
This study was given exemption status by the Committee for the Protection of Human Subjects (Dartmouth College/Dartmouth-Hitchcock Medical Center). Potential participants were informed about the voluntary nature of the study and that data would be audio recorded and analyzed anonymously.

Sampling
This qualitative study used a purposeful sampling strategy of 5 focus group sessions with 28 fourth-year medical students (16 female, 12 male) who had completed both independent psychiatry and neurology clerkships at the Geisel School of Medicine at Dartmouth. One researcher (G.H.S.) sent recruitment emails to students who were about to complete their second of the 2 clerkships (neurology, n = 38). All of our medical students complete their required 6-week inpatient psychiatry clerkship during their third year, and almost all students complete their required 4-week primarily inpatient neurology clerkship in their fourth year. The 60-minute focus groups took place at Dartmouth-Hitchcock Medical Center in Lebanon, New Hampshire, from July 2017 through January 2018 on the final day of a neurology clerkship.

As data analysis progressed, we also targeted specific students who were not available when they completed their neurology clerkship as they were rotating at away sites. We also invited 3 students completing their neurology subinternship at Dartmouth-Hitchcock Medical Center, who had completed both clerkships the previous academic year. These additional students were thought to help advance our understanding of developing categories and emerging theory as the focus groups were iteratively analyzed.12 The majority of students completed their clerkships at Dartmouth-Hitchcock Medical Center. Our other students completed their clerkships at 3 nearby affiliated sites and at California Pacific Medical Center in San Francisco, where we have away rotations. The focus groups had 4–8 students per group. Group sizes were dependent on variable clerkship enrollment. The optimal size of a focus group is between 6 and 10 participants,13 but a minimum of 3–4 participants is sufficient.14

Data Collection and Analysis
Focus groups were used to facilitate student interaction to gain depth and interconnections in the exploration of the topics.15 The moderator (G.H.S.) had background knowledge of the neurology and psychiatry clerkships but was not involved in clerkship student education or evaluation. Semi-structured interview questions were created based on important concepts of neurology and psychiatry curriculum integration.5,6,8,9 G.H.S. facilitated the discussion using a list of questions for guidance (table).

The focus groups were audio recorded and verbatim transcripts were created. Focus groups and analyses were conducted iteratively to facilitate the expansion of categories in later focus groups. Focus group data were compared within each group and among the other groups.16 The primary approach for data interpretation was via a constructivist grounded theory approach.17 In this process, we iteratively explored how and why our students constructed meaning in specific contexts. We worked to develop more of a partnership with our participants, which facilitated a mutual construction of meaning during the focus groups, and reconstruction of student stories as openly as possible into a grounded theory approach.18 Investigator triangulation was used with interpretation comparisons among the authors J.J.M. and J.R.F., and major themes emerged after discussion of the codes.
Emerging themes were discussed and reviewed with G.H.S. and final theme consensus was reached. Theoretical sufficiency was determined by the authors after analysis of the fifth focus group. We determined sufficiency when we had enough data for a clear understanding of our essential themes without gaps in our analysis. Member checking was used to reduce bias of the data analysis. G.H.S. emailed all of the study participants with the preliminary themes, about 2 months after the final focus group, to provide them an opportunity to assess the adequacy of the results. Students were asked to communicate any concerns of misinterpretation or additional considerations about the findings to G.H.S., and no specific feedback was received. It is important to recognize that our students may have been hesitant to provide constructive feedback based on the time lag between data collection from their focus group and final analysis of all transcripts, as well as their possible perceptions of expertise of the researchers.

**Results**

Three major themes arose: (1) combining the clerkships was not favorable as students needed sufficient time to delve deeper into each discipline to make links for deeper learning; (2) observations of a nonintegrated clinical approach by psychiatry and neurology faculty; (3) positive value of making links between neurology and psychiatry for effective patient care. We present the results supported by distinctive quotes from the focus groups (labeled FG), organized according to themes, and described in relation to our conceptual framework (figure).

### Perceived Effects of Combining the Clerkship and Student Learning

Although students emphasized the importance of having both clerkships in the third year of medical school, combining them was not favorable to most students as they had concerns that this method of integration of complex material might inhibit learning.

“Right off the bat, the first thing I thought about was length and how you are supposed to master both the psychiatric interview as well as something like the neurological exam. I feel like that might be a difficult thing to do at the same time.” (FG2)

“...but there was a lot of neuro on the psych shelf that I remember.” (FG2)

“...how the shelf would look because you would take two shelves at the end? That would be super stressful if they were integrated.” (FG1)

Some students did see opportunities for faculty observation of their clinical skills, and described potential links between psychiatry and neurology core examination skills.

“...one benefit would be that technically the mental status exam has a lot of similarities between the two, maybe not all things but that would be one other reason to think that you could teach them at the...” (FG1)

### Table 1 Focus Group Interview Guide

| What are your perceptions of the strengths and limitations of psychiatry and neurology clerkship integration? (Prompt: Perception of a combined clerkship vs a block clerkship that occurs sequentially vs keeping the clerkships in separate years) |
| What are your perceptions of psychiatry and neurology clerkship faculty working together to integrate the disciplines and the multidimensional manifestations of nervous system and psychiatric presentations? (Prompts: Small group settings/case-based learning in a combined clerkship or possibly faculty teaches sessions in each other’s clerkships that are linked sequentially; Any particular clinical presentations where you would find a more integrated approach helpful?) |
| What are your perceptions of competency-based assessment and grading integration of these clerkships? What are your perceptions of the strengths and limitations of combining these or having them separate? |

Students also perceived barriers to implementation of a more holistic combinatory form of integration, which included multiple clinical services and sites, as well as concerns for integrated assessments. Students emphasized significant concern on how to integrate high-stakes National Board of Medical Examiners (NBME) neurology and psychiatry examinations. They recognized some content overlap for these examinations, but had anxiety about combining the examinations or taking them in close proximity to each other.

Figure Student Considerations and Associated Influences on Neurology and Psychiatry Clerkship Integration Identified Through Thematic Analysis
same time and say this is a more neurologically focused mental status exam and this is a psychiatrically focused mental status exam.” (FG3)

Students perceived that high-stakes summative clinical performance evaluations may penalize learners who integrate their skills, even if they provide more effective care for their patients. Students recognized a clear lack of a shared mental model of integration by psychiatry and neurology faculty for student clinical performance evaluations.

“I just think the things that the people who are evaluating value on the clerkships are completely different. Like the things that a psychiatrist might mark me high for a neurologist might mark me low for. So I don’t know how well they would go together.” (FG2)

“From a skills-based standpoint of what you’re supposed to derive from each of these clerkships, I think that they’re very disparate in that respect. So, I think that, at least in my experience, psychiatry was a clerkship in which you really honed your interviewing skills…and, I think neurology is not the opposite in the sense that there isn’t an interview component, but it really is, I think, one of your greatest experiences in using the physical exam. And, I think that’s where the integration would hit a pretty hard stop…” (FG4)

Integrated Clinical Approach by Faculty Not Observed

Although students did see a benefit of making some links between the 2 clerkships for their learning, a significant barrier to integration on any level is that students did not observe this clinical approach among psychiatry and neurology faculty and residents.

“I think the aspiration to teach and to have students experience these two disciplines in tandem is really good, because they are really related…when I was in my rotation, a lot of providers do not really make the connections that they could be making. To have students go in there with the expectation that they are going to be combining these two disciplines to a better extent that they currently are, when the practice really is not...” (FG1)

“We are in two different worlds…” (FG3)

Students perceived that psychiatry and neurology residents rotating on each other’s services opens opportunities for clerkship integration and facilitates broader perspectives for patient care, but currently is too superficial and limited to be credible.

“Often times you would turn to him in rounding and be like, ‘What do you think? Maybe if that were more of a widespread experience, and also from the other direction…” (FG1)

“In the conversation that we are having, we are trusting a 1-week intern to be the psychiatrist. That just also demonstrates that they are not really prepared to have those collaborations across disciplines, even though I do think it was helpful and it was beneficial. There is room for that.” (FG1)

Positive Value of Making Links Between Neurology and Psychiatry for Effective Patient Care

Students recognized the value of making links for effective patient care, which they emphasized for diseases that have strong but complex overlaps between the 2 disciplines, such as dementia, Parkinson disease, and epilepsy or seizures.

“(In) some people it is a mixed seizure. Some people have epilepsy, but they also have pseudo seizures.” (FG2)

Students supported piloting limited integrated sessions on both clerkships as a clear opportunity to explore these links.

“It could be whatever topics come up that really follow the middle of the pie chart for both. I think it could be cool to have 2 sessions where it is combined. It would probably be 1 neurologist and 1 psychiatrist going over it together. You could offer that in both clerkships.” (FG3)

Students also emphasized the importance of clear goals and careful implementation of any interdisciplinary session, where discussion of the complex links essential for patient care can be explored by faculty prepared to discuss these links.

“I think the value of doing a joint session of some type would have to be a little bit more focused on what it is like to take care of these people, and less about teaching at the same time because it would be weird to be, ‘I am going to teach you about dementia.’ ‘No, I am going to teach you about dementia.’ I think it would better to be like, ‘This is my experience with taking care of a patient with dementia. These are the challenges we face and things we are able to do’ and see that from both sides.” (FG1)

Discussion

Students perceived that combining the neurology and psychiatry clerkships would be inhibitory for their learning. Our students valued sufficient time to delve deeper in each discipline to make links for deep learning. Students perceived barriers to implementation that included multiple clinical services and trepidation for integrated assessments (including specialty-specific NBME examinations and faculty performance evaluations). Integration can enhance learning when a curriculum calls upon students to establish connections, but time-linked schedules are not an integration panacea. Students may also feel anxiety in an integrated curriculum if they are uncertain of the width and depth of the subject while studying for discipline-specific examinations. One combined neurology and psychiatry clerkship showed a negative effect on NBME examination scores compared to when these clerkships were independent. Student workplace-based performance evaluations are also emphasized in clerkships and it is essential to address student concerns of psychiatry and neurology faculty variability on what they judge as important for student competency. Clerkships and their teaching faculty must build and communicate to students a shared model of clinical performance evaluation. This process should include frequent direct observation assessments of students, coupled with performance feedback, to facilitate guided practice for safe, effective, and patient-centered care. Based on our student perceptions, we suggest that psychiatry and neurology faculty should incorporate components of each other’s clinical skills to facilitate clerkship integration, while augmenting patient care. Trainee direct
observation is important for high-quality patient care at the point of care, but requires effective faculty development.  

The sociocultural lens of clerkship student learning and assessment, which reflects the complex clinical workplace, is also important to consider.  

Sociocultural perspectives situate learning within specific contexts and cultures, and as a social process.  

Medical student learning depends on their interactive experiences with faculty and the meaning they attach to these experiences.  

This framework has been applied to longitudinally integrative and primary care clerkships where the outpatient environment can create the developmental space for trainees to be able to learn and develop their professional identity.  

Although our students saw a benefit of making links between the disciplines for their learning, a significant barrier to clerkship integration is that students did not observe an integrated clinical approach among psychiatry and neurology faculty and residents. Students described that psychiatry and neurology residents rotating on each other’s services opened opportunities for clerkship integration and facilitated broader perspectives for patient care. However, these opportunities in the clinical learning environment were perceived by students as sporadic and insufficient to be credible. Longitudinal psychiatry and neurology residency training, as recommended for psychiatric training in primary care, would be a positive step for integration.  

Family practice residencies provide more longitudinal workplace psychiatric training with higher resident satisfaction in their psychiatry training compared to internal medicine and pediatric residency programs. Another recent study found board-certified psychiatrists were less satisfied with their neurology training than their primary care training and they wanted longitudinal neurology training in all years of their residency. A similar survey to board-certified neurologists concluded that most were not very satisfied with their psychiatry training in contrast to their primary care training, and only one third felt highly prepared for practice from the psychiatry aspect of patient care. These neurologists desired more longitudinal experience with psychiatry teams and more outpatient care. One suggestion by our students was increasing presence of senior neurology and psychiatry residents on each other’s consultation services, and allowing clerkship students to rotate with those integrated teams with prepared faculty.

Subspecialists in behavioral neurology and neuropsychiatry have made calls to lead neurology and psychiatry integrative care in the clinical learning environment. However, we suggest, based on our students’ perceptions, that all psychiatry and neurology trainees and faculty need to take an active role to facilitate a culture of integration. Neurology faculty may not be comfortable with their own psychiatric interview, mental status examination, diagnostic formulation, and management skills when relevant for their patients. Faculty development can facilitate focused competency in integrated patient care, and provide the tools to help faculty train their learners. The neurology Accreditation Council for Graduate Medical Education milestones for psychiatric patient care may also help provide a common language to support faculty development integrative initiatives. Innovative programs can be implemented with minimal faculty time commitments such as focused podcasts. Neurology clerkships could partner with their psychiatry colleagues in order to create focused reviews of essential topics. A faculty development curriculum has been published for teaching the psychiatric interview and mental status examination to medical students, which could be modified and implemented by neurology faculty to augment their integrative teaching skills.  

The classroom context can be a starting point for psychiatry and neurology programs wanting to improve clerkship integration. Our students recognized the positive value of making interdisciplinary links for effective patient care, which they perceived as particularly relevant for diseases such as dementia, Parkinson disease, and epilepsy. Students supported piloting limited interdisciplinary integrated sessions on both clerkships to advance the culture away from discipline silos. According to sociocultural learning perspectives, integrated sessions can be disruptive experiences that may catalyze change in cultural norms. A longitudinal integrated clerkship described interdisciplinary teaching as an ideal instructional approach for integrated clerkship didactics. Limited multidisciplinary case-based sessions on psychiatry and neurology clerkships could be trialed where faculty discuss important overlaps together. These sessions may also help catalyze change in neurology and psychiatry cultural workplace norms, which is essential for effective clerkship integration.

Limitations

Limitations of this study include that our sample of students was from 1 US medical school, which may not be transferrable to other institutions; however, students who participated completed their clerkships at multiple different sites. Our students had limited outpatient experiences that may have affected their perceptions of neurology and psychiatry clerkship integration. Block clerkships that emphasize the outpatient setting, as successfully utilized in longitudinal integrated clerkships, may offer other patient opportunities that could impact student perceptions of clerkship integration. The study also only sought student perceptions; faculty and resident perceptions of psychiatry and neurology clerkship integration would also be important to explore. J.J.M. and J.R.F. had direct but limited contact with many of the students through their respective clerkships, which carried potential reflexive effects. However, the focus groups were carried out by G.H.S., who was not directly involved with the clerkships.

Conclusions

Students perceive the importance of making stronger links between neurology and psychiatry for their learning and to improve patient care; however, a significant barrier is that they do not observe this clinical approach in the workplace. Students perceive that improved integration of neurology and psychiatry clerkships starts with increased engagement of the complementary discipline by trainees and faculty in both
specialties. For medical education programs, both undergraduate and graduate, a response to this call from students will not be easy. In order to move forward in psychiatry and neurology clerkship integrative education to best meet societal demands in the common block clerkship formats, medical training programs will require focus on the system and sociocultural factors in workplace learning. Quality improvement in this dynamic context will train students for complex neuropsychiatric presentations and facilitate a continuous commitment in the clinical environment that best integrates the disciplines to care for patients.

**Study Funding**

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**Disclosure**

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### Appendix

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<tr>
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</tr>
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### References

Emerging Subspecialties in Neurology

Emerging Subspecialties explores the diverse array of fellowship and career opportunities available for neurology trainees. Manuscripts can fall into one of two categories. First, traditional submissions may review the history and development of emerging subspecialties in neurology training, such as Interventional Neurology, Neurodevelopmental Disabilities, and Autonomic Disorders, and provide guidance on how to pursue these fields or incorporate new opportunities into existing training programs. Second, as part of the “Cortical Careers” series, papers should focus on career pathways outside of clinical neurology, including neuro-informatics, health services research, and global health. Through an interview-based format, manuscripts should summarize advice from senior leaders on how to pursue a particular career pathway and provide concrete, actionable steps that trainees can take to develop the skills needed to succeed in this area. Find detailed information about submission guidelines for this series at: NPub.org/emsub. Those interested in writing manuscripts for this subsection should contact the Resident & Fellow Section Editor prior to submission at rfsection@neurology.org to inquire about the need for an article on a particular topic.
Emerging Subspecialties in Neurology: Becoming an Editor-In-Chief

Nara Miriam Michaelson, MD, Ashley Elimar Aaroe, MD, Steven L. Lewis, MD, and Joseph E. Safdieh, MD

Neurology® 2021;97:e2046-e2049. doi:10.1212/WNL.000000000012609

Abstract

An Editor-in-Chief leads the editorial team and supervises the daily tasks required to prepare articles for publication while managing the overall content and style of the journal. To become Editor-in-Chief, one must have dedicated work ethic, close attention to detail, passion for the editorial process, and a keen ability to work with and give feedback to section editors and authors. For this article, we interviewed Dr. Steven L. Lewis, Dr. Joseph E. Safdieh, and Dr. S. Andrew Josephson about their collective experience of becoming Editors-in-Chief of Continuum, Neurology Today, and JAMA Neurology, respectively. We have compiled tips for aspiring medical writers and editors, based on their expert advice, to guide trainees in this potential career path.
An Editor-in-Chief manages a variety of daily responsibilities, such as screening manuscripts for acceptance or further revisions, suggesting ideas for journal design and article accessibility, creating content for website and social media, responding to questions from other editors and authors, and managing the overall content and style of each edition. Some start with publishing or directing medical education, whereas others serve as reviewers on editorial boards. In this article, we discuss how Dr. Steven L. Lewis, Dr. Joseph E. Safdieh, and Dr. S. Andrew Josephson became Editors-in-Chief of Continuum, Neurology Today, and JAMA Neurology, respectively. We summarize 3 approaches to becoming an Editor-in-Chief and outline actionable steps.

Steven L. Lewis, MD (Editor-In-Chief of Continuum)

Early Career Path
My path to becoming Editor-in-Chief of Continuum started with interests in both academic general neurology and medical education. My background in general neurology ultimately prepared me well to oversee a publication that covers the breadth of the field. Initially, my entry into publishing came with writing multiple-choice questions.

Positioning Oneself for Success
After years in private practice, I assumed a position in academic general neurology at Rush University Medical Center, and about 25 years ago, I attended a course at the American Academy of Neurology (AAN) Annual Meeting on how to write national board–style questions. This was moderated by Dr. Ralph Jozefowicz and 2 PhD experts in education. I expressed my interest, and exactly 1 year later, I received a fax inviting me to the next National Board of Medical Examiners (NBME) question writing meeting.

Seeking Opportunities/Mentorships
Through my experience writing questions for the NBME, I became a multiple-choice question writer for Continuum and ultimately served as an editorial board member and Associate Editor. When Dr. Aaron Miller, then Editor-in-Chief, retired, I submitted a proposal as a candidate to fill his position. One of the changes I suggested and ultimately made was to increase the number of core topics to 15 to ensure that no major topics were excluded in any 3-year curricular cycle.

Dr. Robert Gross, who was Editor-in-Chief of Neurology at that time, was a helpful mentor. As a fellow editor, he was able to suggest solutions to common and somewhat sticky issues that arose. I also found wonderful mentors in my editorial staff at AAN and my editorial board, including many affiliated topic experts.

Overcoming Challenges
When my very first issue as Editor-in-Chief went to press, I realized that a major dosing error had been made with an antiepileptic. Ironically, I was in clinic about to prescribe this very same medication to a patient when I discovered the mistake in a draft of the manuscript I had saved on my computer. I turned this lesson into an opportunity to create a new role of pharmacy reviewer for Continuum and enlisted a PhD clinical pharmacist to join the editorial board as additional quality control for all issues.

Joseph E. Safdieh, MD (Editor-In-Chief of Neurology Today)

Early Career Interests
My initial interest also started in medical education. I specifically tried to use my skills as an educator to combat “neurophobia”—a general fear of neurology, which can be largely mitigated through how neurology is taught.

Positioning Oneself for Success
Interestingly, my path to editorship also involved writing multiple-choice questions, initially for Continuum with Dr. Lewis as Editor-in-Chief and for the AAN Neuro Self-Assessment Examination (NeuroSAE) program. I later became an Associate Editor for Self-Assessment and Continuing Medical Education and edited clinical vignettes for accuracy and clarity.

Seeking Opportunities/Mentorships
When the AAN put out a call for applications to be the next editor of Neurology Today, I applied thinking that I had very little chance of being selected. Previous editors were prominent chairs of neurology departments—both were also prior Presidents of the AAN—and I was still an early mid-career neurologist at the time. Nevertheless, I was motivated to bring Neurology Today into the 21st century with fresh ideas. My idea was to focus on making the publication more accessible in a variety of formats, including making the website more engaging and expanding its social media presence to platforms such as Twitter. I proposed that Neurology Today should also tell stories about neurologists themselves. I credit my position as Editor-in-Chief of Neurology Today to the skills I gained from being Associate Editor of Continuum and from the personal mentorship I received from Dr. Steven L. Lewis. Currently, 2 of my Associate Editors, Drs. Orly Avitzur and Barney Stern, serve as mentors as we work together closely and share ideas about various articles.

Overcoming Challenges
A preeminent neurologist once provided commentary on a pharmaceutical agent without acknowledging previous personal funding from the maker of the drug. The author’s connection to the funding was listed in a disclosure in another journal but not in ours, and we confirmed this by searching the Centers of Medicare & Medicaid Services (CMS) Open Payments. The neurologist further refused to admit the conflict of interest, but ultimately, we did what we felt was right and printed a disclosure on the author’s behalf. It can also be challenging to balance clinical and educational responsibilities with editorial ones. In addition to reviewing issue proofs on weekends, I set aside one-half day per week and use my commutes to work on Neurology Today.
S. Andrew Josephson (Editor-In-Chief of JAMA Neurology)

Early Career Path
My passion for editing developed through a focus on helping neurologists at all levels of training better understand cutting-edge research so that they could apply it to their practices. I personally found editing to be an exciting way to keep up with the literature and help with broad dissemination of ideas.

Positioning Oneself for Success
I gained some initial experience by serving as Editor-in-Chief of NEJM Journal Watch Neurology, where I realized how exciting it was to summarize papers to meet the needs of all readers, especially trainees in neurology. I was chosen to become one of a handful of Associate Editors of Annals of Neurology by then Editor-in-Chief Dr. Stephen Hauser. I learned first-hand how the editorial team is responsible for every article that comes in—ensuring that they are in proper format, sending them for review, or deciding to reject them—in addition to determining peer reviewers, collecting reviews, and communicating with authors. My time at Annals made me really fall in love with the idea of being an editor. After my term at Annals ended, the opportunity later arose for me to become Editor-in-Chief of JAMA Neurology.

Seeking Opportunities/Mentorships
I was fortunate to work at the University of California, San Francisco (UCSF) where the editors of Annals of Neurology were then based. Many of my colleagues, including Drs. Clay Johnston, Donna Ferriero, Bob Messing, Dan Lowenstein, and Jorge Oksenberg, were leaders in their own subspecialties and served as natural mentors to me. Each Friday, we would gather and spend 3 hours going over every article that was being considered for publication, passionately discussing methods, biostatistics, trial design, and ways to convey results most effectively and accurately. It was the most incredible and rewarding “on-the-job” learning, which, to this day, still influences my editorial approach.

Overcoming Challenges
One of the biggest challenges as editor is time management, specifically balancing this role with other important academic responsibilities, including serving as Chair at UCSF. My approach has been to block off a set amount of time each day dedicated solely to my editorial duties, which helps me balance my role as Editor-in-Chief with my other responsibilities in and outside of work.

Further Opportunities for Training
Publons is a website for researchers and editors that provides a free learning service called Web of Science Academy (www.scienceacademy.clarivate.com/learn). Courses include the following: An Introduction to Peer Review, Mentoring in Peer Review, and Coreviewing with a Mentor. After completion, trainees will receive a certificate and an opportunity to be invited to review articles. Trainees can also volunteer to review for any partnering journal based on their skill set. Coursera provides coursework in biostatistics and clinical trial design with certificates (www.coursera.org/learn/clinical-research). ResearchGate (researchgate.net) is another great platform for connecting with other clinicians and scientists and keeping on top of the literature. Join online networks in your field and associated subspecialty and reach out to editors. Apply to be part of the editorial board of the Resident & Fellow Section of Neurology to help with editing articles and creating web content for the blog.

Conclusions
Beyond the core qualities of leadership, diligence, timeliness, and a passion for knowledge, one must try to gain as much exposure to the publishing world as possible to become Editor-in-Chief. A range of pathways exist, from being a basic or translational researcher, to a general neurologist or a subspecialist, or to an administrator or educator. Regardless of the approach, one needs to demonstrate the skills needed to effectively work with other editors and authors, make editorial decisions, and supervise and manage the overall content of a publication. Several important themes, summarized further, can serve as practical guidance for trainees (Table).

<table>
<thead>
<tr>
<th>Table</th>
<th>Key Takeaways From Our Editors-In-Chief</th>
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<tr>
<td>1.</td>
<td>Think outside the box. Sometimes, a fresh perspective is what is needed to take a publication to the next level. Don't be afraid to be yourself—bring your unique perspective and skill set to the table.</td>
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<td>2.</td>
<td>Put yourself out there. Keep an eye out for editorial positions. Respond to calls to serve as a Resident/Fellow board member of Continuum, a reviewer of the Resident and Fellow section of Neurology, or an Associate Editor of a journal. Offer to help with web content by contributing blog posts or podcasts.</td>
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<td>3.</td>
<td>Make connections. Attend national meetings and express your interests to like-minded individuals who can serve as mentors.</td>
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<td>4.</td>
<td>Think like a publisher. Cultivate valuable qualities such as timeliness, attention to detail, and a sense of what is important and valuable to your target audience.</td>
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<td>5.</td>
<td>Read (and write) voraciously. Keep abreast of the medical literature. Reading different journals can not only emphasize topics that are important and relevant to neurologists today but also afford editing and reviewing opportunities in your area of interest. Submit manuscripts frequently to various journals, including narrative medicine pieces such as JAMA Neurology “On the Brain” section or Neurology “Humanities in Neurology.”</td>
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<td>6.</td>
<td>Maintain your principles. Editors are responsible for the reliability of research and published news, which can influence physicians and patients on a large scale. Remaining principled and open-minded, with a fastidious attention to detail, is important on your path to becoming an Editor-in-Chief.</td>
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Study Funding
The authors report no targeted funding.

Disclosure
N.M. Michaelson has no disclosures; A.E. Aaroe has no disclosures; S.L. Lewis is the Editor-in-Chief of Continuum; and Joseph E. Safdieh is the Editor-in-Chief of Neurology Today. Go to Neurology.org/N for full disclosures.

Appendix Authors

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<tr>
<th>Name</th>
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<tr>
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<td>Drafting/revision of the article for content, including medical writing for content; major role in the acquisition of data; study concept or design; and analysis or interpretation of data</td>
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References
Future of Neurology & Technology

This subsection focuses on the trainee perspective of neurology and technology. These articles will provide a case-based discussion of new, emerging, or existing technologies that are being used with patients. Each piece should begin with a patient case presentation and discuss new, emerging, or existing technologies used with patients.
Future of Neurology & Technology: Virtual and Augmented Reality in Neurology and Neuroscience Education
Applications and Curricular Strategies

Stefano Sandrone, PhD, and Chad E. Carlson, MD

Neurology® 2021;97:740-744. doi:10.1212/WNL.0000000000012413

Abstract

Virtual reality and augmented reality have become increasingly prevalent in our lives. They are changing the way we see and interact with the world and have started percolating through medical education. In this article, we reviewed the key applications of virtual and augmented realities in neurology and neuroscience education and discussed barriers and opportunities for implementation in the curriculum. Although the long-term benefits of these approaches over more traditional learning methods and the optimal curricular balance remain mostly unexplored, virtual and augmented reality can change how we teach neurology and neuroscience.

Introduction

Virtual reality (VR) and augmented reality (AR) are changing the way we see and interact with the world and hold great potential for the future of education. Although often used interchangeably, these expressions refer to distinct approaches to enhance user experiences. VR simulates a real environment and permits the presentation and the control of stimuli within a multisensory, 3D dynamic environment while recording quantifiable responses.1 Within an educational context, it provides an environment that is as similar as possible to a real-life scenario.2 Instead, AR uses a view of the real world enhanced by overlaying and superimposing computer-generated information, including text, videos, or sounds, on the actual environment.2 The development of mobile technologies have made AR possible via mobile devices3 and expanded the realm of potential applications to neurology education. In this article, the key applications of VR and AR in neurology and neuroscience education, including neuroanatomy and histology—and potential clinical applications—are reviewed. Opportunities and potential barriers to widespread implementation are discussed.

The Virtual Classroom

In this section, specific ways in which topics traditionally taught via didactics in the classroom can be transformed with VR/AR technology will be explored.

From Cadaveric Dissections to Computers

During the past 2 decades, VR and AR tools have been used to teach basic and advanced neuroanatomy to enhance, or replace, traditional cadaveric dissection. A recent review of studies using different methods to teach neuroanatomy showed that nearly half of these already takes advantage of 3D teaching tools or AR.3 A crossover design study was performed to assess the potential benefits of cadaveric vs 3D computer-based learning of neuroanatomy. Forty-seven undergraduate medical education students completed an anatomy knowledge and spatial ability test before being assigned to either a 3D
neuroanatomy e-learning module or a gross anatomy laboratory featuring cadaveric dissection. Then, they completed a post-test and were crossed over to the other learning modality before taking a final post-test. Students assigned to the 3D neuroanatomy module performed better on the post-test (an absolute difference in mean scores of nearly 12%). After crossover, both groups performed similarly, but transitioning from the cadaveric anatomy module to the 3D learning module resulted in a significant increase in test scores.

**Immersive VR Neuroanatomy Training**

The impact of an immersive VR neuroanatomy training, as opposed to a neuroanatomy textbook, was assessed via a randomized controlled study featuring 64 first- and second-year medical students. Virtual material was created in Blender with T1-weighted anatomic magnetic resonance images and tract maps. Pre- and post-tests were designed with 13 questions assessing the material presented in the module and 9 questions on general neuroanatomic knowledge (not included in the modules), along with a 44-question test, given 1 week after the sessions. A significantly higher number of students felt VR should be used in classrooms compared with the paper-based system (94% vs 33%) and felt less afraid of neuroanatomy after VR (81% vs 12%). The VR group did better than the paper-based group regarding the questions focused on the presented material. Although this report suggests that integration of VR into training has the potential to increase study motivation and decrease neurophobia, as indicated by the results of the satisfaction survey, the follow-up period was brief and the number of questions to assess knowledge retention was probably too small.

Another study divided 84 students into 3 groups. All groups attended a lecture, with 1 group having only traditional 2D images presented in a single view, the second group having access to VR 3D images shown in the lecture (with which they can interact), and the third group having the same interactive 3D images presented stereoscopically. The postclass assessments focused on naming the structures of the limbic system, followed by a practical examination requiring them to recognize the same structures on anatomic specimens. No difference was observed between the stereoscopic vs traditional 3D VR groups, yet these 2 groups performed better on both the knowledge assessment and the practical anatomy assessment. Although these studies are limited to 3 institutions and had no assessments of long-term retention (e.g., 1 year or beyond), they demonstrate that VR-based learning of neuroanatomy is at least noninferior, and potentially superior, to traditional learning methods of cadaveric anatomy and paper-based materials.

**AR Neuroanatomy With a Smartphone**

AR neuroanatomy teaching was assessed with 70 students who participated in 2 lectures on basic, relevant concepts of the ascending and descending tracts of the medulla with 2D materials. The control group studied on a book, whereas the experimental group used the same book as a MagicBook with tagged elements, when viewed with a smartphone, permitted further interaction and visualization. The group studying with AR materials performed better on the knowledge assessment, and students felt that using the mobile AR application facilitated (79%), or partially facilitated (21%), their learning; 3 students of 4 felt it helped decrease their cognitive load, and 1 of 4 thought it partially decreased their cognitive load.

**VR Wearables to Manipulate Neurons**

An even more immersive experience was piloted using wearable VR technology and layered images allowing the virtual manipulation of a neuron. This was possible thanks to a prototype favoring real-time interactions with high-resolution cellular modules. GLASS® technology wearables permitted a user-centric educational experience, which can be flexibly applied to histologic and anatomical contexts, individually or in simultaneous, real-time group. This approach can be more useful with experienced learners, with certain visuospatial abilities and more complex anatomical aspects. A randomized trial of e-learning instructional design demonstrated that multiple views of a neuroanatomical element might impede learning, particularly for those with relatively low spatial ability; high degrees of control to the students can reduce the effectiveness of learning.

In conclusion, VR and AR allow learners to go beyond the limitations imposed by 2D, noninteractive images and create a training environment where visualization and manipulation are possible. However, future research will have to investigate personalized learning approaches capable of maximizing individual learning experience.

**The Virtual Patient**

VR/AR applications also encompass standardized simulations offering immersive experiences focused on decision-making and clinical reasoning. The virtual patient is a computer program simulating real-life clinical scenarios. Students can conduct the patient’s anamnesis, physical examinations, and define the diagnostic and the therapy, thus developing a series of cognitive clinical skills. A combined systematic review and meta-analysis in health professionals’ education showed that the use of virtual patients was associated with positive effects compared with no educational intervention. However, many studies were lacking key methodologic details, and less than half have been randomized. Hence, a focus on rigorous study design methodology might allow better comparability among different works. It is difficult to ascertain whether the virtual patients improved the learning process because of the more standardized experience offered or because of the overall increased patient exposure. Therefore, future educational studies will have to clarify this aspect and create more varied clinical presentations.
Simulating the Patient Experience

Virtual technology permits experiencing symptoms and medical conditions, which can help medical providers understand specific pathologies. A VR device was developed to simulate Parkinson disease psychosis combining Oculus Rift technology with the input of patients, caregivers, and healthcare providers. More than 500 viewers experienced 2 hallucinatory scenarios during 2 international meetings. Motion sickness, which can be a negative consequence of this approach, was rarely reported. The VR scenarios were rated as “likely/very likely” as effective teaching tools for HCP (87.5%) and caregivers (90.8). One respondent of 2 would even “likely/very likely” change their medical practice.

Building on previous work designed to provide a virtual simulation of hallucinations in the setting of schizophrenia, patient descriptions of auditory and visual hallucinations have been displayed in a virtual environment. Using the virtual world system of Second Life (Linden Lab, San Francisco, CA), an inpatient psychiatric unit has been created to virtually experience hallucinations. For 2 months, 579 users took the self-guided tour before completing a survey. The experience improved the understanding of visual hallucinations (for 69% of users) of auditory hallucinations (for more than 3 people of 4). Disease simulation can be applied to other neurologic and psychiatry diseases: a VR simulation of a specific symptom can be paired with a video providing instruction to assess and treat the condition itself and coupled with a test.

The Virtual Operative Assistant

Simulation-based education (through VR and, to a lesser extent, AR) is another growing trend in neuroscience and neurology education. VR and AR can increase the efficiency of training and treatment delivery and improve patient outcomes by mitigating patient risk, decreasing the chances of error within a zero-risk training environment, and can be used to learn patient-specific anatomy. Over the past 10 years, it has become increasingly prevalent in procedural fields, including neurosurgery, namely, skull base surgery, stereotactic and functional neurosurgery, vascular surgery, tumor resection, trauma, hydrocephalus, and spinal neurosurgery. Promising data have also been obtained with VR simulators for neuroendovascular intervention and training of lumbar puncture. VR has also been coupled with artificial intelligence (AI) to develop the “Virtual Operative Assistant.” This automated educational feedback platform was piloted in 50 among neurosurgeons, fellows, residents, and students, divided into skilled and novice groups to use the VR simulator to perform a subpial brain tumor resection task. The Virtual Operative Assistant correctly classified skilled and novice participants using 4 metrics with 92% accuracy.
Overall, it showed the feasibility of a new educational paradigm based on objective feedback based on proficiency benchmarks, expertise classification, and instructor input.14

Future Developments and Curricular Strategies

The aim of reaching a fully immersive, dynamic multisensory fusion of virtual and real information,7 which can provide a useful platform for real-time navigation for educational and training purposes, remains elusive. As demonstrated from the examples discussed above, using VR/AR technologies can bring advantages, also in increased confidence levels and procedural competency, while offering a safe training environment. There are barriers to overcome, but the steps here described can mitigate them and facilitate the implementation of VR/AR (figure).

The first step is an accurate cost-benefit analysis for the development and usability of these devices. Costs can vary dramatically based on the technology used. These figures are rarely mentioned in peer-reviewed publications, and very few reports have evaluated the feasibility of implementing VR/AR elements within the curriculum.13 The lack of a robust financial model or, at least, of a framework increases the difficulty of evaluating feasibility and sustainability of technological devices across educational settings, particularly the under-resourced ones. On the one side, VR/AR technologies might provide access to educational opportunities that otherwise might not be available to specific groups of learners, hence addressing gaps in medical education. On the other side, although collaborations with industry or startups (and renting, instead of buying, equipment) might mitigate the cost,13 money for device maintenance or software updates, i.e., to increase real-life aspects further and improve the immersivity and interactivity, must be budgeted and represents another barrier.

An additional challenge is linked to identifying contents to be used with VR or AR and proper curricular space. Not all educational opportunities might be equally suited for VR/AR, and foundational aspects, more than the advanced ones, had a more widespread adoption so far. To ensure that the identified VR/AR solution factually addresses the needed gaps in the curriculum, it is necessary to re-evaluate and realign the learning objectives within the context of the VR/AR training module. Besides the timing of the curricular adoption, the modality of the implementation (i.e., as a standalone module vs integration into a multimodal educational unit5) must be pondered.

Beyond financial resources, VR and AR typically require an investment in human resources and expertise. Cognitive biases, such as the reluctance of some educators to change the educational status quo, can slow the adoption rate of such technologies. Increasing awareness of the potential benefits of VR/AR can help in this case. Moreover, a lack of local expertise can be compensated by national and international collaborative efforts might lead to a better standardization of experimental methods and outcomes assessment. This, in turn, will potentially provide the playing field for educational alignment and the creation of new educational benchmarks, in collaboration with societies and relevant stakeholders.

Although computer-based training enhanced the educational landscape, new technological devices have raised novel ethical and legal questions. AI’s intrinsic limitations, raising over data collection methods, and data ownership need to be carefully considered. With VR, besides personal data about location, search queries, and verbal communications, nonverbal behavior such as eye movements, facial expressions, and posture are collected: 20 minutes of VR simulation leads to 2 million unique recordings of body language.15 Although these datasets may provide significant scholarly opportunities, they open up considerable privacy concerns for participants. When implementing VR/AR tools for teaching or educational research purposes, considerations of data storage and data protection should be in order.

Conclusions

VR and AR applications have already altered the educational landscape and constitute promising approaches in medical education. These tools have made their way into neuroscience and neurologic education, in particular neuroanatomy. Simulations of patient experiences in disease states and surgical simulators have become available, although potential barriers, including cost and the necessary expertise to use these tools, persist. As VR and AR become more prevalent, medical educators need to identify ways to adapt curricula to incorporate these teaching tools. Looking forward, collaboration across multiple centers to assess their long-term value remains a crucial opportunity for educational research into VR/AR.

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Please access the Author Center at NPub.org/authors for full submission information.
Global and Community Health

More than 85 percent of the world’s population lives in low and middle income countries, where the burden of neurologic disease is greatest. In addition, more than 50 million Americans live in medically underserved communities. Despite these figures, relatively little is known about patients and practitioners of neurology in resource-limited settings. This section aims to explore global and community health topics in neurology education. We welcome manuscripts describing international educational exchanges, personal rotations in low- and middle-income countries, and work by neurology trainees from around the world. We also welcome manuscripts that discuss community health initiatives and volunteer experiences in underserved regions of the United States. Inclusion of practical information on local or international volunteer opportunities would also be of use.
Global & Community Health: Implementation of and Patient Satisfaction With the First Neurologic Telemedicine Program in Mexico During COVID-19

Rogelio Domínguez-Moreno, MD,* Miguel García-Grimshaw, MD,* Oswaldo Alan Chávez-Martínez, MD, Daniel Rebolledo-García, MD, Jarumi Crystal Diestel-Bautista, MD, Anaclara Michel-Chávez, MD, Juan Andrés Calderón-Martínez, MD, Dioselina Panamá Tristán-Samaniego, MD, Alma Vigueras-Hernández, MD, Humberto Estrada-Rodríguez, MD, Felipe Arturo Vega-Boada, MD, Luis Dávila-Maldonado, MD, Miguel Ángel Tanimoto, MD, Carlos Cantú-Brito, MD, PhD, and Alejandra González-Duarte, MD*

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Due to the large number of patients requiring in-hospital care during the coronavirus disease 2019 (COVID-19) pandemic outbreak, hospitals worldwide were converted into COVID-19 referral centers. In addition to social distancing and mandatory use of face masks, other measures to reduce the risk of infection among health care workers included increasing the time between work shifts and sending high-risk personnel to in-home isolation. This resulted in a significantly reduced workforce, requiring relocation of medical personnel from multiple specialties to the frontline.1,2 Due to staff shortage, many Mexican hospitals had to reduce the number of non–COVID-19 face-to-face consultations.2,3 Across multiple specialties—including neurology—telemedicine proved to be an effective outpatient follow-up method4 as it satisfied public health mitigation strategies by increasing social distancing and reducing mobility.5,6 Furthermore, it helped clinicians track patients’ follow-up and detect those who may need an in-person evaluation or acute in-hospital management.4,7 We describe our experience in developing and implementing a teleneurology program in Mexico.

Methods
This exploratory study was conducted at the Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, a third-level teaching hospital in Mexico City that was converted into a COVID-19 referral center in March 2020. Local ethics and research committees approved the study (NER-3618-20-20-1). Usually, our center provides approximately 800 monthly follow-up general neurology consultations in a resident-led continuity clinic, supervised by 2 attending neurologists. By April 2020, due to the reduction of medical and administrative staff in addition to the steadily increasing number of patients, our center authorities stopped all face-to-face non–COVID-19 consultations. We adapted to the challenges and started researching how to implement a teleneurology program to reopen our continuity clinic (figure 1).

Program Implementation
By the end of May, we began training on how to perform a virtual neurologic examination (VNE).e1,e2 Due to our populations’ characteristics, where many patients have limited or no access to an in-home computer with Internet connection, one of the initial problems we faced was deciding which platform to use. To solve this, we conducted several telephonic and videocall surveys with the patients who were originally scheduled for a follow-up visit during the last week of May. We offered them and tested 3 different platforms (Zoom, Doxy.me, and WhatsApp). Based on those results, we concluded that WhatsApp was the most available and user-friendly platform for our population, despite the limitations imposed by cellphones’
narrow screen size and camera angle. Another problem was that in approximately 50% of patients, contact data had not been updated on their electronic medical records (EMRs). We were unable to contact them. Furthermore, some patients did not have smartphones or Internet access. After consulting and obtaining permission from our institution’s legal department, we decided to provide telephonic consultations in such cases. As our program was starting, the ethics committee and legal department only allowed us to schedule follow-up patients.

One week before starting the program, due to administrative personnel shortage, the neurology residents started contacting patients who were already scheduled for a consultation to reschedule a teleneurology appointment. After describing the telemedicine process, we sent and asked them to sign and send us back an informed consent form (ICF) that we uploaded to the EMR. This ICF included information regarding privacy, potential benefits, and limitations of teleneurology and conditions under which consultations should be terminated to perform an in-person evaluation, such as a new or rapidly progressing neurologic condition requiring acute care. For those patients for whom the consultation was telephonic, we asked for their verbal consent and documented it on the EMR before starting the consultation.

On July 6, 2020, using 3 smartphones provided by neurology department personnel, we started our program with a monthly cost of approximately $35, used for all smartphones’ data plans (figure e-1, available from Dryad, doi.org/10.5061/dryad.tqjq2bvxg). To assess patient satisfaction and quality of the health care received, at the end of the consultations, to those who had Internet access, we sent via email or text message an anonymous 24-question online-based questionnaire (modified for the COVID-19 pandemic) developed and validated for the Spanish-speaking population (tables e-1 and e-2, available from Dryad).e3

Results

From July 6 to September 30, 2020, 322 patients were scheduled. For this report, we excluded 18 patients (14 did not answer the video calls, and in 4 the appointment was cancelled). We included 304 patients (233 [76.6%] women, mean age 52.8 ± 16.9 years); 29 (8.5%) were telephonic consultations. The most common neurologic disorders we attended were neuromuscular disorders in 102 (33.6%) patients, headache disorders in 100 (32.9%), epilepsy in 35 (11.5%), cerebrovascular diseases in 18 (5.9%), and movement disorders in 17 (5.6%). Table e-3 (available from Dryad, doi.org/10.5061/dryad.tqjq2bvxg) includes a detailed list of all the evaluated neurologic disorders. None of the patients required acute in-hospital care. Only 2 (0.66%) patients required in-person evaluations due to suspected progression of polynuropathy.
Of the 304 patients, only 125 (41%) answered the survey; 108 (86.4%) preferred telediagnosis instead of an in-person consultation, 83.3% (90/108) of them because of concerns about getting COVID-19. A total of 115 (92%) patients completely agreed that they felt comfortable when talking to the neurologist through a camera and a microphone, and 120 (96%) reported being satisfied with their consultation; 5 (4%) were not satisfied, but their reasons were not specified; 109 (87.2%) completely agreed that they trusted that their privacy would be protected. Table e-4 (available from Dryad, doi.org/10.5061/dryad.tjq2bvxg) describes all responses.

Discussion

As of March 8, 2021, with 2.1 million confirmed cases (11% of them among health care workers) and more than 190,000 deaths, Mexico had the third-highest number of deaths and active cases globally, just behind the United States and Brazil. Only 0.48% of our population had been fully vaccinated at that time. The impact of the COVID-19 pandemic on outpatient visits and its long-term consequences are unknown. In response to the pandemic, the use of telediagnosis has increased worldwide. In neurology, the strongest evidence supporting its use derives from experience in managing acute ischemic stroke, where it has proven to be as effective as an in-person evaluation. Currently, due to limited evidence, telediagnosis is mainly recommended as a follow-up method for a few neurologic conditions, including nonacute headache disorders, where there is evidence proving that telediagnosis is as useful as an in-person evaluation; other diseases include epilepsy, multiple sclerosis, dementia, and neuromuscular and movement disorders.

Although it is possible to perform a reliable VNE, making feasible the use of telediagnosis for new patients, there may be conditions requiring in-person visits, especially those needing a comprehensive eye examination, assessment of the vestibular system, and examination of muscle tone, reflexes, and sensory testing. If combined with some well-known red flags, telediagnosis could be an effective method to triage patients requiring acute care. Telediagnosis offers many benefits for both patients and health care providers, including expediting care, continuous monitoring of chronic conditions, and follow-up after hospitalization. It also increases access to a neurologist, especially for patients with limited mobility and those traveling long distances to attend their visits, reducing patient costs. Furthermore, reducing the number of face-to-face consultations may help mitigate the pandemic by maintaining social distancing and reducing social mobility, particularly for those more vulnerable to COVID-19.

In Mexico, according to a global survey conducted by the Telemedicine Study Group of the Movement Disorders Society, the Movement Disorders Clinic of the National Institute of Neurology and Neurosurgery in Mexico City has started using telemedicine using Cisco Webex as its platform. Their results and experiences are yet to be reported. As reported in a position paper by the COVID-19 Pandemic Health System Resilience Program consortium, in Latin America and especially in Mexico, there are many legislative, economic, and technological challenges to overcome in order for telemedicine to reach its full potential. Unlike in the United States, where telehealth is subject to HIPAA (Health Insurance Portability and Accountability Act) rules, there are no specific regulations on telehealth in Mexico. Nonetheless, its use is encouraged by the Mexican Ministry of Health in its General Health Law.

In December 2020, 6 months after starting the program, our center launched an institutional Web-based telemedicine platform called CONeCTA to standardize and regulate the service. Throughout this process, we have learned that there are many challenges to overcome. Mexico has an urgent need to develop specific legislation regarding telehealth, expand technology access to remote locations, and increase telemedicine awareness and adoption among clinicians. In our center and as neurology trainees, we learned how to implement a telediagnosis program with limited resources to keep caring for our patients. How to perform a virtual neurologic examination adapted to our population and the need for continuous improvement and training for our administrative personnel, nursing staff, and our programs’ current and upcoming residents are important areas of research.

Our study has several limitations. First, as we were not allowed to include new patients and owing to the low percentage of survey respondents, our satisfaction and quality results may be biased. Second, we did not assess provider satisfaction and limitations during the consultation. Third, the small number of cases compared to our usual number of visits may overestimate our results; however, this was an exploratory study proposed by neurology residents to reopen our outpatient clinic to provide medical care and to continue with our training.

We described our experience developing and implementing a low-cost telediagnosis program with many improvement opportunities, but so far with good results. At the time we submitted this manuscript, this is the first Mexican report describing the implementation of telemedicine in a general neurology continuity clinic. As illustrated in the flowchart (figure 1), this program may be easy to reproduce in other developing countries depending on their laws. We hope that our experience may assist neurology residents and fellows from other developing countries in designing and adopting a telediagnosis program.

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Disclosure
The authors report no disclosures. Go to Neurology.org/N for full disclosures.
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References


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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 NPub.org/aheadofprint 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 three-year residency cycle. Submissions should be timely and are requested no longer than four 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. 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.
Journal Club: Diffusion-Weighted MRI in Transient Global Amnesia and Its Diagnostic Implications

Daniel Talmasov, MD, and Arjun V. Masurkar, MD, PhD

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The term transient global amnesia (TGA) was introduced by C. Miller Fisher and Raymond D. Adams in 1958 to describe a condition characterized by the abrupt onset of dense anterograde amnesia, followed by a return to normal cognition after a number of hours.1 TGA’s underlying pathogenic mechanism remains a matter of debate,2 but transient dysfunction of brain regions deputed to memory, especially the hippocampus, appears to play a central role.2 While TGA is associated with delayed appearance (24–48 hours from symptom onset) of hippocampal lesions on diffusion-weighted imaging (DWI) magnetic resonance studies,3 diagnosis remains completely clinical, is based on diagnostic criteria established by Hodges and Warlow in 1990,4,5 and requires either direct observation of transient anterograde amnesia by a clinician or collateral from a capable observer who witnessed the episode.

In this retrospective observational study, Szabo et al.6 propose the use of hippocampal DWI as an adjunctive role to history and examination in cases of low clinical diagnostic certainty: patients in whom TGA is suspected, but for whom the attack was neither observed by a clinician nor can be corroborated by a reliable observer.

Hypothesis and Design

The authors’ hypothesis was that hippocampal DWI lesions can be used as a diagnostic criterion for TGA. They stratify the study population into those patients with high diagnostic certainty of TGA and those of low diagnostic certainty—patients in whom a diagnosis TGA is suspected, but the potential amnestic episode was not witnessed by an outside observer, and thus not strictly diagnosable by the Hodges and Warlow criteria. While DWI abnormalities on MRI have been observed in patients with TGA for over 2 decades, it is unclear in what situations DWI is diagnostically useful, and thus the use of MRI in TGA diagnosis has yet to be operationalized. If a positive diagnostic role of DWI in TGA were to be validated, it has the potential to be of greatest effect in supporting a diagnosis for patients who present after an unwitnessed potential amnestic episode. The validity of the authors’ hypothesis that DWI lesions can be used as a diagnostic criterion for TGA is contingent on the assumption that diffusion-restricting hippocampal lesions (on diffusion-weighted MRI specifically protocolled with thin slices through the mesial temporal lobes) must be rare in control populations. This is important, as TGA-associated hippocampal lesions and isolated punctate hippocampal infarctions are indistinguishable on MRI,7 and thus a rigorous comparison to appropriately protocolled control scans would be necessary to rule out the possibility of lesions being incidental. A prior study3 found that 84% of 31 consecutive patients diagnosed with high diagnostic certainty TGA (episode witnessed by an outside observer) showed evidence of diffusion-restricting lateral hippocampal lesions on DWI. The authors performed a retrospective observational cohort study, which is in principle is a feasible means of testing the hypothesis, but limited in this study by a lack of age-matched normal controls.
Methods

Authors analyzed demographic, clinical, and MRI data of 390 patients diagnosed with TGA in a prospectively collected database of patients treated at University Medical Centre Manheim at Heidelberg University between 1999 and 2018. All patients included had cranial MRI including a dedicated DWI protocol parallel to the long axis of the hippocampus, which was optimized for the detection of DWI lesions associated with TGA. The spatial distribution of DWI lesions and their temporal relationship to the reported time of TGA symptom onset was evaluated, as was the relationship of DWI-positive lesions to the degree of diagnostic certainty with which the TGA diagnosis was made according to the patient’s history. Patients in whom an alternative diagnosis to TGA was considered on the basis of additional symptoms or in whom another diagnosis was confirmed on diagnostic testing were excluded.

Results

DWI-positive lesions were detected in 272 of 390 (70.6%) patients diagnosed with TGA in the Heidelberg cohort, including 76 patients (69.1%) among those 110 patients in whom TGA was diagnosed with lower diagnostic certainty (amnesia witnessed by a layperson or self-reported). DWI-positive lesions were most likely to be detected 12–24 hours after symptom onset, with 93% of detectable DWI lesions evident upon scans conducted during this time interval. The majority of patients in this cohort presented to the emergency department (ED) during their amnestic episode (280/390, or 71.8%), allowing for direct clinical diagnosis by Hodges and Warlow’s diagnostic criteria. Many others (98/390, or 25.1%) of those diagnosed with TGA during this 10-year interval were asymptomatic at time of presentation but had history available from a reliable observer who was present during the patient’s amnestic episode. The remaining 12 patients (3.1%) presented for a self-reported memory gap but were asymptomatic in the ED and did not have witness corroboration.

The statistical analyses employed by the authors are appropriate, with distributions of continuous variables between groups compared with Student t test and distributions of categorical variables compared using χ² test for large cell sizes and Fisher exact test for smaller cell sizes.

Interpretation

A major limitation of the study is a lack of formal controls. Without demonstrating it in a control population, the authors implicitly assume that hippocampal abnormalities are very rare in the general population, and thus can be attributed to TGA in patients with relevant symptoms. Although this seems to be a fair assumption, it has not been demonstrated in controlled studies. This limits our ability to interpret the significance of the DWI abnormalities detected—namely, what percentage are attributable to TGA vs an incidental finding in the normal population. More curious is the authors’ finding in 11 patients (2.8% of the cohort), of multiple small extrahippocampal lesions—a phenomenon the authors compare to “ischemic amnesia,” a previously reported rare radiographic finding postulated to be associated with postembolic amnesia. An important point to be made, however, is that while this study lacks an asymptomatic control group, many patients underwent multiple MRI scans at different time points, opening the possibility of patients being used as their own controls, with the understanding that new lesions that temporally correlate with emergence of TGA symptoms can be considered markers of an underlying pathophysiologic process. The authors present aggregated data in figure 2 from 187 patients (46.3% of their cohort) in whom the precise time of onset of TGA symptoms was known and demonstrate a temporal pattern supporting the hypothesis that DWI-positive hippocampal lesions appear following a delay (12–24 hours) from symptom onset. This cannot be proven in the authors’ group of greatest interest, however—the group of patients in whom time of TGA onset is unknown, or who present following a subjective amnestic episode without collateral history from a reliable observer. Given that statistical methods exist for evaluating the efficacy of a diagnostic test in absence of a gold standard diagnosis for all or some participants in a research study, the authors’ conclusions may have been strengthened by adjusting for this limitation. A controlled study using the same imaging protocols in patients without a history of TGA-like symptoms would be useful in contextualizing the significance of these lesions and definitively demonstrating their association with TGA. Another limitation of the study is that 24-hour ambulatory EEG was not used; this would have been useful in ruling out transient epileptic amnesia, particularly in patients in the lower diagnostic certainty group.

Despite these limitations, the authors’ finding that DWI-positive hippocampal lesions were present in 76 (69.1%) of 110 patients with a presumed episode of TGA but in whom the episode was not directly observed by the diagnosing clinician has clinical import. This finding supports the existing practice, advanced by Hodges and Warlow, of diagnosing those patients who present after resolution of the amnestic period but with collateral history of an amnestic event from a witness with TGA. More importantly, these results support expending diagnostic criteria for TGA to include asymptomatic patients who present with subjective report of a discrete amnestic gap with no direct collateral from witnesses (12 patients of 390, or 3.1% of this sample) if their MRI reveals new diffusion-restricting hippocampal lesions. This can readily be applied to practice as hippocampal-sensitive DWI protocols can be widely implemented at any MRI-capable radiologic department. However, before such a change to clinical practice can be implemented, it is necessary to demonstrate that hippocampal abnormalities on DWI are indeed very rare in the general population before attributing such abnormalities to TGA. This requires a controlled study in which patients with suspected TGA are compared to age-matched controls with identically protocoled imaging, including DWI with thin slices through the hippocampi and mesial temporal lobes. A positive diagnosis of patients with TGA by imaging criteria, rather than diagnosis by exclusion, would be useful in guiding clinicians considering further testing, such as EEG. It may also prove reassuring to patients, as TGA is benign and rarely recurs.
Study Funding
No targeted funding reported.

Disclosure
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References
Pearls & Oy-sters

“Pearls and Oy-sters” is a feature focusing on fundamental clinical neurology. Each article addresses a specific niche of neurological 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 neurological disease such as localization, elaboration of a differential diagnosis, evaluation, or treatment. These articles 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.
Pearls & Oy-sters: Eyes-Open Coma

Daniel Kondziella, MD, PhD, and Jennifer A. Frontera, MD

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Pearls

- The classical definition of coma denotes unarousable unresponsiveness with absent sleep–wake cycles and closed eyes, but comatose patients may defy that definition by showing eye-opening early after brain injury.
- Coma with eye-opening (either spontaneously or on physical stimulation) differs from the vegetative state/unresponsive wakefulness syndrome (UWS) in that it has a different clinical trajectory (worsening rather than stabilization) and no sleep–wake cycle.

Oy-sters

- Coma with eye-opening may occur with supratentorial, infratentorial, or global brain insults of various etiologies (e.g., stroke, anoxia). Brainstem involvement either as primary injury or secondary injury due to herniation appears to be a commonality among patients with eyes-open coma.
- International efforts1 are underway to develop an endotype-based coma definition that considers actionable pathophysiologic information and clinical trajectories (as opposed to a merely descriptive coma phenotype); hence, the classical definition of coma is likely to be modified in the future.

Assessment of eye-opening is key to the evaluation of unresponsive patients. According to the seminal definition by Plum et al.,2 coma is a state of profound unawareness from which the patient cannot be aroused, a normal sleep–wake cycle is absent, and the eyes are closed. Classically, return of eye-opening after brain injury is thought to indicate recovery of consciousness or progression to UWS (i.e., wakefulness without clinical signs of awareness).3 However, some comatose patients exhibit eye-opening (either spontaneously or on physical stimulation) early after brain injury and do not meet criteria for UWS. Prognostic scales such as the Glasgow Coma Scale and the Full Outline of Unresponsiveness (FOUR) score, which both positively weight spontaneous eye opening, may generate overly optimistic outcome estimations for patients with eyes-open coma. Here, we present 3 case vignettes, with infratentorial, supratentorial, and global brain injuries, illustrating an underrecognized coma phenotype that is characterized by spontaneous eye-opening, but poor, and often fatal, outcomes.

Case Vignette 1: Infratentorial Brain Injury

A 62-year-old woman with a history of hypertension and diabetes presented with sudden onset of left hemiparesis and dysarthria (NIH Stroke Scale 6). Head CT showed small right caudate and corona radiata hypodensities that appeared chronic. She received IV tissue plasminogen activator (tPA) within 53 minutes after stroke onset. CT angiogram revealed bilateral vertebral artery intracranial stenosis, but no large vessel occlusion. Thirty-seven minutes after initiation of tPA, the patient complained of a headache and became unresponsive. tPA was stopped, the patient intubated, and cryoprecipitate administered. Repeat head CT demonstrated a 35 mL pontomedullary intracerebral hemorrhage with intraventricular hemorrhage and hydrocephalus. The next day, off

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Go to Neurology.org/N for full disclosures. Funding information and disclosures deemed relevant by the authors, if any, are provided at the end of the article.
A 61-year-old man with a history of hypertension and hypercholesterolemia developed sudden onset of headache, neck stiffness, and vomiting. In the emergency department, the patient was unarousable with a right fixed and dilated pupil and bilateral upper extremity flexor posturing. The patient was intubated. Head CT demonstrated a modified Fisher 4 subarachnoid hemorrhage dissecting into the right subdural space with 17 mm midline shift. CT angiogram revealed an 18 mm right suprachordid internal carotid artery aneurysm. Upon arrival in the intensive care unit, his examination off sedation revealed spontaneously open eyes, but no blink to threat, saccade to voice, tracking, or command following. Using a pupillometer, the right pupil was 5 mm and fixed; the left pupil was 3 mm and reactive. Corneal, cough, and oculocephalic reflexes were present and the patient was breathing above the ventilator. He showed bilateral extensor posturing with noxious stimuli (FOUR score: eyes 3, motor 1, brainstem 1, respiration 0; total 5). Four days later, she was declared brain dead based on clinical examination and an apnea test.

Case Vignette 2: Supratentorial Brain Injury

A 61-year-old man with a history of hypertension and hypercholesterolemia developed sudden onset of headache, neck stiffness, and vomiting. In the emergency department, the patient was unarousable with a right fixed and dilated pupil and bilateral upper extremity flexor posturing. The patient was intubated. Head CT demonstrated a modified Fisher 4 subarachnoid hemorrhage dissecting into the right subdural space with 17 mm midline shift. CT angiogram revealed an 18 mm right suprachordid internal carotid artery aneurysm. Upon arrival in the intensive care unit, his examination off sedation revealed spontaneously open eyes, but no blink to threat, saccade to voice, tracking, or command following. Using a pupillometer, the right pupil was 5 mm and fixed; the left pupil was 3 mm and reactive. Corneal, cough, and oculocephalic reflexes were present and the patient was breathing above the ventilator. He showed bilateral extensor posturing with noxious stimuli (FOUR score: eyes 3, motor 1, brainstem 1, respiration 0; total 5). Four days later, she was declared brain dead based on clinical examination and an apnea test.

Case Vignette 3: Global Anoxic Brain Injury

A 50-year-old patient had out-of-hospital cardiac arrest and return of spontaneous circulation after 20 minutes. The patient was treated with 24 hours of therapeutic hypothermia. CT of the brain showed mild generalized sulcal effacement; neuronspecific enolase was 187/L. EEG the next day revealed a flattened background with monomorphic generalized periodic discharges. The eyes were spontaneously halfway open and fully opened following sternal rub and temporomandibular joint pressure. There was no blink to threat and no visual pursuit or fixation during the mirror test. Automated pupillometry showed minuscule pupillary reactions to light; pupils were pinpoint. Corneal reflexes were absent, as were oculocephalic reflexes. There was preserved cough on tracheal suction including a rise in blood pressure. There were a few myoclonic jerks in the face, occasionally increasing with physical stimulation but unrelated to the generalized periodic discharges,
suggestive of subcortical myoclonus. The FOUR score was eyes 3, motor 0, brainstem 2, respiration 0 (total 5). Median nerve somatosensory evoked potentials on day 3 showed absent N20 responses and CT of the brain revealed generalized edema, including a white cerebellum sign and temporal horn enlargement. The patient was terminally extubated.

Discussion

Each patient presented acutely after brain injury with prolonged eye-opening despite unarousable unawareness. Unlike UWS, which typically develops weeks after coma onset, there was no neurologic improvement or stabilization, such as return of sleep–wake cycles. Instead, brainstem reflexes were progressively lost, including nonreactive pupils, and eye-opening was present until death. Although the FOUR scores ranged from 5 (associated with 50% in-hospital mortality) to 8 (30% in-hospital mortality), all 3 patients died in-hospital, including 2 who died following withdrawal of life support owing to their poor neurologic status. The implication of this observation is that comatoso states exist that challenge the classic definition of coma, stressing the importance of recent initiatives like the Neurocritical Care Society’s Curing Coma Campaign, which aims to characterize the anatomical, electrochemical, and electrophysiologic underpinnings of coma and disorders of consciousness. The exact anatomical and physiologic mechanisms in coma with eye-opening are unknown. Normally, elevation of the eyelids involves activation of the levator palpebrae superiors muscles (LPS) and concurrent inhibition of the orbicularis oculi muscles. The LPS receive bilateral innervation from the central caudal nucleus of the oculomotor nucleus complex. The supranuclear control is less well understood. Experimental data suggest involvement of the cortex, extrapyramidal motor systems, and rostral brainstem structures, and some evidence indicates that the right hemisphere may be dominant for cortical eyelid control. In our patients, coma with eye-opening occurred with a primary infratentorial lesion, a supratentorial lesion with brainstem herniation, and a global anoxic insult. In 2 previous reports, periodic eyelid opening following cardiac arrest was associated with a burst-suppression pattern on EEG, and eye-opening triggered by flexion of an arm was described as a manifestation of the decerebrate response in a patient with diffuse bilateral hemispheric damage, but neither of these mechanisms was identified in our patients.

Two other cases of unresponsiveness with eye-opening may delineate the anatomical boundaries within which coma with eye-opening may occur (figure). At the most cranial level, intraoperative stimulation of the globus pallidus internus (GPi) in a woman undergoing deep brain stimulation surgery led to consistent eye-opening, despite complete unresponsiveness (figure, A). Full opening of both eyes could be induced by stimulation in both hemispheres (implying that descending control to the LPS is exerted bilaterally), but was topographically restricted to sites between the GPi and the posterior part of the basal nucleus of Meynert. The authors suggested that the subpallidal basal forebrain is involved in the premotor control of eye-opening. Given that the pathways controlling LPS tonus run in close association with the ascending arousal system through the paramedian tegmentum of the upper brainstem, there must have been a dissociation between these intact pathways and a nonfunctioning arousal system.

At the most distal level, consistent (albeit partial and unilateral) eye-opening has been observed in a remarkable case of brain death (figure, B). As brainstem function was irrevocably lost, the eyelid opening was interpreted as resulting from preserved sympathetic function of the cervical spinal cord, activating the Müller muscle. Indeed, in a similar case, unilateral stellate block with lidocaine abolished eye-opening on the side of the injection, demonstrating the sympathetic origin of this phenomenon.

As autopsy was not performed, we can only speculate about the mechanisms at play in our patients. Cerebral edema and distortion of the GPi and basal nucleus of Meynert might have led to tonic activation of LPS pathways and heightened sympathetic activity leading to activation of the Müller muscle is also plausible. However, we can infer that coma can occur in patients who have eyes open all the time and patients showing eye-opening to a noxious stimulus.

These patient vignettes illustrate that a coma phenotype associated with eye-opening exists and defies classic coma definitions. This phenotype occurs with various etiologies, including primary or secondary infratentorial lesions and global anoxic–ischemic injury. Autopsy and functional imaging studies are needed to reveal the mechanisms behind this phenomenon and epidemiologic studies are needed to determine the prevalence and outcomes associated with eyes-open coma.

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Disclosure

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• Read previously posted comments; redundant comments will not be posted
• Your submission must be 200 words or less and have a maximum of 5 references; the first reference must be the article on which you are commenting
• You can include a maximum of 5 authors (including yourself)
Right Brain

Right Brain publishes meaningful, high-quality creative writing, including narrative fiction, non-fiction, and poetry which have broad appeal to a trainee audience. Stories and narratives should focus on an aspect of the neurology training experience, giving voice to trainees’ unique perspectives and sharing lessons learned. Pieces should be relatable and personable, highlighting and normalizing common experiences in training. Stories may share experiences in patient care, career development, or personal growth. Articles may highlight uncertainty and ambiguity in training, demonstrate challenges and successes, and illustrate moments of tension or relief.

Priority will be given to pieces exploring the experience of being a trainee in neurology. If you are unsure if your article is a good fit for Right Brain, please reach out to the editors ahead of submission at rfsection@neurology.org.
Back when I was living in Singapore, my family hosted an annual Lunar New Year party every Spring. On that day, friends and relatives would pack into our modest, three-bedroom apartment, fold pieces of circular dough over dollops of meat, trade red envelopes stuffed with money, and slurp pieces of shrimp and napa cabbage out of a steaming pot. After I left for North America, I made a new tradition of video calling my relatives on the evening of New Year’s Day. Year by year, they watched as I grew, matured, and took on new identities: from acne-riddled teenager to young adult, from undifferentiated high schooler to college graduate and, in a couple months, from medical student to the first doctor in my extended family. That was when my conundrum arose.

It started with a seemingly innocuous question, asked by my aunt during our Lunar New Year catch-up call.

“Lele,” she said, referring to me by my childhood pet name, which means “happiness,” “I want to ask you about this herb your grandpa is eating. It’s some sort of sea product.”

Apparently, as a graduating medical student and future neurologist, I was expected to know all things in medicine, with some zoology and botany thrown in as well.

“What is it called?” I asked.

Even as I asked this, I could hear my 2 personas arguing. The Chinese nephew in me posited that my aunt probably had cultural expectations that my training would benefit the family somehow—in the rural part of China where she grew up, a doctor in the family is equivalent to a doctor for the family—but my American-trained professional persona protested. After all, most ethics papers and professional societies discourage giving medical advice to family members because there is no way for the provider to maintain complete objectivity.

“海参,” she said, meaning “ocean ginseng.” The words themselves evoked images of a pensive, wispy root much like ginseng, its terrestrial sibling. Much to my surprise, after typing the Chinese characters into the Google search bar and hitting Enter, my screen filled with images of a black slug-like creature with a gelatinous coat. A few images showed the slimy body lounging on the seabed. Others showed it cupped by hands as though being caressed. One depicted it in a dish with goji berries and a mint leaf. 海参, otherwise known as the sea cucumber, noted one caption.

I stared at it for a full minute as my aunt stared at me through my screen, awaiting my response. In Chinese folklore, eating something that looks like an organ is considered beneficial for that organ. Walnuts are good for the brain, for example, purportedly boosting cognitive function.

So I wondered: Why was my grandfather eating this flaccid thing?

Maybe that is irrelevant, I thought. After all, I appreciated the desire to ingest the odd herb or sea creature every now and then, having grown up in a Chinese household very much in touch with its cultural roots. I have eaten bird’s nest (swiftlet saliva), hasma (frog fallopian tubes), and snake gallbladder. On the other hand, after spending the past 5 years learning the potential
harms of unstudied medicines and watching medical providers scoff at the patients who take them, I felt reluctant to give my aunt any advice that was not scientifically sound.

A quick search on PubMed revealed several articles claiming that sea cucumber extracts had antioncogenic properties. Never mind that these studies were performed on cell lines and animal models, which do not necessarily translate into clinical results. If I told my aunt that, all she would hear was “it prevents cancer,” and soon my entire extended family would be munching on sea cucumbers as tea snacks.

“What did you find out?” asked my aunt, impatiently.

“Seems like this thing has a good amount of protein and some vitamin A, calcium, and iron,” I said, referring to a dubious page on Nutritional Facts of the Sea Cucumber, something I have told patients not to do. “Chinese herbs really aren’t my specialty. I probably know about them less than you do.”

There, I did it, I thought. I have walked the tightrope between my filial duties and my professional ones, and all I lost was some respect from my aunt.

Sensing her disappointment at my lackluster answer, I changed the topic.

“How’s uncle doing?”

“He’s doing alright, all things considered. Hey, you are going into neurology, right? What is that, like, treating crazy people?”

“You’re thinking of psychiatry. Neurology deals with strokes and seizures and stuff.”

“That’s great! Listen, your uncle was diagnosed with epilepsy 6 years ago, and he stopped his seizure meds a while back. He has not had a seizure since. Do you think he still needs the meds?”

In that moment, I realized that my aunt, who helped raise me and feed me, was treating me like an authority figure, a source of knowledge and assurance. Unlike with the sea cucumber question, I could no longer use “this is not my specialty” as an excuse. I wanted to say that even if I were a fully trained neurologist, I did not know my uncle’s full history and that most of my knowledge came from clinical studies and trials based largely outside of China with limited Chinese patient recruitment, so the results may not even apply. Would she understand that? Or would she just see an unfilial nephew, ungrateful to the ones who helped raise him?

“He should follow-up with his neurologist,” I said, using an answer I would pick on a licensing examination.

In this real-life case, however, my relatively innocuous advice had serious implications. The nearest reputable neurologist was in the city, 250 miles from the relatively rural area where they lived. A simple “follow-up” would mean a weekend trip, at least, which meant lost wages for both my aunt and her husband. At the risk of betraying too much professional hubris, I, a doctor-in-training, may be the best source of information they had.

There I was, caught between my aunt cast virtually on a screen and my cozy New Haven apartment, between my duties as a soon-to-be physician and my duties as a member of a Chinese family. I imagined this must be how sea cucumbers feel, torn between their identities as marine animals, underwater vegetables, and Chinese herbal supplements. After all, in that moment, who was I: a student or a health care provider? A professional or a nephew? I sat at the center of an identity tug-of-war. What was I to do?

That same Lunar New Year evening, tired of COVID-19 and missing my family, I experimented with making dumplings on my own. Carefully, I folded pieces of circular dough over dollops of chopped vegetables held together by shiitake mushroom. I replayed the conversation with my aunt in my mind. Did I say the right things? Have I offended them? Did I commit any ethical breaches?

Just then, my phone buzzed. My aunt had sent me a message: “Grandpa getting check-up soon. Will see if sea cucumbers help him or not. Also, your uncle and I are making a trip to see a neurologist, just to be safe. Just needed to hear it from you. Love you.”

I placed my phone aside and returned to my dumplings, feeling a sense of wholeness as I squeezed each piece of dough into a neat little packet of ingredients, transforming the disparate parts into a cohesive whole, as though I, too, was being packed into something complete.

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Disclosure
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Teaching NeuroImages

Teaching NeuroImages are interesting, previously unpublished photomicrographs, patient photographs, neuroradiologic images, or other pictorial material. They are clear examples of established observations intended for the trainee audience. Educational videos may also be submitted under this category (Teaching Video NeuroImages). Teaching NeuroImages and Teaching Video NeuroImages now feature accompanying ‘Teaching Slides.’ These slides are available online with the article as a teaching tool for trainees and program directors.
A 57-year-old woman presented with a 1-year history of frequent, sharp, prickling pain in the right oropharynx, often triggered by swallowing or talking. Oxcarbazepine, pregabalin, and mecobalamin were tried but pain relief was not satisfactory. MRI with fast imaging employing steady-state acquisition indicated neurovascular compression of the cranial nerve IX (figure 1). Glossopharyngeal neuralgia was diagnosed and microvascular decompression was performed. The patient achieved complete relief of pain immediately after surgery. Evident focal nerve volume loss above the compressing artery was observed during operation (figure 2), highlighting mechanic force as the cause for glossopharyngeal neuralgia.

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- Your submission must be 200 words or less and have a maximum of 5 references; the first reference must be the article on which you are commenting
- You can include a maximum of 5 authors (including yourself)
Teaching Video NeuroImages

Teaching Video NeuroImages are interesting, previously unpublished educational videos. Teaching Video NeuroImages feature accompanying 'Teaching Slides.' The slides are available online with the article as a teaching tool for trainees and program directors.
Teaching Video NeuroImage: Reflex Facilitation in Lambert-Eaton Myasthenic Syndrome

Antonio Edvan Camelo-Filho, MD,* Eduardo de Paula Estephan, MD, PhD,* Carlos Otto Heise, MD, PhD, and Edmar Zanoteli, MD, PhD

Neurology® 2021;97:e1168-e1169. doi:10.1212/WNL.0000000000012180

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A 41-year-old woman presented with progressive fluctuating lower limb weakness, urinary incontinence, and dry eyes and mouth. Physical examination revealed proximal flaccid tetraparesis (Medical Research Council 4). The patellar reflex was absent, but with postexercise facilitation (video 1). Eyelid and eye movements were normal. Electroneuromyography revealed a presynaptic neuromuscular junction disorder (figure). Antibodies to anti-voltage-gated calcium channels were positive. Periodic cancer screening, including whole-body FDG-PET, was negative during 2 years of follow-up. These findings were consistent with non-paraneoplastic Lambert-Eaton myasthenic syndrome.1 The patient had a good response to IV immunoglobulin. The presence of ascending muscle weakness, autonomic dysfunction, and postexercise facilitation of reflexes should raise suspicion for the diagnosis.

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The authors report no targeted funding.

*These authors contributed equally to this work.

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Disclosure
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Reference
Training in Neurology

This subsection features structured descriptions of novel training programs and personal experiences or expert opinion on critical gaps in neurology training across all stages of learning, from pre-collegiate preparation to fellowship and beyond. Manuscripts should provide descriptions of detailed training initiatives and interpret these initiatives within the context of existing literature, teaching, and practice. Authors should thoroughly review the literature to identify an important knowledge gap related to neurology training. Strong submissions will also outline why the educational program was created and provide data on assessments or evaluations. Conclusions should be supported by study findings and provide guidance around how best practices can be translated to other training institutions or generalized for additional learner groups. Note that educational research studies should be submitted to the main journal. Find detailed information about the submission guidelines for this subsection at: NPub.org/train.
Training in Neurology: Diagnostic Accuracy Among Neurology Residents

The “Close the Loop” Project

Emily M. Schorr, MD, Rachel Brandstadt, MD, Peter Jin, MD, Christine Stahl, MD, and Stephen Krieger, MD


Abstract

Objective
To describe cases presented by junior neurology residents and to evaluate resident diagnostic patterns to help address individual and systemic educational needs.

Methods
For 6 academic years, details of all morning report cases assessed and presented by junior neurology residents were logged, including the resident’s independent initial diagnostic impression. Cases were later revisited at subsequent morning reports to “close the loop” on a final diagnosis. We conducted retrospective review to quantify case demographics and to determine resident diagnostic accuracy based on prespecified localization pathways.

Results
Demographic analysis included 1,472 cases; of these, 1,301 qualified for accuracy analysis due to diagnostic uncertainty at time of morning report. Non-neurologic etiologies represented 26.0% of cases. CNS etiologies were the majority (86.0%) of neurologic cases. The most frequent diagnoses were ischemic stroke and seizure. Overall resident diagnostic accuracy was 64.0%. Accuracy was similar between central and peripheral etiologies. Of 1,301 cases, 15.3% were overcalled as neurologic, while neurologic disease was rarely mistaken as non-neurologic (5.1%). Most diagnostic errors (49.1%) occurred when determining whether a case was neurologic. Where in the localization pathway errors occurred varied between etiologies.

Conclusion
Overall diagnostic accuracy for neurology junior residents in our cohort was similar to prior work conducted in smaller samples. Analysis of errors, particularly at the critical “neurologic or non-neurologic” decision point, warrants further investigation. Close the loop methodology is simple to employ and can guide educational and quality initiatives to improve neurology resident clinical acumen.
Neurology residency programs strive for trainees to achieve core clinical competencies and to maximize the education derived from patient care. Endeavors to improve clinical acumen among residents are challenging, as diagnostic patterns are often difficult to capture and quantify. This is in part due to limited systematic data available regarding the types of cases seen in neurology residency. Prior work has captured broad etiologic categories of cases encountered by individual residents but has been restricted by small sample sizes or lack of follow-up data on patient outcomes.1

Furthermore, cognitive error research in neurology has also focused on small cohorts and is often subspecialized.2 We characterized the types of cases presented by junior neurology residents in morning report over a 6-year period with the aim of evaluating resident diagnostic patterns in order to identify individual and systemic educational needs.

Methods

Prospective Database Creation
All inpatients assessed and presented by on-call postgraduate year 2 residents during daily morning report for 6 academic years (July 2010 through June 2016) were captured in a case log. Case demographics collected included date of consultation, age and sex of the patient, encounter venue (e.g., emergency department [ED], medical floor, direct admission), and discharge disposition (e.g., home, medical floor, neurology floor). Details including history of the present illness, neurologic examination, and available laboratory/radiologic data were logged. The resident’s initial diagnostic impression (prior to discussion with a neurology attending) was recorded. In subsequent morning report sessions, residents “closed the loop” by revisiting each previously presented case to record the final diagnosis when available. Cases in which a diagnosis was known at the time of initial presentation were excluded from accuracy analyses (e.g., consult for intracranial hemorrhage already visible on CT scan). Final diagnosis was defined as the diagnosis upon discharge or afterward if available. The Mount Sinai Hospital Institutional Review Board granted an exemption for this project.

Retrospective Case Classification
Retrospective review was conducted to categorize cases and determine accuracy of residents’ initial diagnoses. Both initial impressions and final diagnoses were separately classified according to a prespecified localization and diagnostic pathway, designed to distinguish errors of localization from those of disease state (etiology). Our categorization scheme as shown in figure 1 is described as follows: initial impressions and final diagnoses were deemed to be either neurologic or non-neurologic, and neurologic cases were sorted by localization as either CNS or peripheral nervous system (PNS) and further subcategorized by etiology. By etiology we intend specific categories of neurologic disease; the CNS etiologies are listed in the table, with CNS not otherwise specified (NOS) reserved for more complex cases that did not clearly fit one category (e.g., autoimmune encephalitis, posterior reversible encephalopathy syndrome). PNS classifications are listed in the table, including PNS NOS (mostly peripheral vertigo). Non-neurologic cases were further classified as medical, psychiatric, or ophthalmologic. Frequencies, means, and SDs of particular localizations were calculated.

Accuracy
Accuracy of the initial resident’s diagnosis was categorized as fully accurate, partially accurate, or inaccurate. Cases with accuracy that was difficult to score were discussed among the authors, who would agree as a group on an accuracy score. Accuracy was judged by 2 raters with 94.8% interrater agreement (second rater assessing 154 cases in total, observed Cohen kappa 0.89). The partially accurate designation was applied to a small percentage of cases in which overall localization and general category of etiology were correct, but specific localization or etiology was not (e.g., a TIA diagnosis mistaken for a stroke; stroke recognized as etiology but proposed to be in the incorrect anatomic area; viral encephalitis mistaken for autoimmune encephalitis). Non-neurologic cases were considered partially accurate if the case was appropriately considered to be non-neurologic but the more precise designation was incorrect (e.g., an ophthalmologic diagnosis mistaken for medical).

Results

Case Demographics
A total of 1,472 morning report inpatient cases were included in demographic analysis, 1,301 of which had diagnosis unknown at presentation, and thereby were included in the close the loop (CTL) cohort. Of all cases, 58.1% were female. Mean age was 57.5 years (SD 19.1, range 9–96). A total of 72.2% of cases were from the ED, and 19.3% from inpatient floors (primarily internal medicine services). See the table for case frequencies.

Accuracy: Overall
The overall diagnostic accuracy was 64.0% with an additional 4.8% cases deemed partially accurate. Among cases with a final neurologic diagnosis, accuracy was higher at 67.5% (with an additional 5.8% partially accurate); CNS (67.9% accurate, 6.2% partially accurate) and PNS cases (66.3% accurate, 3.4% partially accurate) had similar overall accuracy. Accuracy for

Glossary

CTL = close the loop; ED = emergency department; NOS = not otherwise specified; PNS = peripheral nervous system.
medical cases was 62.3% (2.0% partially accurate); for psychiatric cases, accuracy was 54.5% (partially accurate 3.0%).

**Accuracy: Neurologic vs Non-Neurologic**
Most diagnostic errors (49.1%) occurred at the neurologic vs non-neurologic distinction. Cases were more likely to be “overcalled” as neurologic (15.3% of all cases) rather than missed as neurologic (5.1% of all cases) (figure 2A). Determination of a neurologic diagnosis by junior residents carried a 94.9% sensitivity, 59.1% specificity, 84.8% positive predictive value, and 82.7% negative predictive value. Of all medical cases, 36.1% were initially deemed neurologic. Conversely, of cases initially deemed medical, 19.7% were actually neurologic.

Similarly, 38.4% of true psychiatric cases were initially deemed neurologic whereas 11.5% of cases initially classified as psychiatric were in fact neurologic disorders.

**Accuracy: CNS vs PNS**
An error was made at the CNS/PNS decision point in 3.4% of all cases (10.9% of all errors; figure 2A). Of incorrect cases that were correctly identified as neurologic, 22% of these were missed at the CNS/PNS level.

**Accuracy: Etiologies**
Of all incorrect cases, 38.0% were missed at the etiologic level (correctly categorized as CNS or PNS, but incorrect etiology within either CNS or PNS). Accuracies for the 5 most common etiologies are as follows: ischemic stroke (75.5% accurate/4.8% partially accurate), seizure (79.6%/2.0%), headache (55.7%/6.8%), neuropathy (50%/3.0%), and CNS neoplastic (57.1%, 2.0%). Errors for each etiologic category occurred at different points in the diagnostic pathway. For example, in the cases with a final diagnosis of ischemic stroke, 20.7% of cases were incorrect. Among all ischemic stroke cases, 4.2% were missed at the neurologic vs non-neurologic level, 3.0% missed at the CNS/PNS level, and 13.5% missed at the etiologic level (figure 2B). For comparison, in the primary headache group, 2.3% were missed at the neurologic/non-neurologic level, 2.3% at CNS/PNS level, and 33.0% of all headache cases were misdiagnosed among specific CNS etiologies (figure 2C).

**Discussion**
Morning report is an essential venue for clinical learning in residency. Over 6 academic years, we have used this forum to categorize cases assessed by neurology residents and to critically evaluate patterns of diagnostic acumen. Nearly one-third of cases presented by neurology residents were ultimately deemed to be non-neurologic, most of which were medical or psychiatric in etiology. The majority of neurologic cases localized to the CNS, with the most common diagnoses being stroke and seizure. This is similar to prior work in which single residents tracked all cases seen during their residency training.1,3,4

Overall junior neurology resident initial diagnostic accuracy when presenting their initial impressions at morning report was 64%, which is congruent with 2 prior studies.5,6 Residents tended to overcall cases presented in morning report as neurologic but rarely missed true neurologic disease. Despite the significantly higher quantity of CNS disorders presented, resident accuracy in morning report cases was similar between CNS and PNS localizations. Patterns where error was likely to occur varied between etiologies. For example, headache was more likely than ischemic stroke to be missed at the more nuanced etiologic categorization, while stroke was more likely than headache to be missed as non-neurologic.
Several limitations of our study warrant consideration. First, a resident’s true independent diagnostic assessment is difficult to capture, as residents frequently interact with coreidents, ED or other attendings, and radiologists in the course of initial consultations. We note also that the amount of supporting clinical data (e.g., laboratory studies, imaging) available at the time of first diagnostic impression varied across cases and the natural diagnostic evolution that occurs during a hospitalization may hinder determination of true accuracy. Furthermore, although we sought to determine diagnostic accuracy, there is often no gold standard for final diagnosis. These final determinations reflect best clinical judgment at the conclusion of the hospitalization or evaluation of each case. There is also challenge in categorizing complex cases into our prespecified diagnostic localizations and etiologies (e.g., vasculitis could be categorized as ischemic stroke, but also as a neuroinflammatory or headache syndrome). Furthermore, not every diagnostic category could be parsed with identical levels of granularity. Mount Sinai is a large tertiary care hospital located in New York City and thus the cases seen by residents in this urban setting may not match those seen at community hospitals or in suburban or rural settings. Finally, our data include inpatient consultations only, thus diagnoses more often seen in our outpatient clinics are necessarily underrepresented.

Importantly, analyses based on morning report presentations are subject to selection biases, as the cases residents choose for presentation may be more complex and may overrepresent neurologic disease, as junior residents are presenting to neurology attendings with the aim of learning from their expertise in localization and management. Our results and conclusions need to be considered with this limitation in mind—the cases presented in morning report reflect only a subset of all cases.

<table>
<thead>
<tr>
<th>Table</th>
<th>Case Frequencies</th>
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<tr>
<td>Total cases (n = 1,472)</td>
<td>N (%)</td>
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<tr>
<td>Neurologic cases (n = 1,089; 74.0% of total cases)</td>
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<tr>
<td>CNS by etiology (n = 936; 86.0% of neurologic cases)</td>
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<tr>
<td>Ischemic stroke</td>
<td>292 (26.8)</td>
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<tr>
<td>Seizure</td>
<td>168 (15.4)</td>
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<tr>
<td>CNS NOS</td>
<td>116 (10.7)</td>
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<tr>
<td>Primary headache</td>
<td>90 (8.3)</td>
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<tr>
<td>CNS neoplasm</td>
<td>79 (7.3)</td>
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<tr>
<td>Multiple sclerosis/demyelinating</td>
<td>62 (5.7)</td>
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<tr>
<td>CNS infection</td>
<td>32 (2.9)</td>
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<tr>
<td>Subarachnoid or subdural hemorrhage/hemorrhagic stroke</td>
<td>62 (7.2)</td>
</tr>
<tr>
<td>Movement disorder</td>
<td>19 (1.8)</td>
</tr>
<tr>
<td>PNS by etiology (n = 153; 14.1% of neurologic cases)</td>
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<tr>
<td>Neuropathy</td>
<td>73 (6.7)</td>
</tr>
<tr>
<td>PNS NOS</td>
<td>41 (3.8)</td>
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<tr>
<td>Radiculopathy</td>
<td>16 (1.5)</td>
</tr>
<tr>
<td>Neuromuscular junction/myopathy/motor neuron</td>
<td>11 (2.1)</td>
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<tr>
<td>Non-neurologic cases (n = 383; 26.0% of total cases)</td>
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<tr>
<td>Medical</td>
<td>246 (64.2)</td>
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<tr>
<td>Psychiatric</td>
<td>99 (25.9)</td>
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<tr>
<td>NOS</td>
<td>28 (7.3)</td>
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<tr>
<td>Ophthalmologic</td>
<td>10 (2.6)</td>
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Abbreviations: NOS = not otherwise specified; PNS = peripheral nervous system.

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<table>
<thead>
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<th>Figure 2</th>
<th>Diagnostic Accuracy</th>
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<tr>
<td>A. Full CTL cohort (n = 1,301)</td>
<td>Neuro vs non-neuro (15.3%)</td>
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<tr>
<td>Neuro vs CNS localization correct (3.4%)</td>
<td>Partially accurate (4.8%)</td>
</tr>
<tr>
<td>Neuro vs CNS localization correct, etiology (11.8%)</td>
<td>Accurate (64.0%)</td>
</tr>
<tr>
<td>B. Ischemic stroke cases (n = 237)</td>
<td>Neuro vs PNS localization correct (3.0%)</td>
</tr>
<tr>
<td>Neuro vs CNS localization correct (3.0%)</td>
<td>Partially accurate (4.6%)</td>
</tr>
<tr>
<td>Neuro vs CNS localization correct, etiology (13.5%)</td>
<td>Accurate (75.5%)</td>
</tr>
<tr>
<td>C. Headache cases (n = 88)</td>
<td>Neuro vs PNS localization correct (2.3%)</td>
</tr>
<tr>
<td>Neuro vs CNS localization correct (2.3%)</td>
<td>Partially accurate (6.8%)</td>
</tr>
<tr>
<td>Neuro vs CNS localization correct, etiology (33.0%)</td>
<td>Accurate (55.7%)</td>
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</table>

Resident accuracy depicted as targets, with degrees of accuracy shown as being increasingly off-target. Accurate diagnoses are shown in green; partially accurate in yellow; and wrong diagnoses shown in orange and red. The wrong diagnoses are subdivided into errors at different stages along the diagnostic pathway, with errors in distinguishing neurologic from non-neurologic disease comprising the outermost ring. (A) Accuracy target for the full CTL cohort (n = 1,301). (B) Ischemic stroke cases (n = 237). (C) Headache cases (n = 88). PNS = peripheral nervous system.
seen and assessed—thus patterns of clinical judgement captured in this study may not reflect diagnostic acumen more broadly. Although our data do not capture all patients evaluated by residents, we have included the entirety of the cases used for clinical teaching in the morning report venue. The analysis spans 6 academic years and more than 1,000 cases with consistency across years, which supports the internal reliability of the results. Future studies could take our CTL approach forward to address the issue of selection bias, for instance by performing a shorter study of several months’ duration closing the loop on all cases, seen by all residents, in every clinical venue. This approach would complement our current study, which evaluated longitudinally all the cases presented in one educational venue, morning report, over several years.

Systematically closing the loop on morning report cases has provided important short-term feedback for residents in the group setting of morning report, allowing for expanded educational discussion facilitated by faculty and senior residents and fostering a culture of continuity and diagnostic humility. Data on a per-resident basis are used in feedback sessions between individual residents and the resident program director to develop a personalized educational plan. More broadly, the CTL methodology in morning report was a component of our adult learning theory–based curriculum, which was found to have a positive effect on Residency In-service Training Examination scores. Further work is needed to assess both subjective (e.g., survey) and objective measures of improved diagnostic acumen in future postgraduate years. We also plan to analyze cases by specific etiology, patient demographics, time of year, patient disposition, and consult venue to pursue multivariate predictors of resident errors that could inform curricular changes. Qualitative examination of incorrect cases may also allow for assessment of the role of cognitive biases (e.g., anchoring or framing) on initial diagnostic accuracy on the group level. CTL methodology is simple to employ, low cost, and can be replicated and expanded upon in other programs. Our findings can guide educational and quality initiatives to improve clinical acumen among neurology residents.

Acknowledgment
The authors thank Dr. Sarah Zubkov and Christine Hannigan; Prof. Emilia Bagiella for data analysis guidance; Ana Ferrer and Karin Cook for assistance with data visualization; the many Mount Sinai residents and attendings who contributed to the dataset; and the patients.

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Disclosure
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Appendix Authors

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<tr>
<th>Name</th>
<th>Location</th>
<th>Contribution</th>
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<tbody>
<tr>
<td>Emily M. Schorr, MD</td>
<td>Icahn School of Medicine at Mount Sinai, NY</td>
<td>Data acquisition, interpretation of data, drafting and revising manuscript for intellectual content</td>
</tr>
<tr>
<td>Rachel Brandstadter, MD</td>
<td>Icahn School of Medicine at Mount Sinai, NY</td>
<td>Data acquisition, interpretation of data, drafting and reviewing manuscript for intellectual content</td>
</tr>
<tr>
<td>Peter Jin, MD</td>
<td>Icahn School of Medicine at Mount Sinai, NY</td>
<td>Acquisition of data, revised the manuscript for intellectual content</td>
</tr>
<tr>
<td>Christine Stahl, MD</td>
<td>Icahn School of Medicine at Mount Sinai, NY</td>
<td>Acquisition of data, revised the manuscript for intellectual content</td>
</tr>
<tr>
<td>Stephen Krieger, MD</td>
<td>Icahn School of Medicine at Mount Sinai, NY</td>
<td>Designed and conceptualized study, data acquisition, analysis and interpretation of data, drafting and revising manuscript for intellectual content</td>
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References
Hypnic headache (“alarm clock headache”) is a primary headache disorder that occurs strictly during sleep, awakening the individual often around the same time of the night. The duration of the episode is 15 minutes to 4 hours, occurring ≥ 10 days/month for > 3 months, without cranial autonomic symptoms or restlessness.¹ This distinctive temporal pattern is helpful in differentiating hypnic headaches from other primary headache disorders that can occur during sleep including migraines, cluster headaches and chronic paroxysmal hemicranias. Additionally, since hypnic headaches typically begin in people over the age of 50, it is important to rule out secondary headaches that also often occur at night such as intracranial tumors, sleep apnea and temporal arteritis. The diagnosis of hypnic headaches is a diagnosis of exclusion and a thorough work up for secondary headaches is needed prior to diagnosis. Common treatments include caffeine at bedtime, melatonin, lithium, and indomethacin.²

References

Submitted by: David Landzberg, MD, Neurology Resident, Emory University Hospital and Swapan Dholakia, MD, Staff Physician, Atlanta VA Medical Center and Assistant Professor of Neurology, Emory University School of Medicine
Drs. Landzberg and Dholakia report no disclosures.

Differential awakening, a phenomenon well described in anesthesiology, occurs after the administration of general anesthesia to patients with an existing attenuated blood supply to the brain or spinal cord.¹² Patients with cerebral ischemia or mass lesions frequently show evolving lateralizing neurological signs upon awakening. These deficits are transient and resolve within 30 minutes in the post-operative period, hence the term “differential awakening.”¹ There are three proposed mechanisms. First, general anesthesia may lodge in the areas affected by the prior insult and escape more slowly compared to healthy brain areas, thereby unmasking focal neurological deficits.²³ Second, previously injured areas might be more sensitive to anesthetic agents, and lastly, secondary pathways that develop following an insult might function only in a completely awake state.²³ This possible pharmacologic effect should be considered when assessing patients with new and transient focal motor deficits in the immediate post-operative period.

References

Submitted by: Bhanu Gogia, Vascular Neurology Fellow at Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, Massachusetts
Dr. Gogia reports no disclosures.