

cnsq IS THE OFFICIAL NEWSMAGAZINE OF THE CONGRESS OF NEUROLOGICAL SURGEONS

congressquarterly

FALL 2022

The Future of **Neurosurgery**

Neurosurgical education, training and care delivery are evolving to meet the challenges ahead.



Congress of
Neurological
Surgeons

6 Neurosurgical Education,
Training, and Care in the
Metaverse

14 Telemedicine: Impact &
Implications

CO-EDITORS:

Co-Editor: Ellen L. Air, MD

Co-Editor: Clemens M. Schirmer, MD

Vice-Editor: Theresa Williamson, MD

EDITORIAL BOARD:

Rushna Ali, MD

Hoon Choi, MD, PhD

Rimal Dossani, MD

Aladine Elsamadicy, MD

Jeremy Hosein, MD

Michael Lawton, MD

James P. Caruso, MD

Khoi D. Than, MD

Scott D. Wait, MD

Han Yan, MD

MANAGING EDITOR:

Michele Hilgart

DESIGNER:

CameronRush, Inc.

CONGRESS OF NEUROLOGICAL SURGEONS

2021-2022 OFFICERS

PRESIDENT:

Nicholas C. Bambakidis, MD

PRESIDENT-ELECT:

Elad I. Levy, MD, MBA

VICE-PRESIDENT:

Alexander A. Khalessi, MD, MBA

SECRETARY:

Martina Stippler, MD

TREASURER:

Daniel J. Hoh, MD

PAST-PRESIDENT:

Brian L. Hoh, MD

CEO:

Regina Shupak

contact: 847-240-2500 or

info@cns.org

CONGRESS OF NEUROLOGICAL SURGEONS MISSION STATEMENT:

The Congress of Neurological Surgeons exists to enhance health and improve lives through the advancement of neurosurgical education and scientific exchange.

Congress Quarterly is the official newsmagazine of the Congress of Neurological Surgeons, located at 10 North Martingale Road, Suite 190, Schaumburg, IL 60173. Members of the Congress of Neurological Surgeons may call 847.240.2500 with inquiries regarding their subscription to *Congress Quarterly*.

© 2022 by the Congress of Neurological Surgeons. No part of this publication may be reproduced in any form or language without written permission from the publisher. Published free of charge for the Congress membership with additional distribution. Send address changes to Congress Quarterly, 10 N. Martingale Road, Suite 190, Schaumburg, IL 60173.



Congress of
Neurological
Surgeons

EDITOR'S NOTE



Ellen L. Air
2021-22 Co-Editor



Clemens M. Schirmer
2021-22 Co-Editor

“Map out your future – but do it in pencil.”

– Jon Bon Jovi

What will neurosurgery look like 10 years from now? If any of us were asked this question 10 years ago,

we probably would have correctly predicted a few things: more widespread use of minimally invasive techniques, robotics, and genetic-based tumor treatments. However, few of us would have imagined a pandemic, dependence on telehealth, or virtual residency interviews. The challenge ahead is to plan for the future while remaining nimble enough to navigate the unexpected. To achieve this, we must think big, drive for excellence, and seek diverse perspectives. This issue of the *Quarterly* explores how the neurosurgery community will recruit, train and practice in the future.

Critical to our future is recruiting the best and brightest. CNS is dedicated to meeting this challenge, continuing to host the Pathways to Neurosurgery program, launched during the 2021 Annual Meeting in Austin, TX. The impact of that focused interaction is highlighted by Chelsey Guzmán and Aroz Laiq Chandio, who share their experiences during this inaugural program. We eagerly await the CNS Foundation's Pathways program in San Francisco. As the pandemic limited one-on-one interactions, Randy D'Amico and David Langer turned to technology to reach a broader audience. The BRAINterns program has now reached thousands of participants across the international spectrum. Throwing a wrench in our best-laid plans, The Match process continues to change. Lola Chambless details these changes and how the SNS is working to address them.

Mara Hoffert zooms out on the broader fundamentals of educating this generation of neurosurgery residents, of which communication is central. Abhishek Ray and colleagues share how virtual and augmented reality may help fill gaps created by work-hour limitations Both are must-reads for anyone involved in resident training.

If the path to neurosurgical practice is demanding, those in practice know the ever-changing landscape of care delivery can be truly arduous. Many now find themselves wanting for more leadership tools to navigate these waters. The CNS Leadership Institute continues to build its programming to meet those needs. Neil Malhotra and colleagues offer a view of the future of telemedicine beyond office visits—if the technology and medical-legal landscape keep up. Speaking of which, Katie Orrico updates us on the state of the regulatory environment and how the Washington Committee fights for neurosurgery. If all the above is stressing you out, Christopher Graffeo and Michael Lawton help us find zen in social media.

The CNS is excited to welcome Doug Kondziolka to the helm of NEUROSURGERY Publications! With the help of Matthew McPheeters, he shares his vision for the future.

There will be challenges and unknowns, but drawing a map is a start, even if in pencil.

CONTENTS



Editor's Note

Ellen L. Air, Clemens M. Schirmer

President's Message

Nicholas C. Bambakidis

THE NEUROSURGERY PIPELINE

4 Pathways to Neurosurgery: Two Aspiring Neurosurgeons Share their Experiences

Chelsey Guzmán, Aroz Laiq Chandio

6 Neurosurgical Education, Training, and Care in the Metaverse

Randy S. D'Amico, David J. Langer

8 The Match of the Future: How Will We Recruit the Next Generation of Neurosurgeons?

Lola Chambless

LOOKING AHEAD: HOW WE LEARN

10 Keeping Neurosurgical Education Sharp and Focused: Communication is Everything

Mara M. Hoffert



12 The Future of Neurosurgical Education

Abhishek Ray, Krystal Tomei, Warren Selman, and Brian Rothstein

LOOKING AHEAD: HOW WE DELIVER CARE

14 Future of Care Delivery: The Impact and Implications of Telemedicine

Neil Malhotra, Clemens Schirmer, Ryan Gallagher

16 Zen and the Art of Neurosurgery Social Media

Christopher Graffeo, Michael Lawton

DEVELOPING NEUROSURGEON LEADERS FOR THE FUTURE

18 The CNS Leadership Institute: Developing the Next Generation of Neurosurgeon Leaders

Ellen Air, Brian Nahed, Anand Veeravagu

20 Journal Feature: *Neurosurgery*: the Future of Publishing

Matthew J. McPheeters, Douglas Kondziolka



22 Washington Focus: The Future of the Regulatory Environment

Katie Orrico

FOUNDATION UPDATE

24 CNS Foundation Update

Alexander A. Khalessi, Martina Stippler

INSIDE THE CNS

27 Washington Committee Report

Katie O. Orrico

CNSQ INSIDE BACK COVER

Images in Neurosurgery

PRESIDENT'S MESSAGE



Nicholas C. Bambakidis, MD
President, Congress of
Neurological Surgeons

Neurosurgery has always been a field of rapid advancement and innovation, and the Congress of Neurological Surgeons has long been recognized for its innovative approach to delivering content and experiences that match our members' current practice challenges. At a time when everything from patient demographics and expectations to payment models are shifting, it is essential that neurosurgical education, training and care delivery evolve to meet the challenges ahead.

If the past few years have taught us anything, it is that life is ever-changing and we can never become complacent, or assume

that our past successes will carry us into the future. Rather, we must constantly adapt to the world around us, never ceasing to strive for excellence in all we do. Given CNS' incredible success adapting our educational offerings over the past three years to meet our members' needs at every stage of the pandemic, I am confident that our organization is poised to continue delivering the right tools and services, innovating in new ways in the years ahead. This issue of *Congress Quarterly* looks at the Future of Neurosurgery, and provides a thoughtful overview of the work many of our members have undertaken to move our specialty forward.

CNS
Virtual Visiting Professor

Stacey Quintero Wolfe
Wake Forest School of Medicine

Title: Surgical and Endovascular Approaches to Intracranial Dural Arteriovenous Fistulae: Pearls and Pitfalls
Date: April 29, 2020
Time: 7:00 am PDT / 9:00 am CDT / 10:00 am EDT

Congress of Neurological Surgeons
Virtual Morbidity and Mortality Conference

Meet your ABNS requirements with the CNS' new Virtual Morbidity and Mortality Conference. This live, quarterly session allows registered participants to submit, present, and discuss their own cases and complications in a small, private HIPAA-compliant online setting.

Monday, May 11
2:00 pm PDT / 4:00 pm CDT / 5:00 pm EDT

To register and submit your complications for this webinar, please complete and submit the form by **Wednesday, May 6**.
Members: \$75 / Non-members: \$125
This activity has been approved for 1.5 AMA PRA Category 1 Credit™

Learn more at cns.org/MandM

CNS
Navigating the Neurosurgery Match in 2020

Tuesday, October 6
5:00 pm PDT / 7:00 pm CDT / 8:00 pm EDT
What to Do After Interviews

Faculty: Constantinos G. Hadjipanyis, Gregory J. Murad, Jamie J. Van Gorpel
www.cns.org/navigating-the-neurosurgery-match-in-2020

Expert faculty will discuss appropriate post-interview contact, including when to write thank you notes and how to follow up; express interest in a program; solve unanswered questions; and learn more about a program of interest.

Thank you to Kuros Biosciences for their support of this session. Kuros Biosciences

Over the past 3 years, the CNS Education Division has adapted our offerings to meet our member's needs throughout the pandemic.

> WE MUST CONSTANTLY ADAPT TO THE WORLD AROUND US, NEVER CEASING TO STRIVE FOR EXCELLENCE IN ALL WE DO. <

I was especially inspired by the article written by Chelsey Guzmán and Aroz Laiq Chandio on their experiences in the CNS Foundation's Pathways to Neurosurgery program. This program, along with the Leadership Institute program profiled later in the issue, perfectly represent CNS' efforts to cultivate the next generation of neurosurgeons and neurosurgical leaders, bringing diverse perspectives to the forefront of our specialty to foster continued innovation in the field. Seeing the impact we have had on these individuals' careers in the field is incredibly rewarding. I look forward to seeing what these authors bring to our specialty in the years ahead.

The articles shared by Drs. Kondziolka and McPheeters on the future of neurosurgical publishing, and by Katie Orrico on the future of payments are also enlightening and will help our members prepare for what's ahead. I am grateful to these leaders, as well as the many volunteers on our NEUROSURGERY Publications Editorial Boards and the Washington Committee for their work in guiding the CNS in these critical areas.

Whatever the future brings, I hope you will continue to look to the CNS to help you stay abreast of new developments and adapt your practice to meet the new challenges. Even as technology becomes more ubiquitous, and we continue to innovate the way we deliver education and training for surgeons at all stages of their careers, what remains constant is the value of connecting with one another. I, and the CNS, remain committed to helping you connect with your colleagues across the country and around the world in new ways. I encourage you to share your needs and concerns with us, so that we may continue to innovate and provide the services you need to

be successful in your neurosurgical career. You can reach out to me at info@cns.org or contact a member of our headquarters staff at 847-240-2500 to convey your ideas.

It has been a great honor and a very humbling experience to serve as President of your Congress of Neurological Surgeons over the past year. I look forward to seeing you in San Francisco, as we come together again and continue to explore this theme of interconnectedness. Judging by our record-setting 2,363 abstract submissions and the tremendous efforts of our scientific program committee, I think we are positioned to have our most successful meeting ever, impacting our field now and into the future. ■

STAY CONNECTED



https://twitter.com/CNS_Update



<https://www.facebook.com/cns.update>



https://www.instagram.com/cns_update



<https://www.youtube.com/user/cnsvideolibrary>



Chelsey Guzmán



Aroz Laiq Chandio

Pathways to Neurosurgery: Two Aspiring Neurosurgeons Share their Experiences

In early 2021, the CNS Diversity, Equity and Inclusion Committee set a focus on three key objectives—among them, to lower barriers to recruiting a diverse neurosurgical residency applicant pool. It was an ambitious goal, and one that our specialty has grappled with for some time; however, the committee sought to achieve short-term, tangible results by developing a new program with a local focus. The Pathways to Neurosurgery Program was launched in conjunction with the 2021 CNS Annual Meeting in Austin, through a unique collaboration with Breakthrough in Central Texas and Rosalind George, the wife of the late Dr. Timothy George, who was the Chief of Pediatric Neurosurgery at Dell Medical School in Austin and a well-respected mentor and champion for aspiring neurosurgeons in underrepresented populations.

The Pathways program, now under the purview of the CNS Foundation (CSNF), pulls local high school students, with a focus on students underrepresented in medicine, to participate in a one-day immersive experience alongside CNS Annual Meeting attendees and respected faculty. The Foundation is proud of the collaboration created with local nonprofits already working with students interested in a career in science. The students will have the rare opportunity to receive real-world feedback and encouragement from neurosurgeon leaders. This article highlights the personal experiences of two students who participated in the 2021 program in Austin.

Chelsey Guzmán – 10th grade St. Stephen's Episcopal School

Since I was nine, I have dreamed of becoming a neurosurgeon, although the path was unfamiliar to me. The Pathways to Neurosurgery program is teaching me how to achieve my goal.

In my early years, both my parents and my Taekwondo instructor mentored me and invested in my success. Ever since I can remember my parents have done their best to support my interests, from exploring new musical instruments to trying new sports. They always encouraged me to do what I enjoy and never quit. I started Taekwondo when I was seven. I was very shy, and scared to go out of my comfort zone, but I soon met a community and an amazing

instructor that was welcoming and encouraging. Now as I go through high school, I am looking to take this person I have become and turn her into a neurosurgeon. I recently had the opportunity to be a part of the Pathways to Neurosurgery program and was then selected as a recipient of the Neurosurgery Experience award.

Through the program, I had the opportunity to hear Dr. Mae C. Jamison who was eye opening and inspiring. She was the first African American woman to go to space, she was a reminder that nothing is impossible if you have enough determination. During her talk, she used two quotes that have stuck with me and impacted my perspective. The first quote was "Science has found no remedy for the worst (evil) of them all—the apathy of human beings" by Helen Keller. This quote reminds me that nothing is black and white, and that with enough care and effort you can achieve anything you want. Later in her lecture she said, "the extreme nature of interstellar hurdles requires we re-evaluate what we think we know." I interpreted this quote to mean that everyone is human and every individual has their own strengths and weaknesses. Life is always going to give you new challenges but with hard work it is always possible to overcome them.

Moreover, participation in a number of hands-on sessions provided a simplified view on tasks neurosurgeons do on a daily basis. I had an opportunity to practice placing sutures and placing screws and rods into a spine replica, to use tools such as a cranial drill, and to learn about stereotaxy. This left me with an interest for OR exposure. Dr. Tyler-Kabara, has given me insight into the life of a neurosurgeon. She welcomed me and allowed unlimited questions on her career path. Working with her increased my understanding of the path that I hope to take.

I felt both intimidated and inspired throughout my experience in the program. I was intimidated when they broke down for us the typical requirements needed for residency, and neurosurgery training. Although the idea was daunting, it was also very helpful to have a clear plan of what is needed to pursue a career in the field of neurosurgery, and inspiring to imagine what my future will look like. One of the neurosurgeons that spoke to us gave us a rundown of

her everyday schedule, and routine. She explained that she still had time for her family throughout her day. Knowing that you can have a balance between the two was very insightful.

During lunch, I was seated with a group of high school students along with a student from the University of Florida. She answered our questions about the path to neurosurgery, spoke to us about her experience and what her academic life looked like in high school and now in college. She was also kind enough to provide us with her email to further contact her. I found this aspect of the meeting very comforting; it reminded me that this career path is possible, and that others are pursuing and succeeding in it.

Some skills that I think will ensure my success moving forward are perseverance and an indomitable spirit. Perseverance is something that will help me continue the rigorous path towards my career in neurosurgery. The term indomitable spirit was introduced to me in Taekwondo. I interpret it as a reminder to keep going everyday although the odds might be against you.

To receive this award feels surreal. I am so incredibly grateful to receive an opportunity such as this one. I will become a neurosurgeon. Looking back at Helen Keller's quote, "Science has found no remedy for the worst (evil) of them all - apathy of human beings." As Mae C. Jameson stated, the resources are available, I must grasp at every opportunity that comes my way.

Aroz Laiq Chandio – 10th grade at Manor New Tech High School

For the entirety of my life I've always wanted to help people and pursue a career in the medical field. I began to research and learn what I would enjoy pursuing as a career. So naturally I took any opportunity in which I could gain experience and learn what I would be interested in. I can confidently say that The Pathways to Neurosurgery program was by far one of the most enjoyable things I could have been a part of in the 2021 fall semester. It really introduced me to what the field of Neurosurgery is and what Neurosurgeons do. The program was well organized so it gave each one of the students who attended an equal chance to learn and explore from the stations and individual experiences from other neurosurgeons.

One of the initial things we did was hear a speech from the first African American woman to go to space, Mae Jemison. Hearing from someone like her at this program was not only surprising, but also very cool. Another thing that caught my interest were the videos by the other speakers on the future and advancement in neurological surgery.

The best and most anticipated part of the event was the hands-on station. It had all sorts of tools and models which I have never seen before. Regardless if you learn better with hands-on experience or not, the stations were a fun way to learn about the tools and different operations conducted by professionals. The stations showed us the



x-rays and MRI scans used to get a visual inside of patients' heads and spines. The stations also displayed how neurosurgeons insert screws, plates, and rods used between spinal vertebrae. We also got to use drills and learn how to drill holes through the human skull. One of the more difficult things that I found was to insert the stitching. One of our supervisors showed me how to put in the stitches, but I found it very difficult and messed up in the end, but regardless it was very fun, and more importantly I learned a lot from it.

Another thing that I really liked was that the surgeons sat down with us during lunch and we just had normal conversations. Usually, talking face to face with the surgeons, I would have felt intimidated and wouldn't have tried to talk as much but the nice woman who sat with us made our lunch enjoyable and quite comfortable. The woman who sat with us talked about her journey and the education she pursued for her career choice. We also talked about our own current educational situations. The high school students who sat with me also were taking college courses with Austin Community College, which left us some middle ground to talk about.

I am very grateful that I was presented with this opportunity. Even if you're someone that doesn't currently want to professionalize in a medical related field, let alone Neurosurgery, I recommend you participate because you can learn a lot and maybe even develop an interest. ■

The CNSF will hold the Pathways to Neurosurgery program again this fall in San Francisco. We are excited to meet the next class of future neurosurgeons and to share all we love about this field with them. To learn more, or to volunteer with the Pathways to Neurosurgery program, visit foundation.cns.org/volunteer.

Special Thanks to Drs. Tiffany Hodges and Theresa Williamson for their help with this article.



Randy S. D'Amico, MD

David J. Langer, MD

Neurosurgical Education, Training, and Care in the Metaverse

We live in an increasingly digital world. The internet, multimedia and social media are ubiquitous, and increasingly sophisticated video, audio, and internet presentations enable delivery of high-quality virtual educational and informational content to interested masses. As a result of these advances, concurrent with advances in cloud-based storage technologies, there now exists access to a digital library of almost limitless content available in both synchronous and asynchronous formats. These advances have further translated into high-quality, web-based educational seminars and web-based educational mobile applications available across a variety of platforms, allowing broad consumption of curated information for the general public as well as for targeted audiences.

The COVID-19 pandemic and its associated social distancing mandates served as a catalyst for the rapid adoption of these web-based, virtual methods of information distribution within medicine, and specifically within neurosurgery. The pandemic put a stop to many traditional in-person health care experiences in an effort to limit infectious spread of COVID-19. These ranged from traditional medical education experiences and methods of residency training to

clinical interactions, as many practices rapidly adopted telemedicine to ensure continuous, uninterrupted care with patients. As a result, the past two years have laid the foundation and a roadmap for the future distribution of medical education and health care information for both practitioners and patients.

Medical education has traditionally relied on in-person shadowing and mentorship for career development. However, opportunities for physician shadowing and access to operating rooms often favor those with existing personal relationships with individual physicians or institutions, ultimately conferring advantage to traditionally represented populations. The restrictions of the pandemic effectively put a stop to these traditional in-person experiences, resulting in an expansion of alternative educational modalities, particularly within medical education for students at all levels of training and from all backgrounds and cultures.¹

Specifically, as a result of the disturbances created by the COVID-19 pandemic, a number of successful web-based educational initiatives were created, particularly within neurosurgery such as the Barrow Base Camp series and the Miami Global Brain Tumor

> NEUROSURGERY HAS ALWAYS EMBRACED AND RELIED ON TECHNOLOGY TO IMPROVE CLINICAL OUTCOMES. AS WE MOVE FORWARD IN AN INCREASINGLY DIGITAL WORLD, THE FUTURE OF NEUROSURGICAL EDUCATION AND PATIENT CARE WILL RELY ON NEUROSURGEONS PUSHING FORWARD AT THE CUTTING-EDGE OF THE INTERSECTION OF TECHNOLOGY, NEUROSURGICAL EDUCATION, AND PATIENT CARE. <

Conference. At Lenox Hill Hospital/Northwell Health, we created the “BRAiNterns” (www.braininterns.com) webinar series in 2020 and repeated the series in 2021.¹

BRAiNterns is a free, virtual, interactive web-based educational program that brought together medical educators to cover concepts spanning health care education. Lectures included traditional didactics and incorporated high-quality multimedia presentations as well as operative videos allowing the operating surgeon to teach pathophysiology, anatomy, surgical techniques and to explain outcomes. Using social media marketing strategies, we enrolled over 16,000 participants in 2020 and another 16,000 in 2021 with daily synchronous participation on the Zoom platform of on average of 2,000 live users. Participants came from over 100 unique countries and most notably, 66% of the participants in the second year of the program were first time registrants. Importantly, over two years we saw that the demographics of those involved in our program demonstrated majority participation from traditionally underrepresented populations such as women who made up 80% of our participants and minorities which made up a total of 63%.¹

The success of BRAiNterns over the past two years suggests the durability of web-based education moving forward in a post-pandemic world. Furthermore, it highlights the power of web-based educational content to improve the visibility of neurosurgery across a diverse population of students. The population of health care providers is changing, and as educational infrastructure adapts, it is critical to adapt to the needs and concerns of these interested, motivated, and talented students when designing educational programs. Given the virtually limitless storage of educational data provided by the current digital media, these programs can and should be adapted to the level of education and interests of the target population. The future success of health care in general and neurosurgery specifically to attract the most gifted students is predicated on our ability to grow and incorporate virtual education into our outreach and educational structure.

BRAiNterns and similar web-based content can also augment resident education as the complexity of the material available online can be appropriately tailored to the level of education of the participant. Further advances in mixed reality platforms will likely further enhance training for neurosurgical residents.^{2,3} In addition to the limitations imposed by the pandemic, resident training hours have reduced to 80 hours per week. Neurosurgical education committees have attempted to use mixed reality surgical simulators to augment current training. Mixed reality technologies using virtual reality and augmented reality visualization methods may improve unsupervised instructional training and objective procedural skill assessments. Mixed reality simulators have been applied for training in ventriculostomies, bone drilling, percutaneous trigeminal

rhizotomy, pedicle screw placement and lumbar puncture. Recent evidence also supports that mixed reality systems can provide more engagement and motivation for residents in an era of distanced learning. Importantly, capitalizing on advances in digital technologies means that training can be completed locally or remotely in a distanced learning environment as residents can receive training and feedback without the physical presence of attending neurosurgeons.

Lastly and most importantly, the ability to provide immediate, multimedia digital information to patients anywhere at any time stands to improve clinical care. Effective patient-surgeon communication and patient satisfaction are associated with improved clinical outcomes, better treatment compliance, decreased readmission rates and a decrease in the number of physician targeted lawsuits.² Providing effective communication and ensuring patient satisfaction is critical in neurosurgical patients where surgical anxiety affects nearly 90% of patients. In addition, anxiety worsened by ineffective communication may actually increase surgical and anesthetic complications. A number of mobile, patient centered apps, such as Playback Health⁴ function to empower patient engagement in their own care as well as to share large amounts of information quickly to families and providers with the hopes of increasing understanding of conditions, improving communication and subsequently, improving a patient’s overall surgical experience. Using Playback Health, patients engage in their own clinical care using a mobile platform built to receive, replay, and share health information. Physicians can upload digital asynchronous audio and video content, screen recordings of images, and clinical documents as well as create patient-specific or general disease and treatment information and multimedia, allowing for rapid communication with both patients and providers.

Neurosurgery has always embraced and relied on technology to improve clinical outcomes. As we move forward in an increasingly digital world, the future of neurosurgical education and patient care will rely on neurosurgeons pushing forward at the cutting-edge of the intersection of technology, neurosurgical education, and patient care. The future is virtually limitless. ■

References:

- 1 D’Amico RS, Immidisetti AV, Katz J, White T, Bedi A, Baum G, et al: Web-Based Education and Social Media Increase Access to Careers in Neurosurgery: The Lenox Hill Hospital BRAiNterns Experience. *World Neurosurg* 150:e445-e465, 2021
- 2 Carter J, Ward C, Wexler D, Donelan K: The association between patient experience factors and likelihood of 30-day readmission: a prospective cohort study. *Bmj Quality & Safety* 27:683-690, 2018
- 3 Dadario NB, Quinoa T, Khatri D, Boockvar J, Langer D, D’Amico RS: Examining the benefits of extended reality in neurosurgery: A systematic review. *J Clin Neurosci* 94:41-53, 2021
- 4 Playback: in, Vol 2022, www.playbackhealth.com



Lola B. Chambless, MD

The Match of the Future: How Will We Recruit the Next Generation of Neurosurgeons?

The future of neurosurgery will be written by people we have not yet met. These are our medical students, our undergraduates, and other young people who are only beginning their exploration of science and medicine. The charge of the Medical Student Committee of the Society of Neurological Surgeons (SNS) is to help shape the future of our specialty by attracting the right people to our field, providing them access to education and mentorship, and helping to deliver them successfully to our residency training programs where they will be shaped into expert surgeons and leaders. This is a daunting, mission-critical responsibility. It was with gratitude and trepidation that I took over the role of Chairperson for this committee in May 2022, following in the footsteps of a tremendous leader, Stacey Wolfe, MD.

I inherited from Dr. Wolfe a group of excited, motivated, and highly engaged committee members who are interested in fixing the major issues facing our students. Some of those issues preceded the COVID-19 pandemic, but it is also clear that this disruptive force has brought additional serious problems to the fore. Through careful study and iterative changes, our goal is to make the neurosurgery match work better for our students and our profession.

To put it bluntly, The Match is out of hand. While the match rate for US Seniors entering neurological surgery has been essentially stable for many years, the amount of time, money, and stress expended on the process has ballooned. The experience should indeed require significant and thoughtful investment from all sides, but the current system has the potential to undermine our goal of placing well-prepared students into appropriate residency positions.

Let's first consider the time a student dedicates to The Match. In 2022, a typical fourth year medical student will spend three to four months of their year on dedicated neurosurgery rotations at home and elsewhere, often starting in May. Over the summer, they will also work long hours on their residency application, as well as the new supplemental application which can include up to as many as nine additional new essays. They will squeeze in USMLE Step 2, along with some dedicated study time, as the transition of Step 1 to Pass/Fail means many programs will want to see Step 2 scores before offering interviews. They will do their best to attend the various virtual meet-and-greet events hosted on evenings and weekends showcasing

different residency programs, both to indicate their interest and to try to figure out where to send their eight "preference signals." No doubt they will also devote many hours to finalizing research manuscripts, hoping to submit them in time for inclusion on their application.

From October to January, they will interview. Many of these opportunities will be virtual, limiting the time needed to travel. However, survey data from the COVID-19 era tells us that this simply means applicants go on more interviews, generally as many as they possibly can based on their number of invitations and their schedule. A sizeable proportion of applicants attended >35 virtual interviews in 2020/21. So, of course these months must be free of other responsibilities, including most other medical school rotations.

In the latest adaptation to the COVID-19 Pandemic, February will bring optional "campus visits" to those programs that interviewed virtually. These must be performed between Feb. 1- Feb. 28. While we advise students that these are entirely optional and should only be used to answer their lingering questions about specific programs, I expect we will see students crisscrossing the country to attend many of these sessions at significant time and expense. This is of course another month where rotating on a clinical service would be impossible for many.

By the time The Match arrives in mid-March, our future neurosurgeons will have spent their entire fourth year on this endeavor. They will have struggled to fit in a few medical school requirements and failed to experience clinical subjects they will never again get to see. They will have spent up to \$3,000 on their ERAS application (a common application which nonetheless costs up to \$26/program applied) as well as substantial funds on housing and transportation for months of away rotations and a flurry of campus visits. In the pre-pandemic era, it was typical for most students applying in neurological surgery to take out specific loans for this process, with many reporting a total expenditure of \$20,000-\$30,000 in 2019. A quick look at short term rental rates and airline ticket prices suggests this could be much worse today.

From the program perspective, the situation is also dire. With applicants applying ever more broadly, programs receive ever more applications. My program, Vanderbilt, now receives applications from more than 95% of candidates. That means well over 300

applications require holistic review by two separate faculty members in an attempt to do justice to our candidates' unique strengths. Objective measures of an applicant's abilities are scant with letter grades, USMLE scores, and metrics like AOA disappearing. Quality assessment of applications takes an incredible time commitment from busy faculty.

To introduce our program to candidates, we now produce videos or participate in virtual events. In addition to blocking faculty and resident time for interview days, these faculty members must also now be available during campus visits. We have calculated the cost to the department of shutting down elective practice for an interview day, and it is dramatic. Adding campus visits to virtual interviews of the same candidates means even more revenue loss for the department. We are lucky to be a department with outstanding educational resources, including two full-time administrators, whose efforts are largely focused on residency recruitment for many months of the year. We believe that in general, money spent on resident recruitment is money well spent. Yet, as a specialty, we have not yet analyzed the financial effects of match trends on departments educational budgets intended largely to support those residents who are already with us. These funds are not limitless, and the more time educational leadership and other faculty spend away from revenue-generating clinical practice, the more budgetary pressure is created.

It is important to recognize there are parties involved in The Match beyond neurosurgeons and applicants, most importantly the Association of American Medical Colleges (AAMC) and National Resident Matching Program (NRMP). Any proposed reforms must be negotiated within their guidelines and outright requirements. Yet, there is momentum toward the realization of more specialty-specific match processes and this is where the SNS Medical Student Committee will focus our efforts. Over the next two years we intend to work towards these goals:

- Right-size the number of applications submitted and interviews attended per applicant through processes such as preference signaling or caps.
- Provide early guidance to students about fourth year rotations and USMLE exam scheduling to promote a more balanced and educational final year of medical school.

- Provide residency programs resources and information to help design a more efficient recruitment process, with the hope that cost savings could be invested back into the applicants through support for travel expenses, housing during rotations, etc.
- Advocate for in-person interviews as an option for programs who wish to conduct them.
- Develop an educational research collaboration between residency programs to analyze our applicant data at a granular level to better assess the issues inherent to the neurosurgery applicant pool.

Neurosurgery faculty may be feeling whiplash at the rapid changes to The Match since the pandemic began. Hold on, because the changes are still coming. As I write this article, we just received notice the NRMP is requesting comments regarding a "two phase" match in 2024, and we are considering our response. It is clear the transition from medical school to residency is evolving throughout medicine. It is helpful, though, to remember we were already seeing troubling trends prior to pandemic in terms of vanishing means of objective applicant assessment, increasing numbers of applications per applicant, and ballooning costs. The changes at hand represent the opportunity to not just return to the pre-pandemic era but to create a process that is more effective, efficient, and equitable than any system we have ever had. I believe the future neurosurgeons, who rely on us to get this right, have every reason to be confident in the neurosurgical leadership. At our May SNS Committee meeting I marveled at the energy and enthusiasm of 40+ colleagues discussing and innovating around these problems. Our field has a well-earned reputation for a commitment to education, and we have every reason to be excited for the future of neurosurgery. ■



Mara M. Hoffert, PhD

Keeping Neurosurgical Education Sharp and Focused: Communication is Everything

Best practices in neurosurgical education are cyclical, with newly developed approaches often tracing back to the fundamental elements of effective instruction. Neurosurgeons learn in many ways, such as through one-on-one mentorship, peer-to-peer interactions, conducting research, and engaging in patient interactions. Within these learning situations, effective communication and interpersonal skills are essential. Speaking to the future of neurosurgical education, I would suggest several critical components that medical educators must never lose sight of: Fostering meaningful relationships; Creating safe spaces; Promoting instructional best practices; and Incorporating actionable, timely, consistent assessments. These concepts should work in concert to ensure that neurosurgery education will continue to meet the needs of aspiring neurosurgeons and their patients. Here, I will focus on these often overlooked competencies, which lay the foundation for the development of stellar neurosurgeons.

Fostering Meaningful Relationships

In my conversations with attendings, concerns regarding generational differences between faculty and trainees often come up. I believe that the solution to most of these matters is transparency. Today's trainees want to know that what they do matters and why. They are not a generation that falls in line simply "because we said so." They do not believe that because "you did it that way, they should too." Trainees now demand a valid, applicable rationale to why they are being asked to perform certain tasks. For these reasons, fostering meaningful relationships across generations can be difficult without a commitment to appreciating the unique needs of trainees and meeting them where they are.

At Henry Ford Health, I am lucky to have the support of forward-thinking leaders who encourage me to create cutting-edge Graduate Medical Education programs. During the process of enhancing our medical education systems, we found that high-impact instruction for teaching physicians how to foster meaningful relationships works best when elements of mentoring, coaching, and growing a physician identity are used: concepts that are essential for promoting a growth mindset.

We first created a structured mentorship program, with a systematic approach that engenders mentor-mentee relationships more quickly than traditional, ad hoc mentoring. But while physicians are familiar with the more hierarchical mentorship approach to training, we realized that coaching would be yet another valuable educational tool for them to use with trainees. Therefore, several of our Instructional Designers underwent training to become International Coaching Federation certified coaches. With this gold standard training, Instructional Designers reimagined a new instructional program to teach physicians "Coaching as a Communication Skill." Coaching interactions involve inquiry and interactive dialogue over overt instruction, and this approach fosters a strong bond of trust between attendings and trainees. Although physicians do not become certified, master coaches, they do learn how to expertly use key coaching behaviors for empowering trainees to take control of their own personal and professional growth. Finally, we created an innovative program to help trainees deliberately and thoughtfully form their professional physician identity. Here, physician leaders engage in conversations about their professional experiences with trainees, helping junior physicians plan career goals and connect with other professionals who can be approached for support throughout the trainees' medical careers. By including physicians at all levels of experience within these programs, we are establishing a common language for the discussions that take place during the vast process of medical training. However, for these discussions to be effective, they must take place within a safe space.

Creating Safe Spaces

Neurosurgeons are no strangers to risk, and the best education takes place when measured risks are permitted. This cannot happen without a safe culture. Intentionally integrating diversity, equity, and inclusion principles into educational practices fosters safe spaces for optimal learning. This approach goes beyond merely understanding microaggressions and bias; rather, neurosurgeons must recognize and reflect upon their own microaggressions and bias, understanding that they, like all people, have these human traits, and that they can recognize when biases arise and pivot their behavior to deliver

the most optimal, equitable care. Achieving this skill is crucial for developing a growth mindset and a truly inclusive practice, thus creating safe spaces.

Feedback is another critical component of establishing safe learning spaces. With physician input, we created an easy-to-use institutional feedback model, which is structured as a two-way conversation that invites commentary and learning from all stakeholders. In this approach, trainees are prompted that they are receiving feedback, and the tool's structure allows for timely, specific, consistent feedback prior to evaluative moments in the trainee's career. The consistency and openness of these conversations leads to a culture of safety for learning and growing as a neurosurgeon.

Promoting Instructional Best Practices

Neurosurgeons thrive on systems thinking. To that end, a well-planned educational pipeline can create meaningful and sustainable interactions. Physicians at academic institutions are thrust into a world in which they must educate others and where they are expected to intrinsically know how to teach. At Henry Ford Health, we believe that faculty must stay up-to-date with best educational practices and that trainees should also be prepared as educators.

One of our institution's most successful educational initiatives has been our five-part Teaching Essentials Endorsement Program. We synthesized adult learning theories with the Charlotte–Danielson teaching framework to create educational sessions on clinical instruction, giving and receiving feedback, dynamic leadership, instruction and assessment, and cultural humility. All sessions are implemented collaboratively with physician facilitators and include learner-centric activities. The courses stress team-based, collaborative learning and empower medical educators to move from a strictly didactic format to an interactive one, where learners take ownership of their learning with guidance; this enables learners to experientially apply skills to generate behavioral change. When trainees take ownership of their learning, they transform knowledge into skill. After completing the program, participants can opt to have educational scholars observe them in a teaching encounter and receive feedback on their teaching practice. The demand for this program from both faculty and trainees has been so high that we developed an advanced teaching program that includes advanced feedback and evaluation techniques, how to assist struggling learners, and how to develop medical education simulation exercises.

One interesting potential barrier to neurosurgical education is that today's learners have grown up with more screen time than their instructors have. This generational difference means that trainees may not always interact with others in a manner familiar to senior attendings. The pandemic furthered the presence of technology

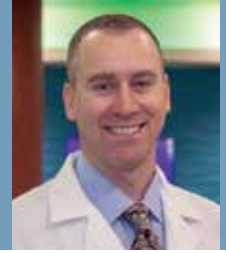
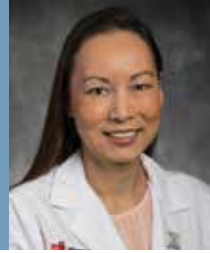
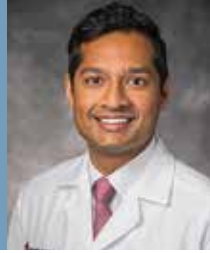
in medical education, and while remote learning has risen out of pandemic-related needs, we should be careful not to fall back on remote learning out of convenience. Rather, we must pursue best educational methods to ensure that the new generation of physicians have both the intrapersonal and interpersonal skills necessary for connecting with patients. Medicine does not exist in a vacuum, and best medical care demands human connection.

Incorporating Actionable, Timely, Consistent Assessments

Lastly, formative and summative assessments are equally important within a robust neurosurgical educational framework. Understanding the distinct roles of feedback and evaluation in education can help shape culture and deliver the necessary data for evaluating trainees' competence and for determining the effectiveness of the neurosurgical teaching program. Implementing the structured, formative feedback process discussed previously fosters an open environment and creates a culture where all stakeholders appreciate actionable, timely, consistent feedback. When the time comes for summative evaluations within a feedback-friendly culture, marked improvements are common and unpleasant surprises are rare. Involving trainees and faculty together to discuss each party's roles and expectations within the feedback process is the first step in fostering an educational environment in which growth is encouraged and fostered.

Considerations of Neurosurgical Education – The Evolution of Training and Care Delivery to Meet Challenges Ahead

Neurosurgery is, by nature, extremely complex, and this discipline demands that practitioners develop keen physical, intellectual, and psychological skills. Thus, neurosurgery attracts some of the most talented physicians whose instructional contributions can pave the way for innovative medical education. To nurture excellence in tomorrow's neurosurgeons, the physicians who train the next generation must be able to adapt within a context of new technologies and scientific knowledge, as well as within a culture of trainees who have grown up within a unique cultural milieu marked by a pandemic, computer screens, and distance learning. Using educational approaches grounded in helping trainees develop excellent communication and interpersonal skills will be the key to future progress in neurosurgery. Fostering meaningful relationships, creating safe spaces, promoting instructional best practices, and incorporating timely, actionable, consistent assessments will be the critical brick and mortar of a successful neurosurgical educational edifice. ■



Abhishek Ray, MD

Krystal Tomei, MD

Warren Selman, MD

Brian Rothstein, MD

The Future of Neurosurgical Education

Introduction

While general adherence to the principles of Halstead's surgical residency have produced excellent trainees, neurosurgeons have always had a keen interest in improving the process of neurosurgical education.

This year marks the fiftieth anniversary of the publication of The Special Emphasis Panels on The Education of a Neurosurgeon. The Society of Neurological Surgeons (SNS) convened these special emphasis panels specifically to elevate neurosurgical resident education.^{1,2}

Their vision was that the neurosurgeon of the future, on completion of their prescribed training will be like El Greco's "St. Paul with a Book, whose finger marks the last page read and on his face are the wonder and will to understand after the book is closed."

In 2007, Dr. John Popp noted in his Presidential Address to the SNS that navigating the complexities of resident training was like Magellan's Voyage where he found a series of channels and inlets, not the simple straightforward westward passage that was imagined at that time.³

To achieve an elevation of neurosurgical education to meet the challenges of this reality, Dr. Popp believed that the first step was to create a new comprehensive curriculum, which would have a core to be mastered by all, would contain both cognitive and procedural elements, and most importantly...would be able to evolve.

In conjunction with the Congress of Neurological Surgeons, the SNS, with the help of all the major neurosurgical organizations just published such a curriculum.⁴

In this article, the authors will summarize new theories on adult learning and how differences in learning style may necessitate novel approaches to teaching this new curriculum. We will also look at how the development of novel technology using both virtual reality and augmented reality may provide unique opportunities to elevate neurosurgical education throughout a neurosurgeon's lifetime.

Adult Learning Theory and Learning Styles

When considering resident education, it is imperative to differentiate the education of adults from the education of children. Adult learning theory runs parallel to the concept of lifelong learning

in medical education. Namely, that the adult learner should seek intrinsic rather than extrinsic motivating factors for learning.⁵ Rarely is this more apparent than in medicine where our motivation to learn centers around improving our ability to treat and heal our patients. This knowledge that we are learning so that we may treat others, as well as the real-life scenarios that residency affords, where residents carefully balance the scales between service and education, meld well into adult learning theory and the development of skills in lifelong learning.⁶

Additionally, while the educational mantra of old, "read more," may ring true for some learners, additional understanding of learning styles suggests that we as educators benefit from flexibility in adapting our teaching styles to match the optimal learning styles of our residents. Neil Fleming developed the VARK model, categorizing learners based upon their preferential learning style(s): visual, aural, read-write, and kinesthetic.⁷ Though these style preferences have not been well studied specifically among neurosurgery residents, multiple studies of surgery residents suggest that trainees largely have multi-modal learning styles, benefitting from reinforcement with multiple modalities to optimize learning.⁷⁻⁹ Among residents who had a unimodal style, the majority were kinesthetic learners – those who do best with experiential learning.^{7-9,10}

Considering the nuances of adult learning theory where both residents and post graduate students are self-driven learners, using their internal motivation of wanting to help their patients, and placed in a situation where they are both working and continuously learning, the future of neurosurgical education should capitalize on multi-modal educational strategies to augment and supplement this knowledge acquisition.

Virtual Reality

The role of simulation for skills training in neurosurgery was recently reviewed by Davids and colleagues.¹⁰ They found that the use of simulators of various types was associated with an improvement in procedural knowledge in all domains. They also found a non-significant improvement in safety through minimizing errors associated with procedural-related discomfort, whereas objective procedural-related safety parameters such as depth perception and

minimization of tissue injury showed significant improvement. As the authors noted, their progressive scholarly analysis suggests that we are yet to reach the point of widespread acceptance of virtual reality (VR) simulation as an integral part of neurosurgical training, but the impact of artificial intelligence and neural networks in enabling future objective procedural knowledge and skills analysis offers tremendous potential for automated feedback directed learning, which will be important for educating the next generation.

We have found VR to be especially beneficial with our medical students. For the last five years, we have offered a comprehensive, multicomponent, year-long neurosurgical elective course using VR as a primary teaching tool to second-year medical students. Students felt utilizing VR helped them gain a deeper understanding of neuroanatomy and neurosurgery, better retain the anatomical and functional details of the brain and spine, and better understand neurosurgical skills taught.¹¹ As we have seen, many of these students go on to do rotations in neurosurgery and/or acting internships and eventually go on to complete neurosurgery residencies, we have heard repeatedly how beneficial this early exposure to neurosurgery with the help of VR was.

We have also found that VR is a useful tool in preparing for cerebrovascular procedures such as aneurysm clipping.¹² Preoperative rehearsal using a VR surgical rehearsal platform increased efficiency in aneurysm microsurgery with a statistically significant improvement in time per clip used. Although every subspecialty in neurosurgery has undergone numerous advancements, the paradigm shift in aneurysm treatment toward endovascular procedures is especially noteworthy. This has severely limited trainees' exposure to microsurgical aneurysm clipping, and the need for other techniques to adequately train and promote retention of these skill is more prominent than ever.

Augmented Reality

Augmented Reality (AR) consists of devices which allow the user to interact with their surroundings, while additional details are presented with the use of lens, holograms, or other projected images. Commonly recognized devices include the HoloLens and Magic Leap lens. These devices are often connected to gaming, however there are more and more examples of their use for design, industrial applications, and other forms of training.^{13,14}

The use of AR for the education of medical students is documented in the experiences of the Case Western Reserve University (CWRU) School of Medicine HoloAnatomy program. During the Pandemic, the Anatomy curriculum was delivered through remote learning on the HoloLens and a large percentage of students indicated they found no difference in experience as compared to in person learning. Additionally, when comparing the HoloLens to traditional cadaveric anatomy education, there was no statistical significance between how

students scored on examinations, no matter the modality of learning.^{15,16}

These authors have experience with the building and design of a neuroanatomy course which is delivered 100% through the HoloLens at CWRU School of Medicine. 3D artists/sculptors, anatomists, and clinical content experts, collaborated to build a model of the central nervous system with key pathways, nuclei and surgical landmarks. This content is now the primary source of neuro-anatomical education for medical students at CWRU.

Given these experiences, we believe there is great potential for the adaptation of Mixed Reality educational models for the education and training of surgical residents and improving the skills of post graduate practitioners. There is much to be learned from didactic implementations, however we are hopeful that with industry partnership, we will build the next generation of tools that can not only assist in teaching, but also promote safer procedural care in the operating room and at the bedside. Our early experience suggests that intraoperative AR combined with preoperative VR planning offers the practitioner the ability to decrease their cognitive load and support intraoperative decision making with the potential to enhance surgical safety and performance.¹⁷

Summary and Conclusions

While some aspects of neurosurgical training still resemble the first surgical residency training program established by Halstead over a century ago, others have for good reason, changed. Thus, the slogan, "see one, do one, teach one" that was used to describe the training of the past, is certainly out of place in today's environment. What remains constant is the need to always strive towards perfection.

With duty hour restrictions leading to a decreased time in the hospital, and changes in practice associated with new technology and treatment, it is only natural to seek greater efficiency in training. One area of promise in this regard is the use of virtual and augmented reality for both cognitive knowledge and skills acquisition. These technologies have the potential to enhance "real world" experience by creating a life-like environment that provides a "safe place to fail."

While this technology is promising, more rigorous evaluation will be needed to determine to what extent mixed reality can be used to enhance time-tested processes in acquiring neurosurgical knowledge and skills for trainees and post graduate practitioners. ■

See page 31 for a complete reference list.



Ryan Gallagher



Clemens M. Schirmer, MD



Neil Malhotra, MD

Future of Care Delivery: The Impact and Implications of Telemedicine

Technological advancements in the past century have enabled healthcare delivery to expand beyond the walls of hospitals and clinics.¹ A current definition of telemedicine is electronic communication for direct patient care.^{2,3} The growth of internet communication in recent decades has allowed audio and video transmission between patients and medical providers to facilitate medical visits. This digital medium for medical interaction has been studied in various settings, most extensively in longitudinal patient care such as heart disease and diabetes. It has been shown to likely benefit clinical time efficiency and access to care without any detriments to care.^{4,5} The COVID-19 pandemic necessitated a rapid shift towards telemedicine-based practices, which provided further experience and strategies in implementing this care model.⁶⁻⁸

The care of the neurosurgical patient is unique and ranges in acuity. From more longitudinal clinical encounters to acute, point-of-care resource triaging, telemedicine has demonstrated potential for broad implementation in our field. It is expected to rapidly increase access to medical and subspecialty care to populations in resource-limited settings. It has enabled a tailored approach to the economic distribution of care in high-resource settings.⁹

Gaps still exist in our working knowledge of the utility and limitations of telemedicine, such as the economic impact, access to the internet, and physician liability.¹⁰ Nonetheless, this technology has been established as another tool for clinicians and surgeons to provide care, and it seems that its application will continue to grow

in various cases. In this article, we aim to survey the arc of telemedicine to date, with applications specific to neurosurgical patients, and provide a roadmap for the neurosurgical implementation of this technology going forward.

Prior Use and Current Applications

Before the COVID-19 pandemic, telemedicine established itself as a means for 1) longitudinal patient care,^{4,5} and 2) rapid triaging of patients, most notably in stroke.¹¹ In the current COVID-19 public health emergency era, medical-legal laxity has enabled rapid implementation of telemedicine services and telemedicine has become a platform for resident education.¹²⁻¹⁴ Review of these applications provides meaningful insight into the direction of telemedicine moving forward.

Clinic

The incorporation of telemedicine in neurosurgical clinics was in its nascency before the pandemic, with multiple regulatory and reimbursement challenges. The clinical time efficiency and increased access to care for deprived populations seen in other medical disciplines had been hypothesized as transferable to our specialty.¹⁵ A prototype model was deployed across state lines to provide pediatric neurosurgical care to an underserved population, demonstrating the feasibility and the impact of accessible, subspecialty care.¹⁶ The overhead cost to implement telemedicine pipelines, ensure reliability and security of the systems, and navigate barriers of reimbursement were

proposed drawbacks of the application and likely contributed to its delayed adoption.

The COVID-19 pandemic forced the introduction of the technology to neurosurgical clinics broadly. The accelerated timeframe provided many examples of success in designing and implementing telemedicine clinics; patient care resumed swiftly, and multiple studies agree that the technology will find utility indefinitely in the clinic.⁶⁻⁸ As expected, administrative and technological barriers to success were found, regulatory challenges remain, and continued reimbursement at parity remains threatened. With further optimization of the technology, the value of clinical efficiency and broader access to care will likely justify the bureaucratic barriers to implementation.

Acute Care

An exemplar of telemedicine for acute care, the success of tele-stroke has enormous implications for the role of telemedicine in neurosurgery. A focused and thorough neurologic exam remains an integral part of the data collection process for any patient presenting with an acute neurologic deficit, and the ability to perform and interpret a physical exam remotely remains a source of contention toward the rollout of telemedicine.^{6,11,17} Through the demonstrated literature in tele-stroke, reviews in neurosurgical literature, and our own institutional experiences, essential components of the neurological exam can be reliably and reproducibly gathered via telemedicine communication.^{8,11,13} There will indefinitely be neurosurgical patients that need immediate in-person attention. Still,

virtual communication provides a reliable and fast option for point-of-care triage and dispatch of further resources.

Education and Training

In addition to facilitating direct patient care between patient and provider, telemedicine is well suited as a platform for standardized student and resident training. The AMA codified this plan in 2016,¹⁸ and this goal has since been implemented and studied for neurosurgical didactics.^{14,17} The digital medium for care enables traditional educational theories to be incorporated into patient visits; trainees may be evaluated by live observers in the tele-visit, and recorded standardized encounters would allow trainees to learn from self-observation. Studies suggest that establishing a therapeutic patient-provider relationship is more difficult through an electronic platform, and the current level of trainee involvement in telemedicine remains low.¹⁷ The general agreement for the continued use of telemedicine in the future, and the necessity of training a future workforce adept at this model, invites opportunities for solutions toward increasing trainee involvement in tele-visits in beneficial ways for trainees, supervisors, and patients.

Future Directions

General sentiment within medical literature and professional organizations hold that the use of telemedicine should and will continue to grow. In a review of prior applications of this technology, it is evident that it promises great utility for our specialty. Thoughtful implementation in the clinic may improve time efficiency while increasing access to those geographically or socioeconomically restricted from specialty care.

Sixty percent of the world's population has access to the internet, and over 80% own a phone.^{19,20} Neurosurgery is a small and highly geographically concentrated field reliant on prohibitively high-cost imaging

and operative tools. With the advent of low-cost, portable imaging, the future of neurosurgical workup may consist of an initial patient visit via telemedicine followed by direct-to-home mobile neuroimaging modalities before necessitating any higher-cost imaging or in-person workup. This model would enable a dramatic expansion of equitable access to neurosurgical care.

Emergent and inpatient neurosurgical care has already gained value from telemedicine advancements for stroke triaging. These may be directly transferable to other neurosurgical emergencies demanding point-of-care evaluation with a proper clinical exam and rapid distribution of resources. In practice with COVID-19 ICU literature, highly acute and highly specialized care can be performed remotely.²¹ Digital technology to facilitate efficient perioperative and ICU care for neurosurgical patients should also be further studied.

Clinical skills are now and will continue to be developed by trainees at all stages in remote encounters. Given the burgeoning field of virtual and augmented reality technology to train medical students in anatomy and surgical skills, surgical residents may also be able to learn their procedural skills remotely initially and further hone them in the OR. Multimodal and diverse learning strategies will train the future generation of technologically adept neurosurgeons.

Technological inefficiencies remain for optimal implementation of telemedicine, and medical-legal solutions must navigate cross-state licensing and reimbursement plans that satisfy patients, providers, and payers. Nonetheless, face-to-face interaction with a neurosurgeon is now available with just a camera, a microphone, an internet connection, and a few mouse clicks. With this degree of this development over just a few decades, the future of telemedicine looks pretty encouraging.

References

- 1 Balas EA, Jaffrey F, Kuperman GJ, et al. Electronic Communication With Patients: Evaluation of Distance Medicine Technology. *JAMA*. 1997;278(2):152-159. doi:10.1001/jama.1997.03550020084043
- 2 Telemedicine | Medicaid. Accessed August 19, 2022. <https://www.medicaid.gov/medicaid/benefits/telemedicine/index.html>
- 3 Medicare Telemedicine Snapshot. Published online 2020:11.
- 4 Flodgren G, Rachas A, Farmer AJ, Inzitari M, Shepperd S. Interactive telemedicine: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev*. 2015;(9). doi:10.1002/14651858.CD002098.pub2
- 5 Gonçalves-Bradley DC, Maria ARJ, Ricci-Cabello I, et al. Mobile technologies to support healthcare provider to healthcare provider communication and management of care. *Cochrane Database Syst Rev*. 2020;(8). doi:10.1002/14651858.CD012927.pub2
- 6 Blue R, Yang AI, Zhou C, et al. Telemedicine in the Era of Coronavirus Disease 2019 (COVID-19): A Neurosurgical Perspective. *World Neurosurg*. 2020;139:549-557. doi:10.1016/j.wneu.2020.05.066
- 7 Daggubati LC, Eichberg DG, Ivan ME, et al. Telemedicine for Outpatient Neurosurgical Oncology Care: Lessons Learned for the Future During the COVID-19 Pandemic. *World Neurosurg*. 2020;139:e859-e863. doi:10.1016/j.wneu.2020.05.140
- 8 Eichberg DG, Basil GW, Di L, et al. Telemedicine in Neurosurgery: Lessons Learned from a Systematic Review of the Literature for the COVID-19 Era and Beyond. *Neurosurgery*. 2021;88(1):E1. doi:10.1093/neuros/nyaa306
- 9 World Health Organization. *Global Strategy on Digital Health 2020-2025*. World Health Organization; 2021. Accessed August 20, 2022. <https://apps.who.int/iris/handle/10665/344249>
- 10 Ekeland AG, Bowes A, Flottorp S. Effectiveness of telemedicine: A systematic review of reviews. *Int J Med Inf*. 2010;79(11):736-771. doi:10.1016/j.ijmedinf.2010.08.006

See page 31 for a complete reference list.



Christopher S. Graffeo,
MD MS



Michael T. Lawton, MD

Zen and the Art of Neurosurgery Social Media

The List Read 'Round the World

Like many aspects of social media at large, the splash made by a recent peer-reviewed publication ranking the top Twitter influencers in neurosurgery likely surprised even its own authors.³ Any merits or shortcomings of the article notwithstanding, its impressive impact highlights the ways in which social media has recently come of age for neurosurgery, which in turn provides an important opportunity to reflect on best practices within this unusual and exciting paraclinical space.

#NSGY Grows Up

In less than five years, the presence of dedicated neurosurgery social media accounts has grown exponentially, especially on Twitter—widely regarded as the core network for online communication between medical professionals. Since the first formal social media team in neurosurgery was formed by *Journal of Neurosurgery* in 2016, what was little more than a scattered network of individual surgeons, blog reposts, and occasional links to normal articles has blossomed into a constellation of accounts representing doctors, departments, training programs, practices, and professional organizations.^{1,2}

Today, thousands of neurosurgical posts are generated daily that share and remix clinical content, anatomic information, operating videos, patient stories, educational anecdotes, and more, with audiences ranging from colleagues to patients, students, trainees, or the #medtwitter community at large. This sea change in utilization has happened too quickly to be studied or understood in real time, and although most of the impacts of social media on neurosurgery have been positive, the phase is akin to an adolescence, during which the rapid developments have unpredictable and, at times, unsettling consequences. Like so many coming-of-age experiences, the social media explosion for neurosurgery has revealed both sophistication and immaturity, as we collectively grapple with these novel tools and their impacts on our professional lives.

With Great Power...

The explosion in neurosurgery social media has been overwhelmingly positive across numerous domains, especially within the context of the COVID19 pandemic. Free open-access medical education

(#FOAMED) resources provide students and trainees with self-guided teaching tools. High-quality operative videos help trainees prepare for cases, or instantly disseminate new techniques to a worldwide audience. Online discussions, both formal and informal, have superceded journal clubs by helping draw attention to particularly noteworthy articles, or dissecting them in real-time with diverse experts and thought leaders. Numerous webinars or video series have launched, most of which provide high-quality, high-yield clinical content, targeting trainees, surgeons, and other members of the care team at all levels of experience.

Residency programs and fellowships are able to introduce their faculty and trainees, detail their curricula, showcase research achievements, field questions, and highlight their strengths to an audience that includes potentially all resident applicants prior to ERAS submission. This robust digitization of pre-application, pre-interview content offers particularly strong advantages for programs in relatively inaccessible locations, or with less prominent national reputations, as well as for students whose financial, personal, or academic commitments may limit their opportunities to participate in the maximum number of sub-internship or interview experiences.

In tandem, social media has inadvertently generated a large number of easily measured surrogate markers for success in neurosurgery that are inaccurate at best, and potentially misleading if substituted for meaningful outcomes. Follower counts, engagement rates, page views, video plays, even raw post tallies have been cited as potentially insightful parameters in establishing a putative hierarchy. Although these and related metrics may tell an interesting story about social media utilization, the ranking enterprise is fundamentally misguided, and neither aligned with the essential mission of neurosurgery, nor with the core strengths of social platforms.

...Comes Great Responsibility

Arguably the most empowering features of networks like Twitter are those that flatten hierarchies, give voice to traditionally under-represented groups, and democratize information flow in a way that invests users with autonomy as they sift through, consume, and share content. In spite of this, although many of us are now online, far

fewer can say why they are there, whether it genuinely benefits us in our careers, or how we might focus our time and collaborative efforts on social media in the service of our shared missions.

In our view, social media is a minor but fundamentally positive force in neurosurgery. We strongly encourage students, residents,

and interested staff to carve out a small slice of time in their routine to explore the educational content, connect with colleagues, and develop their online presence. Notwithstanding, distractions abound, and in order to strive for a zen-like posture with respect to social media in neurosurgery, we suggest consideration of a seven-fold path:

The Seven-fold Path Toward Neurosurgical Social Media Zen

1. **Right Goal** ("Why are you posting?"):

Center the interests of all patients in your activities, with particular attention to the most vulnerable. For many future patients, the development of robust #FOAMED resources will continue to be a boon; notwithstanding, the development of these teaching tools should never come at the expense of a current patient's privacy, or the focus their neurosurgeon on delivering optimal and individualized care

2. **Right Self** ("Who is posting?"): In the era of hyper-produced content, externally managed #nsgy accounts, and Digital Newspeak, authenticity sends a powerful message. Represent yourself honestly, participate in the generation of any content that will carry your name, and neither be afraid to stand up for a deeply held belief, nor to walk away from the trivialities that precipitate most online conflicts

3. **Right Speech** ("How do your posts sound?"): When crafting posts, strive to communicate with words of uncompromising truth, kindness, and clarity. Your tone should make others feel confident in your intentions, and encouraged to emulate your compassion. When speaking of others, issue only praise and altruism, eschewing harshness in the public forum

4. **Right Message** ("What are your posts saying?"): Deliver content that is useful, compelling, and clear, and the right audience will find you. The core goals of contributing to social media in neurosurgery are to advance patient care, education, and research; anything else should be considered a distraction. Of note, work towards these goals may take on a wide range of forms, including sharing interests or activities outside the scope of neurosurgery, as these aspects of your authentic self will help humanize your online presence, and facilitate meaningful connection with others

5. **Right Media** ("Are your posts engaging?"): Among the most universally ratified truths of social media is the importance of visual content. Posts lacking media elements are often ignored—perhaps even subconsciously by many users—and may not succeed in communicating their messages as clearly and compellingly as possible. Although any visual content adds value to a given post, attentiveness to media that is high in quality or salience will pay dividends for you and your audience alike

6. **Right Relationships** ("Do your posts empower connection?"): If step one establishes a goal, and steps two through

five help you craft content in service of that goal, step six is an opportunity for reflection. More specifically, although internally referential social media metrics and rankings are straightforward to measure, meaningful progress is found in the development of enduring relationships with other users, which may manifest through indirect indicators such as individuals returning regularly to consume, share, and engage with your content. A useful question for self-assessment of this subjective parameter is: What are the core challenges confronting members of my target audience, and am I receiving consistent feedback indicating that I am helping them learn and improve across pertinent domains?

7. **Right Discretion** ("Is this post necessary?"): In the zen spirit, the final step centers on nothingness. Before publishing any post, consider quietly to yourself, "Does this serve the interests of my patients and my team?" If not, know that there is great power in discretion. A voice that is heard too often or without clarity will begin to sound like noise; a voice that speaks less often but clearly will hold the attention of many 🙏

References

- 1 Linzey JR, Graffeo CS, Wang JZ, Haider AS, Alotaibi NM: Neurosurgery and the rise of academic social media: what neurosurgeons should know. *J Neurosurg* 129:1-5, 2018
- 2 Linzey JR, Robertson F, Haider AS, Graffeo CS, Wang JZ, Shasby G, et al: Online Impact and Presence of a Specialized Social Media Team for the Journal of Neurosurgery: Descriptive Analysis. *J Med Internet Res* 22:e17741, 2020
- 3 Riccio I, Dumont AS, Wang A: The top 100 social media influencers in neurosurgery on Twitter. *Interdisciplinary Neurosurgery* 29:101545, 2022



Ellen L. Air, MD



Brian V. Nahed, MD



Anand Veeravagu, MD

The CNS Leadership Institute: Developing Leaders of the Future



The CNS Leadership Institute (CNS-LI) began six years ago in a collaboration with Medtronic to develop an innovative leadership course for physicians. What began as a small cohort of 14 junior attending neurosurgeons discussing the basics of healthcare economics, leadership and influence has developed into a two-day, two-cohort program. The Leadership in Healthcare program focuses on early career development for those in the first five years of practice, while the Vanguard Leadership in Healthcare program helps those 10-15 years into practice with growing leadership responsibilities become more effective leaders. This evolution is necessary to support our members' skillsets in the ever-changing demands of today's healthcare environment. The future neurosurgeon leader must hone a specific set of skills:

Know one's strengths

Perhaps anathema to the idealized neurosurgeon persona as excelling in all realms, true leaders lean into their strengths and know how to offset their weaknesses. Participants in CNS-LI perform a CliftonStrengths® Assessment, which is a standardized resource providing detailed information of one's top leadership skills. During the course, individuals learn how to apply these skills and balance one's "lesser" strengths through building teams that include members with those skills. The most successful leaders do not play every role but cultivate teams with diverse and complementary strengths geared to the goals at hand.

Negotiate effectively

Finding the "win-win" is critical to moving a mission forward yet is not a natural skill for many. What should you negotiate for? How do you prepare for a negotiation? How do you approach negotiation differently with someone outside vs. inside your organization? Do you approach negotiation differently as a person in an underrepresented

group? How do you choose the best approach for a particular negotiation? A panel of neurosurgical leaders answers these questions, while sharing their wins, losses, and tips. Building from our neurosurgical community's shared lessons learned is a powerful opportunity for the growth of future neurosurgical leaders.

Build Influence


In the operating room, neurosurgeons command significant influence especially when treating complex medical issues in very ill patients. However, the world outside the operating room is rapidly changing and influence is not assumed. Building influence and knowing how to apply it are essential skills for leaders. The CNS-LI puts great focus on this subject. Experts from business and healthcare administration bring their expertise to dynamic sessions which break down the elements of influence and walk through strategies for effective use.

Navigate an evolving healthcare landscape

Residency and fellowship training ensure graduates have extensive clinical knowledge and deft surgical skills to care for the most complex of neurosurgical problems. Clip an aneurysm... Yes! Resect a tumor.... Yes! Explain funds flow and net patient revenue.... Huh? Most neurosurgeons enter their first post-training position with a basic understanding of billing and reimbursement. The remaining education comes through on-the-job learning. Greater focus is now being placed on the "business of medicine" during training, yet the complexity of our business continues to grow exponentially. Neurosurgical leaders cannot be beholden to administrators telling us how healthcare should run. A leader must have a foundational knowledge of the healthcare business to effectively advocate for optimal patient care. The CNS-LI has been fortunate to have Brian Asmussen, MBA, Director of Business Development & Strategy for Medtronic, Inc and former President of the Neurosurgery Executives



every stage of one's career. For example, change-management has become a core responsibility of leadership. Therefore, the emphasis on this topic has grown over time. In 2022, we have worked with the Harvard T.H. Chan School of Public Health to develop six new webinars expanding the curriculum to include topics such as giving feedback, strategic planning and crisis management. We look forward to continued evolution of the program to meet the needs of our members. The CNS Leadership Institute is grateful for the unwavering and continued support from Medtronic towards developing leadership for the healthcare leaders of tomorrow.

Applications are now open for the 2023 Leadership Institute programs. To learn more and submit your application, visit cns.org/leadership. 

Resource Value & Education Society (NERVES), as core faculty. He offers a unique and broad experience spanning from practice administration to industry, which he translates into core principles every neurosurgical leader must know.

Leaders in healthcare must incorporate these skills and put them into action. The old adage "How do you get to Carnegie Hall?" applies here. "Practice, practice, practice" is the answer. Leadership program participants identify a challenge in their own institutions to tackle through the course of the year-long curriculum. This longitudinal problem-solving framework provides an excellent opportunity to apply new skills with the help of faculty and mentors to navigate challenges along the way.

The CNS-LI has focused on the foundational skills of leadership and each year incorporates new faculty and topics to address the everchanging challenges in healthcare. The CNS Leadership Institute is committed to providing leadership education and opportunities at



Matthew J. McPheeters,
MD, MBA

Douglas Kondziolka, MD

Journal Feature:

Neurosurgery: The Future of Publishing

Academic journals have a well-founded and long-standing history of serving their communities through the process of verifying, curating, and publishing advances in scientific knowledge. As such, journals are an indispensable resource for education. These functions developed from the natural evolution and the inherent structure of the publication process. Recently, numerous technologies are disrupting academic publishing and challenging the structure and purpose of traditional academic journals. NEUROSURGERY Publications is dedicated to addressing these challenges and adapting to continue to serve the neurosurgical community with the publication of the latest scientific developments, surgical innovations, and educational material.

A Brief History of Academic Publishing – From Structure Comes Function

At its most basic level, the purpose of science is to identify and organize facts with the intent of building meaningful relationships to develop and disseminate knowledge. Since the advent of the printing press, academic journals became the means by which this knowledge is disseminated. To progress from scientific discovery to publication, academic journals developed a linear process of individual authoring and editing, followed by parallel review, revision, and copy editing, before final publication. While necessary, this process was often long and difficult. From this structure, the function of academic journals developed.

In addition to the prolonged timeline to publication, journals were constrained by the cost and physical limitations of print media. Therefore, to provide value to their readers, journals naturally became responsible for the verification and curation of scientific knowledge. It is argued that over time these three functions (publication, verification, and curation) became the essential features of academic publishing.¹ While these functions were natural developments of the publishing process, they also resulted in unintended functions. Given the relative scarcity of published material, the verification and curation process promoted the credibility and academic stature of the authors able to complete the strenuous process. Publication metrics were developed to measure this success and eventually became a critical component of career advancement for academics.

As such, the academic journals became their gate keepers. As long as the journals were confined by the limits of print media, the need for verification and curation generally maintained the quality of scientific publication.

The Digital Disruption

Over the past few decades, advancements in digital technologies, particularly involving Web 2.0, disrupted the essential functions of academic publishing. Web 2.0 is a framework which views the web as a platform that harnesses “collective intelligence” through user participation to provide rich user experiences.^{2,3} These advancements include two key developments: (1) lower cost of publication and (2) essentially limitless space for publication. As a result, the structural and technical barriers for curation and verification are markedly reduced despite their continued functional necessity in academic publishing.

The disruption of these two essential functions of academic publishing results in additional unintended consequences and is at risk of succumbing to Goodhart’s law, which states that “when a measure becomes a target, it ceases to be a good measure.”⁴ Given the importance of publication metrics for career advancement, the demand for publication is increasing.⁵ As a result, much of the publishing demand is supplied by an exponential growth in the number of open access journals.⁶ While many open access journals serve an important role in the publication of academic research, many also are responsible for predatory tactics. These include minimal peer review (lack of verification), accepting almost every article (lack of curation), as well as charging authors with high fees.⁷ In 2019, a study of >120 million papers published in >20,000 journals over the past century demonstrated an increase in the annual number of publications from ~1,000,000 in 1980 to >7,000,000 in 2014.⁵ An additional trend included an increase in the average number of authors per paper as well as the number of self-citations.⁵

The Future of Academic Publishing – Designing Structure to Promote Function

To continue serving as one of the preeminent neurosurgical journals NEUROSURGERY Publications is dedicated to designing,

developing, and implementing structural changes that preserve the essential functions of an academic journal.

One of the most significant structural changes is the implementation of multiple companion journals underneath the NEUROSURGERY Publications umbrella. This began in 2005 with the introduction of *Operative Neurosurgery* followed by *Neurosurgery Open* in 2020.^{8,9} This structure allows for each publication to curate the highest quality publications based on their independent purposes while also being able to share resources to maintain the rigorous peer review (verification) process.

- **Neurosurgery:** the highest impact scientific discoveries in clinical and experimental neurosurgery.
- **Operative Neurosurgery:** indispensable and practical technical publications featuring operative procedures, devices, and technologies that advance the “craft of neurosurgery”⁸.
- **Neurosurgery Open:** emerging clinical and experimental research, including case series and clinical studies, as well as an avenue for research required to be published in a dedicated open access journal.

Additionally, NEUROSURGERY Publications is developing both intramural and extramural structures to increase engagement with the neurosurgical community across platforms. This is made possible by advances in digital media and publishing. For *Operative Neurosurgery* this includes the development of the Advanced Media initiative including a collaboration with Surgical Theater to develop 360-degree virtual reality (360° VR) videos. Extramurally, the recently developed Enhanced Abstracts can be posted across various platforms (e.g. Twitter, Facebook, etc.), where the community can review the key points of a study without the need to leave outside platforms. At the same time, the current NEUROSURGERY Publications platform allows authors to access their Altmetric data including social shares, article views, and publishing history.

Moving forward, NEUROSURGERY Publications will also work to evaluate and support emerging technologies dedicated to improving the existing publishing structures while maintaining the essential functions of an academic journal. An example of this was World Science, a novel software we (Douglas Kondziolka) developed in 2011 to create a knowledge network that simultaneously serves a platform for “writing, reviewing, accessing, sharing and searching credible science.”^{10,11} At its inception, World Science was ahead of its time, introducing many of the components of what is now referred to as Web 3.0. While still in its early stages, Web 3.0, focuses on decentralized systems built on blockchain technology (e.g. Ethereum, Bitcoin). Potential applications of Web 3.0 technologies in publishing include continuous review, improved search and retrieval

systems, and automated indexing.¹²

The foresight to adapt, and willingness to innovate with disruptive technologies, has positioned NEUROSURGERY Publications to maintain its position as a preeminent suite of neurosurgical publications. As we move into the future of publishing, NEUROSURGERY Publications is dedicated to upholding the essential functions of verifying, curating, and publishing the most relevant and important scientific advances in neurosurgery. ■

References

- 1 Munger, M. The Future of Academic Publishing. American Institute for Economic Research <https://www.aier.org/article/the-future-of-academic-publishing/> (2020).
- 2 O'Reilly, T. What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. <https://www.oreilly.com/pub/a/web2/archive/what-is-web-20.html> (2005).
- 3 Blank, G. & Reisdorf, B. C. The Participatory Web. *Information Commun Soc* 15, 537–554 (2012).
- 4 Goodhart, C. A. E. Problems of Monetary Management: The UK Experience. *Monetary Theory and Practice* 91–121 (1984).
- 5 Fire, M. & Guestrin, C. Over-optimization of academic publishing metrics: observing Goodhart's Law in action. *Gigascience* 8, giz053 (2019).
- 6 Pandita, R. & Singh, S. A Study of Distribution and Growth of Open Access Research Journals Across the World. *Publish Res Q* 38, 131–149 (2022).
- 7 Beall, J. Predatory publishers are corrupting open access. *Nature* 489, 179–179 (2012).
- 8 Apuzzo, M. L. J. The Craft of Neurosurgery. *Oper Neurosurg* 56, 1 (2005).
- 9 Oyesiku, N. M. The Registrar: Neurosurgery Open. *Neurosurg Open* 1, (2020).
- 10 Sochats, K. World Science: About World Science. <http://www.world-sci.com/About.aspx> (2011).
- 11 Kondziolka, D., Nawn, D., Zimmerman, B. & Sochats, K. Knowledge Network for Authoring, Reviewing, Editing, Searching, and Using Scientific or Other Credible Information. *Disruptive Sci Technology* 1, 3–10 (2012).
- 12 Schatten, M. & Malekovic, M. Insights from Web 3.0: Is it Time for a New Scientific Publishing Methodology? in (2011).



Katie Orrico

Washington Focus: The Future of the Regulatory Environment

I wish I could start this article with an optimistic pronouncement that the regulatory burdens neurosurgeons face each and every day will magically disappear in the future. Sadly, this is not likely the case as patients, payers, employers and government continue to pressure physicians — and the health care system more generally — to reduce costs and deliver high-quality care. Nevertheless, there may be a few bright spots on the horizon to help minimize the intrusion of third-party meddlers and their mind-numbing regulations and practice hoops through which neurosurgeons must jump to take care of their patients.

Shifting from Fee-for-Service to Value-based Care

Health care delivery will continue on its march to value-based care into the future. One primary driver of this shift from fee-for-service to value-based care is the Centers for Medicare & Medicaid Services (CMS), which oversees myriad quality improvement initiatives and programs. Recently, CMS published its [National Quality Strategy](#), which aims to “set and raise the bar for a resilient, high-value health care system that promotes quality outcomes, safety, equity, and accessibility for all individuals.” Given that federally funded health insurance programs comprise an increasingly large proportion of annual health care expenditures in the United States, and because federal policy decisions typically guide the decisions of private health plans, CMS will continue to influence the evolution of value-based care.

However, getting to this quality nirvana will not be painless — particularly given the

current programmatic direction. Medicare’s [Quality Payment Program](#) (QPP), with its Merit-based Incentive Payment System (MIPS) and Alternative Payment Models (APMs), continues to fall short of what Congress intended when it established the QPP. MIPS remains a pay-for-compliance program with few quality measures relevant to neurosurgical practice. Its framework for establishing physician performance scores as measured by four categories — cost, quality, electronic health record (EHR) use and improvement activities — is complex and not particularly transparent. Furthermore, the time, effort and costs to neurosurgical practices to participate in MIPS far exceed the meager payment incentives available. The Medicare Payment Advisory Commission (MedPAC) and others have urged Congress to eliminate MIPS and adopt an alternative approach for promoting high-quality clinician care.

Things are not much brighter on the APM front. Neurosurgeons may be participating in local hospital system accountable care organizations (ACOs) or bundled payment initiatives but often report a lack of awareness or direct involvement in these APMs. In practice, ACOs — including those that are part of Medicare’s [shared savings program](#) — have fallen due to considerable startup costs, difficulty in defining standardized outcome measures and challenges in setting appropriate risk-based payments to establish suitable gainsharing incentives for participation. Bundled payments — which provide a single fee to cover an entire episode of care, incentivizing both the physician and hospital to collaborate for increased value and quality of care — especially for episodes

of care that lend themselves to a more formulaic mode of care, such as elective lumbar spinal fusion, are more likely to work in neurosurgery. However, developing appropriate risk-adjusted payment bundles requires clinical outcomes and costs data — which are still scant.

CMS acknowledges the shortcomings of the QPP and is working to develop what it believes are more clinically relevant quality metrics, such as the MIPS Value Pathways (MVP) program. However, this approach merely rearranges the proverbial deck chairs on the Titanic. While the agency intends for the MVPs to reduce the regulatory burdens imposed on physicians to comply with the MIPS program, changes will do little to improve quality. Mandatory bundled payment programs, such as the [Comprehensive Care for Joint Replacement Model](#), may be on the horizon for neurosurgery. However, to date, efforts to create such bundles — including in spine and stroke care — have sputtered mainly due to the complexity and heterogeneity of these services. Looking down the road, it is clear that neurosurgeons will be held accountable for the quality of care they provide as a condition of employment or reimbursement. This will likely include participating in clinical outcomes data registries such as those initiated by the [NeuroPoint Alliance](#). Until augmented intelligence (AI) or other automated methods for extracting data from the EHR advances, the burdens of reporting will continue to fall on neurosurgeons and their staff. While the federal government has adopted rules governing interoperability and data information sharing, in reality, the promise of seamless data transfer is far from realized.

Cost Transparency

A critical element of value-based care and cost-containment is price transparency. CMS continues to move forward with policies requiring providers to publish their prices (e.g., Medicare's [hospital price transparency](#) requirements). Effective Jan. 1, 2021, each hospital operating in the U.S. must provide clear, accessible pricing information online about the items and services they provide.

In addition, with the passage of the [No Surprises Act](#) (included in the Consolidated Appropriations Act, 2021 ([P.L. 116-260](#))), physicians must also provide consumers with good faith estimates (GFE) of expected charges. Under certain circumstances, the treating physician may also be required to provide patients with cost estimates of services provided by additional providers -- including hospitals, radiologists, anesthesiologists, pathologists and rehabilitation clinicians and facilities -- related to the related to the neurosurgeon's treatment, requiring neurosurgeons and their staff to track down this cost information. The GFE requirement for uninsured or self-pay patients went into effect on Jan. 1, 2022. However, in the future, CMS plans to issue additional requirements for physicians to provide GFEs for insured individuals. Neurosurgeons should, therefore, brace themselves for the regulatory hassles associated with this element of the No Surprises Act.

Prior Authorization and Utilization Review

It is no surprise to neurosurgeons that prior authorization and other utilization review requirements bring with them tremendous regulatory burdens. Obtaining the pre-approval for medical treatments or tests before rendering care to their patients is burdensome and costly to neurosurgical practices, requiring neurosurgeons and their staff to spend an enormous amount of time each week negotiating with insurance companies. Furthermore, as

[previously reported](#), according to a [survey](#) of neurosurgeons, 91% of neurosurgeons reported that the burden associated with prior authorization has significantly increased over the past five years. This finding is confirmed by [research](#) conducted by the American Medical Association, which highlighted that 88% of physicians describe the burden associated with prior authorization as high or extremely high, requiring physician practices to spend the equivalent of two business days each week completing prior authorizations.

Prior authorization is but one utilization review tool impacting neurosurgical practices. Step therapy or so-called "fail first" policies require patients to take one or more alternative medications before they can access the medicine prescribed by their physician. While health plans impose these requirements to control health care costs, step therapy has been increasingly applied to patients without regard for their medical situation or treatment history. It, too, results in additional regulatory burdens for physicians as they haggle with insurers to cover the treatments recommended for their patients.

Finally, mandated by the Protecting Access to Medicare Act ([P.L. 113-93](#)), Medicare's [Appropriate Use Criteria \(AUC\)](#) program requires physicians ordering advanced diagnostic imaging to consult with AUC using an approved clinical decision support mechanism before the radiologist can provide the scan. This utilization review program aims to increase the rate of appropriate advanced diagnostic imaging services provided to Medicare beneficiaries. The Congress of Neurological Surgeons (CNS) and American Association of Neurological Surgeons (AANS) have urged Congress to repeal the AUC program, given the additional burdens on physicians and potential delays in imaging services. At the very least, the neurosurgical societies have recommended that Congress adopt legislation that directs CMS to incorporate AUC for diagnostic imaging into the existing QPP.

In a bit of good news for the future, advocacy efforts to address the burdens of these and other utilization review programs appear to be bearing fruit. Legislation to bring needed reforms to prior authorization in the Medicare Advantage program — the Improving Seniors' Timely Access to Care Act ([H.R. 3173/S. 3018](#)) — is gaining momentum in Congress and CMS has indefinitely postponed enforcing the AUC program. The private sector is working diligently to develop electronic solutions to improve prior authorization. Efforts like those initiated by [Stanson Health](#) (a [Premier Inc.](#) company)¹ will allow AI-based software tools to streamline prior authorization. The health plans also understand that the prior authorization must evolve in the future, and they are investing in new technology to modernize the process. For example, AHIP, the health plan trade association, launched a new initiative called the Fast Prior Authorization Technology Highway ([Fast PATH](#)). Working with two technology companies — [Availity](#)² and [Surescript](#)³ — the group demonstrated an ability to reduce the burden of prior authorization, including fewer phone calls and faxes.

The Bottom Line

Medicine is a highly regulated industry that consumes one-fifth of our nation's economy. As such, neurosurgeons will always face a vast array of regulations and attendant burdens. However, through the efforts of the Washington Committee, its subcommittees and Washington Office staff, the CNS will continue to advocate that policymakers, health plans and others reduce regulatory burdens, so neurosurgeons spend their time caring for patients. ■

Resources

- 1 Stanson Health. Accessed: September 29, 2022. <https://stansonhealth.com/>
- 2 Availity. Accessed: September 29, 2022. <https://availity.com/>
- 3 Surescripts. Accessed: September 29, 2022. <https://surescripts.com/>

FOUNDATION UPDATE



Dear Friends and Colleagues,

As we near the CNS Annual Meeting, CNSF Co-Chair Alexander Khalessi and I hope that all of you will join us at the CNS Foundation Donors and Awardees reception on Monday evening, October 10 in the Moscone Convention Center at the CNSF Silent Auction. We will be celebrating the biggest year of impact yet, made possible by YOU, our generous donors to the CNS Foundation. Please join us to celebrate these awardees, thank our donors and expand on the future of the CNS Foundation.

If you have not given yet this year, I urge you to give today. Your gifts will help these incredible opportunities continue in 2023 for our neurosurgeons around the world.

—Martina Stippler, MD, Co-Chair of the CNS Foundation



Alexander A. Khalessi
CNSF Co-Chair



Martina Stippler
CNSF Co-Chair



CNSF/ Joint Cerebrovascular Section Young Investigators Awards

Made possible by a gift from the Joint Cerebrovascular Section.

Isaac J. Abecassis, MD, University of Louisville



NINDS/CNS Getch K12 Scholars 2020

Made possible by a gift from the Congress of Neurological Surgeons in partnership with the National Institute of Health (NIH) and the National Institute of Neurological Disorders and Stroke (NINDS).

Todd Hollon, MD, University of Michigan, Neurosurgery



CNSF/ Joint Cerebrovascular Section Young Investigators Awards

Made possible by a gift from the Joint Cerebrovascular Section.

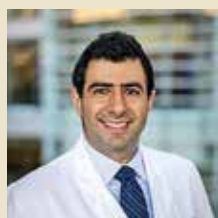
Ananth Vellimana, MD



NINDS/CNS Getch K12 Scholar, 2022

Made possible by a gift from the Congress of Neurological Surgeons in partnership with the National Institute of Health (NIH) and the National Institute of Neurological Disorders and Stroke (NINDS).

Nicholas Au Yong, MD, Emory University School of Medicine



CNS Data Science Scholar

Made possible by a gift from Viz.AI.

Andrew Abumoussa, MD



International Observership

Made possible by a gift from the CNS Foundation and donors to the CNS International Philanthropy Fund.

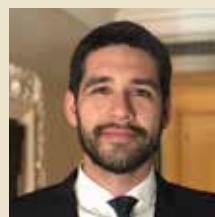
Chrystal Calderon, MD, of Trinidad Tobago, CNSF/Massachusetts General International Observership



CNS Guidelines Scholar

Annually made possible by the CNS Foundation and donors to the CNS Guidelines Fund.

Faith Robertson, MD, Massachusetts General Hospital



International Observership

Made possible by a gift from the TransAtlantic Education Foundation.

Martin Merenzon, MD, of Argentina, CNSF/ Miami University Tumor Observership

Recipients to be announced at CNS Annual Meeting:

Future Women Leaders in Neurosurgery Scholarships

Made possible by a leadership gift from an Anonymous Donor and ongoing support from donors around the world.

CNSF Neurotrauma Visitorship *made possible by a gift from the Neurotrauma Section.*

CNSF Cerebrovascular Visitorship *made possible by a gift from Penumbra.*

Institutional Hosts of new CNS Foundation International Observerships *made possible by generous gifts from Medtronic and Stryker.*

CNS Foundation Donors and Awardees Reception

Please join us to celebrate this year's Awardees and thank our generous donors

- When: Monday evening 5:45 – 7:15
- Location: Silent Auction, Lobby of Moscone West
- Hear a brief, exciting update from our Foundation Co-Chairs
- Meet our award winners and generous donors.
- Bid on dream vacations, fabulous art and sports memorabilia.
- Learn more about dream vacations! <https://foundation.cns.org/cnsf-in-2022>
- All Silent Auction purchases support our 2023 awardees
- Enjoy California wines, light hors d'oeuvres and a cash bar
- Donors will receive a gift and a complimentary beverage

Pathway to Neurosurgery Event

Volunteer an hour, encouraging San Francisco high school students from underrepresented groups and/or disadvantaged backgrounds to pursue a career in neurosurgery.



VOLUNTEER >



Donate today to support these awards and fellow neurosurgeons in 2023!

Would you like to join the group making a difference in our next generation of neurosurgeons and their patients? Please donate! 2022 Donors who attend the CNS Annual Meeting will receive a commemorative pin and invitations to events in appreciation of their support. All donors will receive an invitation to the Donor and Awardee's Celebration Reception, Monday, October 10, 2022!



Annual Gifts of \$5,000 and more.



Annual Gifts of \$2,000 and more.



DONATE!



Annual Gifts of \$1,000 and more.



Annual Gifts of \$500 and more.



CNS

Leadership Institute

Advance your career
and your practice.
Join the next
generation of
neurosurgical
leaders.

May 5-6, 2023 | Chicago, IL

Healthcare continues to evolve, requiring new and different leadership skills for physicians to more effectively meet the needs of their patients. Now more than ever, physicians need leadership skills to effectively influence and make decisions within your institution.



The CNS Leadership Institute is designed to help you grow as a leader. The institute offers a series of webinars and live courses for specific career stages that are designed to impart leadership skills and business acumen required to engage with hospital administrators, industry, and healthcare partners. Offerings include:

- **Leadership in Healthcare Course**
 - One year commitment
 - Focuses on early and mid-career leadership
- **Vanguard Leadership in Healthcare Course**
 - One year commitment
 - Focuses on junior and senior career leadership

Learn more or register and apply at
cns.org/leadership

The CNS Leadership Institute has trained
120 physicians at 61 academic institutions and
18 private practice groups



Exclusive Leadership Institute Partner

Medtronic

INSIDE THE CNS



Washington Committee Report



Katie O. Orrico, Esq

Prior Authorization Legislation Moving Forward in Congress

On July 27, the House Ways and Means Committee unanimously approved the Improving Seniors' Access to Care Act, as amended ([H.R. 8487](#)). The legislation would streamline and standardize prior authorization in the Medicare Advantage (MA) program by, among other things:

- Establishing an electronic prior authorization process;
- Requiring the U.S. Department of Health & Human Services to establish a process for "real-time decisions" for items and services that are routinely approved;
- Improving transparency by requiring MA plans to report to the Centers for Medicare & Medicaid Services (CMS) on the extent of their use of prior authorization and the rate of approvals or denials; and
- Encouraging plans to adopt prior authorization programs that adhere to evidence-based medical guidelines in consultation with physicians.

In advance of the committee consideration, the Regulatory Relief Coalition (RRC) sent a [letter](#) to the committee supporting the amended bill

and urging committee members to vote in favor of the legislation. Rep. **Suzan DelBene** (D-Wash.) singled out the coalition in her statement about the bill. In addition, the Congress of Neurological Surgeons (CNS) and the American Association of Neurological Surgeons (AANS) issued a press release, as did the RRC.

To view the committee markup, the press release from CNS and AANS, and the RRC press release, view the online issue.

In addition to the broad prior authorization reform bill, so-called "gold card" legislation is also under consideration. On June 9, Reps. **Michael Burgess**, MD, (R-Texas) and **Vicente Gonzalez** (D-Texas) introduced the Getting Over Lengthy Delays in Care As Required by Doctors Act (GOLD CARD) Act ([H.R. 7995](#)), a bipartisan bill that the CNS and the AANS helped develop. This bill would exempt certain physicians from prior authorization in the MA program. Specifically, the legislation would exempt providers from prior authorization requirements for one year if the provider had at least 90% of prior authorization requests approved the preceding year.

In announcing the introduction of the legislation, Reps. Burgess and Gonzalez



issued a [press release](#) featuring **John K. Ratliff**, MD, who stated:

"Since most medical services are ultimately approved, the GOLD CARD Act is a commonsense approach to addressing the unnecessary burdens caused by the widespread use of prior authorization. Neurosurgical patients suffer from painful and life-threatening neurologic conditions such as brain tumors, debilitating degenerative spine disorders, stroke and Parkinson's Disease, and without timely care, they

often face permanent neurologic damage and sometimes death. If adopted, Reps. Burgess and Gonzalez's legislation would be a significant step in making sure our seniors get the care they need when they need it, and America's neurosurgeons are proud to endorse this bill."

The neurosurgical groups also joined the Alliance of Specialty Medicine in a [letter](#) to Reps. Burgess and Gonzalez supporting the legislation.

Finally, Rep. **Mark Green**, MD, (R-Tenn.) introduced [H.R. 8078](#), the Reducing Medically Unnecessary Delays in Care Act. If adopted, this bill would reform prior authorization in Medicare by requiring that all preauthorizations and adverse determinations are made by a licensed physician who is board certified in the specialty relevant to the health care service in question. It would also direct Medicare plans to comply with requirements that restrictions must be based on medical necessity and written clinical criteria, as well as additional transparency obligations.

Neurosurgery Adopts Position Statement on Prior Authorization Imaging Requirements

On June 7, the CNS, the AANS and the Joint Section on Disorders of the Spine and Peripheral Nerves adopted a new position statement titled "Image Sharing Requirement for Prior Authorization." The neurosurgical groups believe that the doctor-patient relationship is an indispensable component of shared decision-making in choosing to undergo spine surgery. The concept that image sharing should be a basis for prior authorization is an unnecessary and unwelcome impingement on the doctor-patient relationship, which will detrimentally interfere with the decision for spine surgery. Physicians who treat spine conditions adamantly oppose requiring the submission of patient images as a prior authorization requirement for spine surgery.

Visit the online issue to read the position statement.

Efforts to Fix Broken Medicare Physician Payment System Continue

The CNS and the AANS continue their efforts to fix the broken Medicare physician payment system. On May 25, the CNS and the AANS endorsed [principles](#) for reforming the Medicare physician payment system. Developed in collaboration with the American Medical Association (AMA) and 120 state and national medical societies, the "Characteristics of a Rational Medicare Payment System" document outlines a unified set of shared goals for improving the current system.

Subsequently, the CNS and the AANS issued a [press release](#) announcing support for these unified goals. "The current Medicare physician payment system is on life support and needs an overhaul. We are grateful that Congress has stepped in to mitigate steep cuts over the past few years, but comprehensive reform to reflect practice costs and inflation is needed," stated **John K. Ratliff**, MD, chair of the Washington Committee.

The CNS and the AANS also lead several coalition efforts — including the [Surgical Care Coalition](#) (SCC) — to prevent steep Medicare payment cuts and preserve patient access to care. The SCC officially launched year three of its campaign to stop these cuts and implement changes to the physician payment system. After successfully protecting patients' timely access to quality surgical care in 2020 and 2021 by securing Congressional action to mitigate proposed cuts to Medicare, the SCC has begun to fight against similar cuts proposed for 2023.

Finally, working with a broad coalition of physicians and other health professionals, the CNS and the AANS helped spearhead a [letter](#) to key congressional committee leaders urging them to take legislative action to avoid an expected 8.5% cut to physician payments in the Medicare program. The recently proposed calendar year 2023 Medicare Physician Fee Schedule (MPFS) Rule included a reduction in the Medicare conversion factor of approximately 4.5%.

Additionally, a required statutory pay-as-you-go cut of 4% is slated to go into effect on Jan. 1, 2023. The letter urged Congress to take action to address these cuts stating, "These year-over-year cuts clearly demonstrate that the Medicare physician payment system is broken." The groups also welcomed the opportunity to work with Congress to "establish a pathway for identifying policy solutions that will ensure long-term stability for the MPFS."

The CNS and the AANS are working on developing legislation that would prevent these fee schedule cuts, provide physicians with an inflationary update in 2023 and set the stage for long-term reform of the Medicare physician payment system.

House Passes Continuation of Telehealth Services

On July 27, by a [vote of 416-12](#), the U.S. House passed [H.R. 4040](#), the Advancing Telehealth Beyond COVID-19 Act. Sponsored by Reps. **Liz Cheney** (R-Wyo.) and **Debbie Dingell** (D-Mich.), this bipartisan legislation extends through December 2024 key telehealth waivers implemented during the COVID-19 pandemic. These provisions include the removal of geographic restrictions and the expansion of originating sites for telehealth services, as well as flexibility for providers to continue to provide audio-only telehealth services. In addition, the bill would delay the requirement that a Medicare beneficiary attend an in-person visit with their provider before receiving behavioral health services via telehealth. The Senate must now consider the bill, although it is unclear whether or when the upper chamber will consider this legislation. Without additional congressional action, these telehealth waivers will expire 151 days after the yet-to-be-determined end of the COVID-19 public health emergency. 📌

IMAGES IN NEUROSURGERY

Enterothecal fistula presenting as meningitis

A 25-year-old female with past medical history of an L5 sacral giant cell tumor resected through an anterior transperitoneal approach followed by posterior L4-pelvis fusion presented to our institution with headaches and altered mental status. Subsequent cranial imaging demonstrated worsening pneumoventricle and pneumocephalus (**Figure 1A, 1B**), which prompted spinal imaging. This demonstrated contrast enhancing debris in her lumbar cistern and significant inflammatory changes in the previous tumor cavity (**Figure 2A 2B, 2C**). A subsequent CT abdomen and pelvis with oral contrast demonstrated that a portion of small bowel had migrated into her resection cavity and created a pathologic enterothecal fistula resulting in fecalith within the subarachnoid space and florid meningitis (**Figure 2D, 2E**). The patient was emergently treated with a small bowel resection for fistula obliteration. The small bowel was seen diving into the resection cavity and copious bowel contents were seen in the peritoneum and ventral spinal column. Separation of the bowel from the spinal column revealed a very obvious side wall defect (**Figure 3A, 3B, 3C**). This was repaired with a small bowel resection with primary anastomosis, as well as prolonged intravenous antibiotic therapy. She ultimately developed hydrocephalus requiring shunt placement and two suboccipital craniectomies for persistent foramen magnum crowding. Ultimately, she developed additional wound infections requiring multiple washouts and instrumentation removal. Despite a prolonged hospital course, she has made significant recovery and at 24-months following index presentation, she is awake, oriented, able to participate in activities of daily living, and actively participating in rehabilitation. ■

Submitted by: Timothy Y. Wang, MD

Affiliation: Duke University Neurological Surgery

Figure 1: **A)** Initial head CT without contrast at presentation demonstrating no intracranial pathology. **B)** Subsequent CT head without contrast on hospital day 1 demonstrating pneumocephalus.

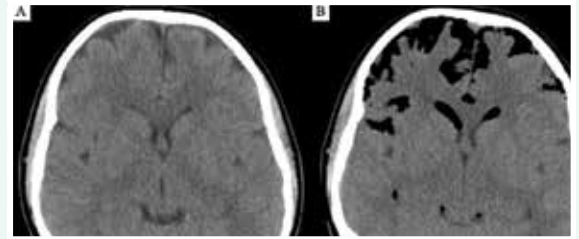


Figure 2: **A)** Previous postoperative non-contrasted CT following giant cell tumor resection and small bowel resection demonstrating bone cement within the resection cavity secured with a ventral bone screw (white arrow). This CT was obtained four-years prior to current presentation. **B)** Sagittal T2 MRI L spine from present admission indicating small bowel invaginating through the previous lumbar defect (orange arrow), new development of posterior pseudomeningocele (red arrow) and fecal matter in the lumbar cistern (green arrow). **C, D, and E)** Sagittal and axial CT abdomen and pelvis with oral contrast from present admission demonstrating a loop of small bowel invaginating into the previous lumbosacral spine defect with direct communication (blue arrows) with the thecal sac. Note that the previous bone cement as well as the ventral cement screw seen on the lumbar spine CT in panel A are no longer present (white arrow). It was presumed to have eroded through the small intestine and been eliminated during a bowel movement.

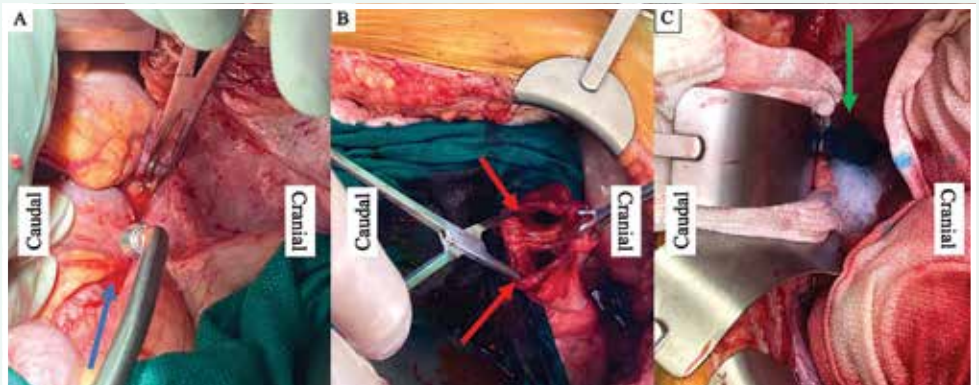
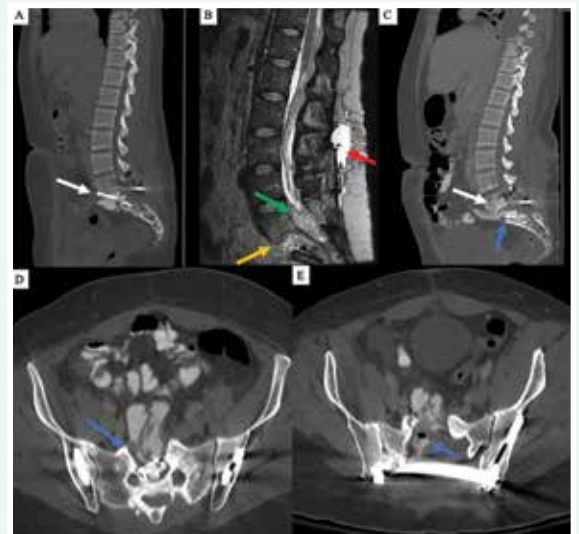


Figure 3: **A)** View of the bowel loop (blue arrow) diving into the previous surgical defect (end of suction device). **B)** Removal of entrapped small bowel, demonstrating clear bowel wall defect with proximal and distal lumen (red arrows). The surgeon's sponge-stick instrument is cannulating both proximal and distal bowel lumens. **C)** The lumbosacral defect has been packed with a large fat graft and covered with polyethylene glycol sealant (green arrow).



Congress of
Neurological
Surgeons

Congress Quarterly, 10 N. Martingale Road, Suite 190, Schaumburg, IL 60173.



NEW! CNS+ houses all the CNS apps you love in one convenient place!

Download the app today and access CNS Guidelines and CNS education in the palm of your hand. CNS+ also integrates with your CNS profile and enables access to “My Education” and “My CME”.



Features include

+ News

Case of the Month
Neurosurgery Watch
Podcasts
CNS Spotlight

+ References

CNS Guidelines
+ Recommendations
+ Summaries
+ Decision Support Tools
Neurosurgery Surgery
Survival Guide
Nexus

+ Publications

Neurosurgery Open
Neurosurgery
Operative Neurosurgery
Clinical Neurosurgery
Congress Quarterly
“Essential Papers in
Neurosurgery”

+ Education

Courses
Webinars



Congress of
Neurological
Surgeons



Scan now to
Download the
CNS app today.



References: Continued from Page 13

The Future of Neurosurgical Education

References

- 1 The Education of a Neurosurgeon Report of a Workshop for Neurosurgical Training Program Directors. *JNS Suppl.* II, March 1969.
- 2 The Education of a Neurosurgeon Report of a Workshop for Neurosurgical Training Program Directors. *JNS 34 Suppl.* February 1971.
- 3 Popp AJ. Navigating the Strait of Magellan: mapping a new paradigm for neurosurgical residency training. Presidential Address to the Society of Neurological Surgeons, May 7, 2007. *J Neurosurg* 109:000-000, 2008
- 4 SNS Core Curriculum <https://www.societyns.org/curriculum-director-toolkit>
- 5 Green ML, Ellis PJ. Impact of an evidence-based medicine curriculum based on adult learning theory. *J Gen Intern Med.* 1997 Dec;12(12):742-50.
- 6 Hartzell JD. Adult learning theory in medical education. *Am J Med.* 2007 Nov;120(11):e11; author reply e13.
- 7 Kim RH, Viscusi RK, Collier AN, Hunsinger MA, Shabahang MM, Fuhrman GM, Korndorffer JR Jr. Learning preferences of surgery residents: a multi-institutional study. *Surgery.* 2018 Apr;163(4):901-905.
- 8 Kim RH, Kurtzman SH, Collier AN, Shabahang MM. The Learning Preferences of Applicants Who Interview for General Surgery Residency: A Multiinstitutional Study. *J Surg Educ.* 2016 Nov-Dec;73(6):e136-e141.
- 9 Kim RH, Gilbert T. Learning style preferences of surgical residency applicants. *J Surg Res.* 2015 Sep;198(1):61-5. doi: 10.1016/j.jss.2015.05.021. Epub 2015 May 16. PMID: 26070495.
- 10 Davids J, Manivannan S, Darzi A, et al., Simulation for skills training in neurosurgery: a systematic review, meta-analysis, and analysis of progressive scholarly acceptance. *Neurosurgical Review* (2021) 44:1853-1867.
- 11 Atli K, Selman W, Ray A. A Comprehensive Multicomponent Neurosurgical Course with use of Virtual Reality: Modernizing the Medical Classroom. *J Surg Educ.* 2021 Jul-Aug;78(4):1350-1356.
- 12 Chugh AJ, Pace JR, Singer J, Tatsuoka C, Hoffer A, Selman WR, Bambakidis NC. Use of a surgical rehearsal platform and improvement in aneurysm clipping measures: results of a prospective, randomized trial. *J Neurosurg.* 2017 Mar;126(3):838-844.
- 13 Noor, A. K. (October 1, 2016). "The Hololens Revolution." *ASME. Mechanical Engineering.* October 2016; 138(10): 30-35
- 14 Vorraber W, Gaasser J, Webb H, Neubacher D, Uri P. Assessing augmented reality in production: remote-assisted maintenance with Hololens. *Procedia CIRP* 88 (2020) 139-144
- 15 Wish-Baratz S, Crofton AR, Gutierrez J, et. al. Assessment of Mixed-Reality Technology Use in Remote Online Anatomy Education. *JAMA Netw Open.* 2020;3(9):e2016271.
- 16 Stojanovska M, Tingle G, Tan L, Ulrey L, et. al. Mixed Reality Anatomy Using Microsoft HoloLens and Cadaveric Dissection: A Comparative Effectiveness Study. *Med Sci Educ.* 2019 Nov 15;30(1):173-178.
- 17 Louis RG, Steinberg GK, Duma C, et al. Early Experience With Virtual and Synchronized Augmented Reality Platform for Preoperative Planning and Intraoperative Navigation: A Case Series. *Operative Neurosurgery* 21:189-196, 2021.

References: Continued from Page 15

Future of Care Delivery: The Impact and Implications of Telemedicine

References

- 11 Hatcher-Martin JM, Adams JL, Anderson ER, et al. Telemedicine in neurology: Telemedicine Work Group of the American Academy of Neurology update. *Neurology.* 2020;94(1):30-38. doi:10.1212/WNL.0000000000008708
- 12 COVID-19 Emergency Declaration Blanket Waivers for Health Care Providers. :47.
- 13 Glauser G, Wathen C, Miranda SP, et al. Letter to the Editor Regarding "Implementation and Workflow of a Telehealth Clinic in Neurosurgery During the COVID-19 Pandemic." *World Neurosurg.* 2020;139:373-375. doi:10.1016/j.wneu.2020.05.098
- 14 Miranda SP, Glauser G, Wathen C, et al. Letter to the Editor "Incorporating Telehealth to Improve Neurosurgical Training During the COVID-19 Pandemic." *World Neurosurg.* 2020;139:728-731. doi:10.1016/j.wneu.2020.05.116
- 15 Kahn EN, La Marca F, Mazzola CA. Neurosurgery and Telemedicine in the United States: Assessment of the Risks and Opportunities. *World Neurosurg.* 2016;89:133-138. doi:10.1016/j.wneu.2016.01.075
- 16 James HE. Pediatric neurosurgery telemedicine clinics: A model to provide care to geographically underserved areas of the United States and its territories. *J Neurosurg Pediatr.* 2016;18(6):753-757. doi:10.3171/2016.6.PEDS16202
- 17 Shafi K, Lovecchio F, Riew GJ, et al. Telemedicine in research and training: spine surgeon perspectives and practices worldwide. *Eur Spine J.* 2021;30(8):2143-2149. doi:10.1007/s00586-020-06716-w
- 18 AMA encourages telemedicine training for medical students, residents. American Medical Association. Accessed August 21, 2022. <https://www.ama-assn.org/press-center/press-releases/ama-encourages-telemedicine-training-medical-students-residents>
- 19 Individuals using the Internet (% of population) | Data. Accessed August 19, 2022. <https://data.worldbank.org/indicator/IT.NET.USER.ZS>
- 20 Silver L. Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally. Pew Research Center's Global Attitudes Project. Published February 5, 2019. Accessed August 21, 2022. <https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/>
- 21 Hollander JE, Carr BG. Virtually Perfect? Telemedicine for Covid-19. *N Engl J Med.* 2020;382(18):1679-1681. doi:10.1056/NEJMp2003539