CURRENTS

Neurocritical Care Insights and Perspectives From Around the World • September 2025

TURNING OVER

New Leaves

NEUROCRITICAL CARE SOCIETY

CURRENTS

News Magazine of the Neurocritical Care Society

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MESSAGE FROM THE EDITORS

Dear Colleagues,

It's that time of year again, and we're thrilled to share *Currents*' latest annual issue to coincide with the Neurocritical Care Society's 23rd Annual Meeting in Montréal. The theme of this year's issue—*Turning Over New Leaves*—speaks to the future of neurocritical care and the "leaves of change" transforming the field. But it also signifies a moment of transformation for *Currents* itself: after four years as Editor-in-Chief (and three years before that as the inaugural editor for Stories of Hope), it's finally time for me to pass the torch.

As we've navigated through some uncertain yet exciting times together, it's been a privilege to share this journey with our remarkable contributors, readers, and editorial board. I'm proud of what we've been able to achieve over these last few years, and I hope that the publication we've cultivated together reflects the innovation, dedication, and diversity of the neurocritical care community. But I also know that *Currents* will continue to evolve in the future, and I'm excited to turn over a new leaf and hand the reins over to our new Editor-in-Chief, Jordan Yakoby.

I first met Jordan at the NCS Annual Meeting in Vancouver in 2019, when he was already well on his way to becoming an accomplished educator, scholar, and leader—and eventually got him to join the *Currents* team in 2023. Since then, Jordan has been a key contributor on important issues ranging from neurocritical care education to nursing advocacy, and I have no doubt *Currents* will reach even greater heights in his capable hands.

We've still got one last hurrah together, though, and I'm proud to go out on a high note. It's been a banner year for *Currents*, and we couldn't possibly fit all of our outstanding features into just one issue—but we hope this one gives you a taste of some of the amazing things our contributors have been up to all year. Whether it's Stories of Hope about brain injury survivors and their journeys to recovery, thoughtful perspectives on cutting-edge technology and innovations in clinical practice, or other new insights into neurocritical care from around the globe, there's bound to be a little something for everyone to enjoy.

Although leaves may change and then fall, the future is bright for us all. The world of neurocritical care continues to grow every year, and *Currents* continues to grow right along with it. But we'll always make room for you to share your own story—all you have to do is turn the page, and there will be a new leaf for you, too.

Sincerely,

Michael Reznik, MD
Currents Editor-in-Chief

I am honored to be stepping into the Editor-in-Chief role. Mike's leadership has shaped *Currents* into the vibrant, thoughtful publication it is today, and I look forward to building on that strong foundation. My goal is to continue delivering timely, thought-provoking, and relevant content while collaborating with our editorial team and contributors to explore fresh ideas, highlight diverse voices, and showcase the incredible work happening across our field.

Jordan Yakoby, EdD, DNP, ACNP-BC, CCRN, CNE, FNYAM, FCCM, FNCS

NEUROCRITICAL CARE SOCIETY

NCS Leadership 2024-2025

Welcome to beautiful Montreal for the NCS's 23rd Annual Meeting! We're thrilled to have you here, as we once again come together to remember what is great about our society and the meaningful work we do for our patients throughout the year. It is time to celebrate, recharge, reengage, and reinvigorate.

Our theme this year is "Leaves of Change," and I cannot remember a year when there has been more change in our world. There are challenges for us to face like never before. But as neurointensivists, we are quite used to challenges, and I hope you'll join me in the hope that we face these challenges head-on, using our innate abilities to adapt, improvise, and persevere. These same qualities we use in the ICU every day suit us well for the extraordinary challenges facing the medical field.

We have an amazing program for you here, whether it's our special sessions, workshops, late breaking science, keynotes, or the many networking opportunities that you encounter. I think you'll find our keynotes particularly inspiring. Our INCC keynote speaker, Dr. Altaf Saadi, is a neurologist at Massachusetts General Hospital who has dedicated her career to social drivers of health, focusing on forcibly displaced persons, immigrants (including those in detention), and justice-involved people. We will also hear from the leaders of the HEARD Center, who continue to inspire us with their deep commitment to underserved people throughout the world of neurocritical care.

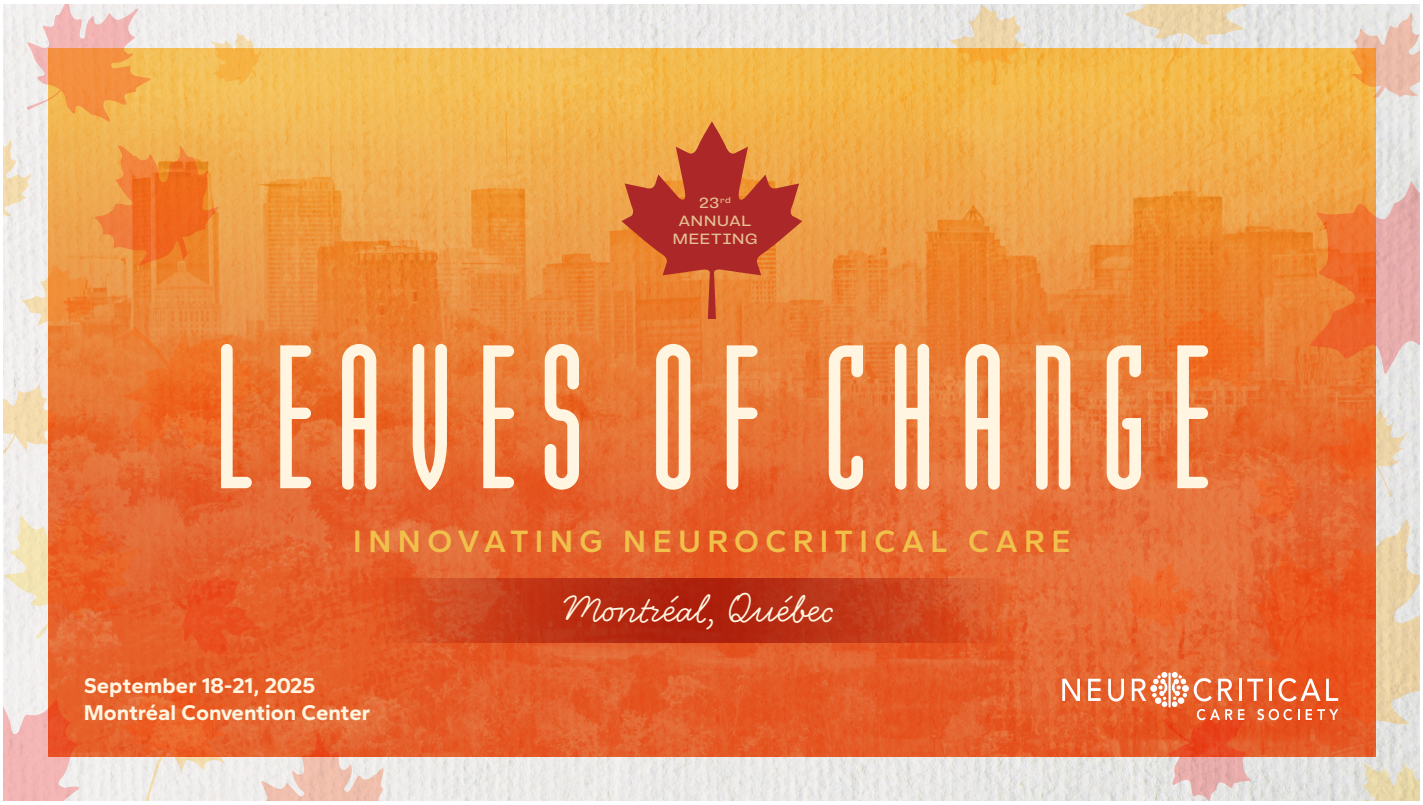
Our main keynote speaker is Dr. Jill Bolte Taylor, author of "My Stroke of Insight," which tells her story as a young neuroscientist who suffered a massive brain hemorrhage and lived to tell the story. We are so fortunate to have her with us, sharing her experience of receiving neurocritical care firsthand. She reminds us of the importance of what we do every day, as well as the great "saves" we all aspire to achieve with every patient who enters our ICU.

I am excited about the research and new discoveries you're seeing this week! We have new workshops this year, including Mechanical Ventilation for the Neurocritical Care Provider, Noninvasive Neuromonitoring, and others. The concurrent sessions are a great mix of research, practice, and quality/safety, so there's something for everyone at every learning level. We will hear about the latest advances in artificial intelligence in neurocritical care, microcirculatory function and support, and many other important topics.

But the best part of the Annual Meeting is the time we spend together. You'll see old friends and likely make some new ones. The social event will be on-site at the convention center this year, with beautiful views of the city. You'll surely venture into the great city and its surroundings, which make me feel like I'm enjoying a European town in the height of autumn.

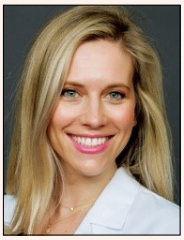
This is a great time for us to be together, feel inspired, and continue to move our great field forward. Together, we can face any challenge. The leaves are changing, and so are we — for the better.

Sincerely,
David Greer, MD, MA, FNCS
Vice President



Ray's Story of Hope

By Kathleen Skeins and Lauren Koffman, DO, MS



Life before the brain injury was busy. Ray was on the move all the time. He worked in the automotive industry for a supplier and was in Mexico, Canada, or China more than he was at home in Michigan.

In 2008 we were living in Northern Michigan but had to move to Texas for employment. After we moved back to Michigan, we purchased a small log cabin "up north" and this became our happy place when Ray wasn't working. We would spend time snowmobiling in the winter, making bonfires in the fall, and river tubing in the summer. I work as a travel agent, so we also tried to go on vacation as much as possible. Usually, we'd travel to somewhere in Mexico, but we had also been to Ireland the last couple of years. This past year we made it to Aruba, which was a bucket list trip for me, and there was never a dull moment.

On the Thursday of our trip, we signed up for an excursion to ride four-wheeled electric scooters. They were built for the military by an Israeli company and were virtually unflippable—or at least they were supposed to be.

We rode for almost three hours and were on our way back to end the excursion. Ray was riding behind our guide, who was some

Listen to Ray's inspiring story now available on the NCS Podcast, and stay tuned for more episodes coming soon!

distance in front of me. They went around a curve about 300 yards from the entrance to the excursion company. When I came around the corner, I saw our guide was on the ground next to Ray, holding Ray's head in his t-shirt. He turned and yelled to a co-worker to call an ambulance.

Many strangers stopped to help. They moved me out of the way and helped load Ray onto a stretcher and into the ambulance. Ray does not remember anything from the accident. He was not talking, just trying to take his oxygen mask off. Meanwhile, I was standing there in a wet bathing suit and cover-up before someone eventually gave me a blanket to wrap myself in. From the way Ray was breathing while unconscious on the ground, I already knew things were going to be bad. Somehow, I stayed calm and focused, waiting to find out what the next step would be.

At the hospital, I was told by the doctors that Ray had received a full body scan, and while they found no internal injuries or broken bones, he did have a severe traumatic brain injury (TBI) that could possibly be fatal. He was conscious at this time but heavily sedated. They told me they needed to completely sedate him and place a breathing tube.

The doctors pulled me aside to discuss what was happening. I asked the neurosurgeon if he could put in an ICP monitor to measure the pressure inside the brain, and he said they did not have the capability in Aruba to provide this kind of care. He mentioned that they normally send these kinds of complicated patients to Colombia. I am going to guess my facial expression said what I was thinking and another physician jumped into the conversation. This doctor had spent eight years as a Neuro-ICU doctor in Belgium and she was very clear she knew what she was talking about and how important it was to get to a more specialized facility as soon as possible. Unfortunately, Michigan was too far away, and Miami was as far as she would let him fly.

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The next morning, I saw my husband surrounded by machines and he looked like he had been in a boxing match. His face was swollen, his eyes were purple, and he was connected to a ventilator. He also had a C-collar on his neck for the only broken bone found—a chip at the base of his skull. While I was standing there in shock, the nurse kindly handed me a small plastic bag with Ray's wedding ring.

Within a few hours I was notified that the insurance company had arranged a medevac flight and that we would be on our way to Miami that afternoon. Jackson Memorial Hospital (JMH) said they had a bed available and were waiting for our arrival. When the medical flight crew, who I believe were a respiratory therapist and an ICU nurse, arrived at the hospital, things started to feel very black and white. I was asked if I understood what was happening and what the possible complications were with flying Ray to the United States. They were very direct and stated there was a chance Ray's brain could herniate in-flight and there would be little to nothing they could do for him, but staying in Aruba was just not an option. I was taken to the airport with my carry-on sized suitcase and Ray was taken by ambulance to the plane. You know it's a small island when the same ambulance crew that picked him up from the scene of the accident also delivered him to the airplane.

Once our plane arrived in Miami we were taken to the JMH by ambulance. It felt like a scene from a hospital TV show as we arrived at the trauma bay, with its glass doors opening and the EMTs wheeling in the patient on a stretcher, and the flight crew following behind them. Even further behind was a woman with some luggage and no clue where she was or even what her name was. The patient and stretcher were whisked away behind a sea of green scrubs, with at least 35 to 40 interns all angling to see what they could learn from this experience—an experience which became more and more surreal with each step.

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On the third day of our six week stay at JMH, Ray started to show increasing signs of stress after a resident came in and did a physical examination to test for a pain response. I was asked to go to the waiting room for a short time. Forty-five minutes passed and no one had come to update me, so I started having a complete meltdown. Eventually I went to find someone to tell me what was happening. I found out Ray's brain pressure numbers started to increase so they took him for a CT scan. Everything was fine with the CT but the fiberoptic cable for the ICP monitor had gotten bent and was not showing accurate numbers. It had to be wrapped for support, and Ray calls this time his "Teletubby" stage.

The following Monday morning I met the doctors who would be working with Ray for the next few days. The nurse practitioner who worked with the neurosurgeon covering Ray showed me his brain from the CT scans. She was straightforward and said that in most patients they would expect this to be a fatal injury. Because Ray's Glasgow Coma Scale (GCS) score was only 3, the lowest possible score, he was diagnosed with a severe TBI. They explained he had more than three locations of his brain affected, and they were going to try and save "what was left." I appreciated their honesty, and I was not delusional regarding his possibility of recovery. Still, I asked if the fact that he was so heavily sedated could have anything to do with the low GCS score. Plus, he hadn't gotten worse, so wasn't that a good sign? The team did acknowledge that the sedation could in fact be contributing to his low GCS. I also knew my husband and his personality, and I felt that this personality and his determination would be huge factors in his recovery. The team was noncommittal whenever I asked them about this, though, as they said they were unaware of anything that suggested personality played a role in TBI recovery.

Over the next couple of weeks I learned so much about all the machines and how Ray responded to the different medications and treatments. In addition to the breathing machine, he was on a cooling system that kept his temperature normalized. A couple of the doctors were very kind and took their time explaining things to me. I learned about how TBIs "normally" progress and how the first 10-14 days are vital to monitor for swelling and bleeding. Whenever I pointed out patterns I noticed with Ray

"Because Ray's Glasgow Coma Scale score was only 3, the lowest possible score, he was diagnosed with a severe TBI… They were going to try and save 'what was left.'"

> They told me that maybe his personality did have something to do with his recovery after all.

or gave them background on his health, the nurses were very supportive. The doctors, on the other hand, were a bit skeptical at first, but they came around to see I was able to help when they were not always there to see subtle changes.

Meanwhile, the University of Miami Health System (which is affiliated with JMH) had a research study in progress called Electrophysiologic Biomarkers of Consciousness Recovery after Acute Brain Injury. They asked if I would consent for Ray to be a participant and I was more than happy to help. They connected him to an EEG monitor and came in twice a day to have him listen to music and recorded commands as a way to look for brain activity that was clinically undetected. Unfortunately, Ray was so medicated and paralyzed as part of his medical treatment (to accommodate the cooling system) that he did not show any response, or at least none that I was aware of.

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Ray started to stabilize about two and a half weeks after his accident. His medical team slowly weaned him off the cooling system and then off each sedating medication. Time was passing quickly at this point, and they needed to get the breathing tube out of his throat. With the bone chip at the base of the skull, they called in a special team of surgeons to evaluate him. He was added to the surgery schedule so many times, but it kept getting cancelled and rescheduled. It was so frustrating not knowing when things would progress, but the surgery did eventually happen. It was a blessing in disguise.

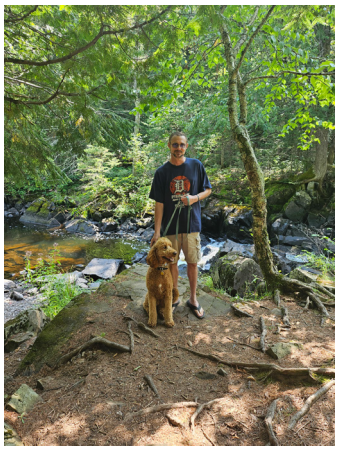
Over the weekend, Ray started to breathe "over the ventilator" on his own. There was a lot of activity going on between the respiratory therapists and the doctors. They were testing to see if he still needed the ventilator or if he could be extubated. He had been relying on the ventilator for about three and a half weeks at this point. Eventually, the doctor said "let's do it," and Ray was extubated and breathing all on his own a couple hours later. This was on April 1st, but even though it all seemed to happen all of a sudden, it was definitely not a prank.

From this point forward things started moving at warp speed. Once the breathing tube was out, we could hear Ray speak, although his voice started off as almost a whisper. Speech therapists had him do a swallow study and started letting him eat soft foods. He quickly discovered apple sauce was good until he tasted the medicine in it. His facial expressions and the hints of his personality were quite a hit with everyone.

He continued getting better and better each day. He was up in a special chair and then moving around on his own in bed. I came in one morning to find him restrained after he decided he wanted to go outside for a cigarette, even though he had quit smoking about three months earlier. Since being hospitalized he had lost about thirty pounds, but he was still so strong and felt like he was ready to go. It was frustrating to see him restrained and agitated, but it was also a special time—on April 5th, 2024, we celebrated our 18th wedding anniversary with him alive and kicking! Another day or so in the Neuro-ICU and we were then moved to the step-down unit.

For the next few days, Ray continued being a bit of trouble when he was awake. He needed a sitter and boxing gloves. He hated the soft collar they gave him and being connected to the IV. But he got more rest, better food, and became more active once he was in the step-down unit. It was hard for him to be dependent, and he would get agitated when he wasn't allowed to get out of bed on his own. The TBI had resulted in some weakness but his memory seemed to be intact, and he had no issues with speech aside from a gruffer than usual voice as a result of all the tubes.

> It was hard for him to be dependent, and he would get agitated when he wasn't allowed to get out of bed on his own.



> From the outside, our lives might now appear the same as they had been before—but if you had known Ray for a while before his accident, you could tell something had changed.

It was at this point someone from the team came back to check on us, and they told me that maybe his personality did have something to do with his recovery after all. I guess there are some things that science and medicine just can't predict.

* * *

Our next step was to get Ray back to Michigan. My goal was to get him into the Rehabilitation Institute of Michigan (RIM), which is part of the Detroit Medical Center family. After jumping through some hoops, they eventually agreed to take him, but our insurance had to agree to fly us home on another air ambulance. We were finally able to leave on April 16, 2024.

Ray spent a week at RIM in downtown Detroit. His personality was coming through so well, and the rehab team asked me if he was really himself or if it was the TBI talking. They weren't used to working with someone who was so sincere yet still had a sense of humor and completely understood sarcasm. He was officially sent home on April 23rd, 2024.

It took me some time to adjust to allowing Ray to re-learn how to do certain tasks. I initially thought he was being stubborn when he wouldn't do something when asked, but I soon realized it wasn't that he didn't want to do it, he just couldn't. The next few months were filled with doctor appointments, rehab, and Ray trying to cook. Making lists, following recipes, and remembering to turn off the stove were all big accomplishments for him.

> His personality was coming through so well, and the rehab team asked me if he was really himself or if it was the TBI talking.

We also went to counseling with TBI specialists. My counselor was such a tremendous help. She was able to help me understand what was happening in Ray's brain and she taught me how to look at things differently.

On July 16, 2024, Ray received a neuropsychological evaluation—this was at just the four-and-a-half-month mark, because he refused to wait six months to return to work. Everyone prepared me ahead of time that this was going to be a very rough day and that it would take all day to complete. The exam ended up taking about four hours, and Ray was told he made it through all the levels available. Next, he was tested by occupational therapy and underwent vision testing in order to be given approval to start driving again. On July 23rd, Ray regained his freedom and was able to go behind the wheel once more.

We received the neuropsychological evaluation results on August 1st and found out that Ray performed exceptionally well. The tests did recognize his usual issues with doing too many things at once and not paying attention to details. (Personally, I blame that on his being a man more than his cognitive capacity.)

On September 5, 2024, less than six months after Ray's accident, he returned to work. Within a month he was back to working full-time in his position as Director of Strategic Planning for an automotive supplier. The last step to close this chapter in our lives was Ray's completion of rehabilitation. The physiatrist from RIM had one last follow-up with him in October 2024, after which he was released from their care without any further follow-up visits needed.

From the outside, our lives might now appear the same as they had been before—but if you had known Ray for a while before his accident, you could tell something had changed. Fatigue remains a challenge for him, but not as much as it could have been considering the severity of his brain injury. We are adjusting to our new life but also trying to maintain some consistency and normality, especially when it comes to travel. Our first trip involving a flight will be to Jamaica for the winter holidays. It will be our first real trip since the accident and perhaps a test to see if Ray is ready to return to work travel. But we also have so many more adventures to look forward to, and the future is beginning to look bright. ●

Glen's Story of Hope

By Liz Jelnicky, ACNP-BC; Tommy Thomas, MD, PhD; Lauren Koffman, DO, MS



After landing in Atlanta on August 1, 2023, Glen Schultz made his way to the Sky Lounge at Hartsfield Jackson Airport to ride out his layover and check in with his family, as was his routine during his work trips. Glen had been en route to South Carolina following a speaking engagement in Alabama. In addition to being a three-time author and professor, he is founder and director of Kingdom Education Ministries, an organization developed for the purpose of educating future leaders to think and act from a biblical worldview. He has been married to his wife Sharon for 55 years and has three children and six grandchildren.

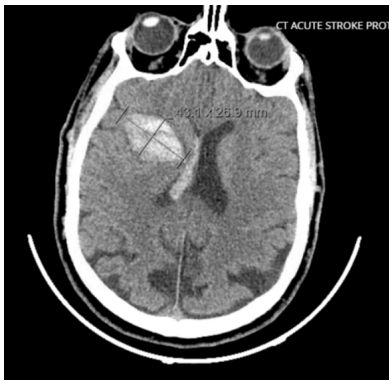
While in the lounge, Glen called his son, Jason, who was on vacation in Montana. On that call, Jason noticed that Glen, who was a proficient public speaker even at 76 years old, was slurring his words and speaking in incoherent sentences. Jason knew immediately that something was wrong and spent the next 45 minutes trying to contact emergency services in Georgia. Glen's grandchildren got on the phone to keep him occupied while Jason attempted to do the impossible and get Atlanta EMS to find Glen in one of many lounges in the busiest airport in the world. This initiated a cascade of events that eventually got Glen transported to Grady Memorial Hospital.

When he arrived in the emergency room at Grady, he was vomiting and no longer able to breathe safely. This prompted the emergency room physicians to place a breathing tube and put Glen on a ventilator. Unfortunately, a CT scan of his head showed a hemorrhage on the right side of his brain. With no history of hypertension and normal blood pressure upon arrival to the hospital, Glen's physicians determined that his brain bleed was most likely due to cerebral amyloid angiopathy (CAA), a condition where abnormal amyloid proteins build up and cause damage in blood vessels in the brain.

Glen's neurologic function improved from his early unresponsiveness, although he had many of the manifestations expected from a right-sided brain injury, such as left-sided weakness. Still, he maintained an extraordinary ability to communicate via writing. During morning rounds, he could be seen from the hallways paying his bills and writing instructions to his wife Sharon on how to handle their business affairs.

His stay in the ICU was a rollercoaster of ups and downs. His neurosurgery team placed a drain to help relieve the pressure that was building up in his brain, but the team would have a tough time getting it out in the ensuing days, as Glen continued to rely on the drain to maintain normal intracranial pressures. He also developed pneumonia, which is a common complication for patients supported by ventilators. After a little more than a week of these ups and downs, Glen and his family were advised to start thinking about planning for a tracheostomy and gastrostomy tube placement. These procedures would move the breathing tube from his mouth to his neck and allow for his nutrition to go directly through a tube in his stomach—both of which are typically more comfortable for people as they recover from a brain injury.





Considering Glen's ability to comprehend and express himself, he was naturally invited to participate in the conversations regarding the recommended procedures. When he was asked for his thoughts eleven days after his hemorrhage, Glen wrote fervently, "take the tubes out" and "DNR," which he underlined three times for emphasis. DNR is a code status that means "do not resuscitate" and would mean the team would not intervene if Glen's tubes came out and he required further life support. The ICU attending physician explained that taking the tubes out could lead to his death. In response, Glen wrote, "I understand the dangers." He signed his name to confirm. Sharon looked at us with wide eyes, seemingly pleading with us not to use these words as proof of his actual wishes.

Over the course of the next few days, Glen had lengthy discussions with his family. He remembers waking up one morning after a long night of prayer with an overwhelming sense of peace and purpose. He had undeniable clarity that his work in this life was not done, and he knew what he had to do. Ultimately, Glen decided to undergo the tracheostomy and gastrostomy tube placement.

After he was discharged to a long-term acute care (LTAC) facility on August 17th, 2023, he spent the next four months transferring from one LTAC to another and then to rehab. With each transfer he inched closer to South Carolina. Finally, on January 11, 2024, he arrived home, over five months from the day he was initially admitted to Grady.

> "Glen has dedicated himself to the education and support of neurological injury survivors, and he has established a support group at his church."

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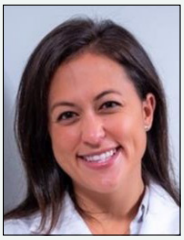
I recently called Sharon to get an update. I fully expected her to still be reading Glen's scribbled thoughts and requests. "Hold on, I have a surprise for you," she excitedly whispered into the phone. I heard a muffled "Glen, it's Liz from Grady," and the next words I heard were his, strong and clear: "Thank you for saving my life."

Despite our collective perceptions of Glen's comprehension during his ICU stay, he says his memories are sparse—only foggy memories of a "man in a white coat" but very little else. He described the months spent at LTACs and rehab and all the improvements he had made, now reaching the point of being able to "make the gym" once a day. Outside of getting his reps in, Glen has dedicated himself to the education and support of neurological injury survivors, and he has established a support group at his church.

Glen told me that his faith is what got him through those long, grueling months, and he wanted me to pass along his message of hope, reminding all of us and our patients that anyone can beat the odds. He reflected on attaining peace by knowing that his purpose in this life wasn't over, and he is now in the midst of writing his fourth book—his own survival story. ●

Who Invited Legal Into the Peer Review Conference?

By Krista Lim-Hing, MD; Alexandra Reynolds, MD; Daryl McHugh, MD; Julia Durrant, MD; Matthew N. Jaffa, DO





Introduction

When asking physicians to reflect on their years of medical training, it is rare to find one without a formative memory connected to a morbidity and mortality conference. The process of discussing complicated cases in an open forum can be traced to the early 20th century, when American surgeon Ernest Codman held conferences at Massachusetts General Hospital as a way to examine patient outcomes and evaluate surgeon competency. From there, modern morbidity and mortality (M&M) conferences have come to serve both an educational purpose and a method for quality improvement. The current model for M&M conference is a standard practice within most medical specialties and is mandated by residency programs as part of medical training. Patient cases, including near misses, significant injuries, and deaths, are selected for review by peer review committees in a confidential setting. These conferences encourage the participants to look to literature for up-to-date evidence-based medicine and discuss ways to clinically improve practices while also evaluating opportunities for improvement in the medical system. Ultimately, this century old practice was designed to provide a forum for professional discussion in a non-punitive environment with the hopes of improving the practice of medicine.

Historically, the legal system has ruled in favor of broad peer review privilege so physicians may conduct candid evaluations to improve future patient care. In 1970, via *Bredice v. Doctors Hospital, Inc*, the court held that documents created by the hospital's peer-review committee were not discoverable in medical malpractice suits. Variation in laws exist across the US regarding protections and privileges provided to hospital peer review and quality assurance committees. In 1986 as an attempt to standardize these laws, Congress passed the Health Care Quality Improvement Act, which established federal guidelines for peer review. Peer review today incorporates quality assurance programs and hospital credentialing, and it is a requirement for both Medicare and Medicaid funding and Joint Commission accreditation of hospitals.

Unfortunately, these time-honored peer review practices are under scrutiny after a number of landmark court cases in recent years. The American Medical Association (AMA) Litigation Center has followed cases closely through state courts. In the 2020 case *Leadbitter v. Keystone Anesthesia Consultants et al*., the Supreme Court of Pennsylvania overturned a lower court ruling allowing plaintiffs in a medical malpractice lawsuit access to peer review documents. In Michigan, a trial court ruling placed peer-review protection at risk in *Dwyer v. Ascension Crittenton Hospital*, though a subsequent ruling by the appellate court later reversed the decision, upholding confidentiality as an important aspect of the peer review process. Physicians in New York have seen the significant impact that these cases can have after precedent set in the recent case of *Siegel v. Snyder* has begun to alter their long-standing M&M practices.

Siegel v. Snyder

Historically, New York State has passed laws dictating that hospital quality assurance and peer review programs remain privileged information that is protected from mandatory disclosure in the case of litigation (Education Law § 6527 and Public Health Law § 2805-m). These laws have protected the quality assurance process within medical and dental care, and allowed members of such a committee to freely comment without concern that any statements made could become discoverable after the fact or require testimony in court regarding the content of these meetings. Of particular note, this law explicitly excludes any statements made by a person who later becomes subject of litigation: "The prohibition relating to discovery of testimony shall not apply to statements made by any person in attendance at such a meeting who is a party to an action or proceeding the subject matter of which was reviewed at such meeting" (Education Law § 6527 (3)).

Siegel v. Snyder was filed in 2016 regarding a patient who presented to the hospital after being struck by a vehicle and ultimately died in 2015. The care provided to this patient was reviewed by the hospital's Trauma Peer Review Committee at the time, which the hospital considered to be protected by Education Law § 6527 and Public Health Law § 2805-m. During the lawsuit, the plaintiff's legal team requested minutes of the

three peer review committee meetings that had been held after the patient's death and were provided with a partially redacted version of the minutes based on what they felt was appropriately discoverable. The minutes did not specify individual speakers or their respective comments. The Supreme Court of Nassau County reviewed the unredacted minutes and determined that a much more comprehensive version of the minutes be provided to the plaintiff's team as part of discovery. The Court declared that statements made during the peer review committee meeting could only remain confidential and remain protected were those that could be proven to have been made by someone other than the defendant. In this case, as most statements were attributed to "the committee," it was the defendants' burden to prove that any documented statement could not be attributed to the defendant themselves (*Siegel v. Snyder* 2019). The Second Department of the Appellate Court upheld on appeal that any Committee minutes protected by Education Law § 6527 and Public Health Law § 2805-m that do not have speakers identified are subject to discovery on the assumption that one cannot rule out that those statements were made by the defendants (*Siegel v. Snyder* 2021).

M&M Adjustments and Impact

While *Siegel v. Snyder* set a precedent in New York, variations in laws and their interpretation currently exist across the US. In both New Jersey and Pennsylvania, for instance, disclosures made by a peer review committee remain protected as long as any M&M documents created are used exclusively by the committee. If these documents are shared outside the M&M peer review committee, such privileges may be forfeited. While the federal Health Care Quality Improvement Act of 1986 established peer review standards, it did not embed protections for peer review documents from federal discovery. Therefore, federal legal cases, such as those involving the Emergency Medical Treatment and Active Labor Act, may require disclosure of M&M peer review documents.

Multiple hospitals and hospital systems have undertaken adjustments in their M&M process due to concerns about potential disclosures of M&M findings and discussions. Each approach introduces potential impacts for quality improvement processes and the academic mission of medical centers. One approach is for peer review committees to only discuss theoretical cases. Such an academic exercise essentially amounts to a form of standardized testing and clinical vignettes. Theoretical cases are likely to lack the nuances of real world situations, reducing learning opportunities for participants and limiting actual quality improvement. Furthermore, "theoretical" cases pulled from the hospital archives introduce the risk of being unmasked and potentially open to disclosure.

> "Regardless of the modified approach adopted, the result is a decline in an organizational culture promoting safety, disclosure of near misses and errors, and missed opportunities for quality improvement interventions."

A second modification to the M&M format might involve continuing the peer review without allowing those involved in direct care for the case under discussion to be present. Excluding these clinicians from the meeting would allow the discussion and materials developed during the peer review to remain protected from disclosure. However, this introduces a major limitation to the committee reducing its ability to determine systemic root causes for patient outcomes or to implement a quality improvement plan when appropriate.

Others might take a more casual approach to M&M with information presented directly from the electronic medical record without prepared notes or slides and elimination of any documentation of the discussions and/or conclusions of the sessions. However, avoiding documentation limits the quality of post-hoc analysis for improvement purposes and prevents opportunities for continued education based on the conclusions of the case, essentially eliminating the mission of any quality improvement committee.

In the most extreme cases, hospitals may consider eliminating M&M committees altogether and stop reviewing any cases which could potentially have legal ramifications. But this approach is in direct opposition to Codman's theory of the "end results system" and the M&M mission of improving patient safety and clinical outcomes.

Regardless of the modified approach adopted, the result is a decline in an organizational culture promoting safety, disclosure of near misses and errors, and missed opportunities for quality improvement interventions. Trainees will also not benefit from the learning opportunities and sense of responsibility that can be fostered in M&M sessions. Most importantly, quality improvement and patient outcomes will suffer. Confidential peer review is vital for health care improvement and accountability, especially in this age of increasing complexity and opportunities for practice improvement. ●

> "Confidential peer review is vital for health care improvement and accountability, especially in this age of increasing complexity and opportunities for practice improvement."

The Role of Ultrasound Guided Lumbar Puncture in the Neuroscience Intensive Care Unit: A Review and Case Presentation

By Cristian Cirjan, MD; Christy Alhannat, BS, BA; Swarna Rajagopalan, MD, MS



Introduction

Ultrasound-guided approaches to procedures such as lumbar punctures (LP) have demonstrated significant advantages over traditional palpation-based techniques in various clinical settings, including the neuroscience intensive care unit (Neuro ICU). Studies highlight several key benefits of ultrasound guidance, including improved success rates, reduced procedural time, fewer complications, and enhanced patient comfort, especially in patients with larger body habitus or anatomical variations. These advantages become indispensable in the Neuro ICU, where the window of opportunity to intervene on acute neurological diseases requires expedient analysis of cerebrospinal fluid.

Across a spectrum of experience and backgrounds, providers performing lumbar punctures succeed more frequently with ultrasound guidance. In the first meta-analysis comparing palpation versus ultrasound-guided techniques in 14 randomized controlled trials (of which 9 trials consisted of epidural catheterization), pooled data revealed that ultrasound guidance decreased the proportion of failed procedures (risk ratio 0.21, 95% CI 0.10-0.43) with an absolute risk reduction of 6.3% (95% CI 4.1%–8.4%) and a number needed to treat of 16 (95% CI 12-25) to prevent one failed procedure.[1] In a second meta-analysis using pooled studies of diagnostic lumbar puncture, spinal anesthesia, and epidural catheterization, there was a lower combined risk of technical failure (risk ratio 0.51, 95% CI, 0.32-0.80) with an ultrasound-guided technique compared to a palpation-based technique.[2] In the most recent meta-analysis of only diagnostic lumbar puncture, Gottlieb et al. found higher success rates in the ultrasound-guided group than in the palpation-guided group (90% vs. 81%), with an odds ratio of 2.1 (95% CI 0.66-7.44). Their analysis also revealed ultrasound-guided LP was associated with fewer traumatic taps (10.7% vs. 26.5%) and reduced pain compared to palpation techniques (3.75 vs. 6.31).[3] Similarly, a randomized controlled trial by Evans et al. noted a significant decrease in the number of needle insertion attempts when using ultrasound (1.54x more attempts, $p = 0.046$).[4]

Ultrasound-guided LP allows for the rapid identification of various anatomical structures relevant to the performance of an LP. In one cohort study, Ferre et al. found that high quality images of spinous processes, laminae, ligamentum flavum, dura mater, the epidural space, and the subarachnoid space could be obtained in around 1 minute (mean acquisition time 57.19 seconds; SD, 68.14 seconds; range, 10-300 seconds).[5]

As patients' BMIs increase, identifying these structures to guide placement and trajectory of the needle becomes exceedingly helpful. When comparing a palpation-based technique to an ultrasound-guided technique in patients with variable body mass index (BMI), Stiffer et al. found that success rates in identifying landmarks using palpation correlated with BMI. There was difficulty palpating landmarks in 5% of patients with normal BMI, 33% in patients who were overweight, and 68% of patients who were obese ($p < 0.0001$). In those patients whose landmarks were difficult to palpate, ultrasound allowed for the identification of relevant anatomy in 16 of 21 patients (76%)6. To illustrate how we use ultrasound at our institution, we will outline our ultrasound procedure and some typical cases we encounter within our Neuro ICU.

Technique

We use a high-frequency linear probe for greater resolution in order to identify anatomical landmarks. These include the spinous process on a transverse plane (the lumbar spinous process is centered on the screen, and a mark is made perpendicular to the transducer) and the interspinous ligament on a longitudinal plane (a mark is again made perpendicular to the transducer). Where the two lines intersect marks the ideal target for spinal needle insertion. A curvilinear or low-frequency phased-array probe may be used if a greater depth is desired, though this greater depth comes at the expense of reduced

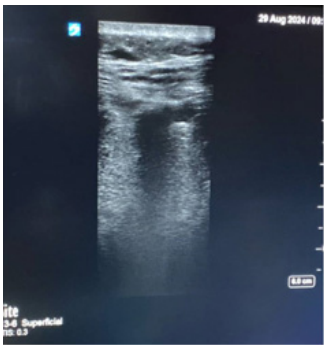


Figure 1: *The hypoechoic structure represents the spinous process, where the spinal midline may be marked.*

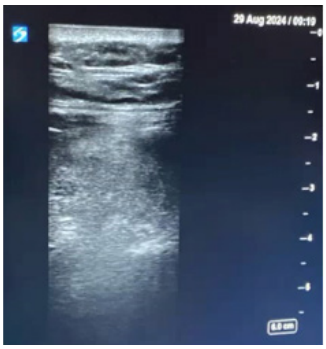


Figure 2: *The hyperechoic spaces in between the hypoechoic spaces represent the interspinous ligaments suitable for needle entry.*

resolution. To orient ourselves to the patient's vertebral levels, we begin by identifying the sacrum, whose appearance is distinct, and proceed to mark the two levels above that as possible insertion sites.

Case 1

An 83-year-old white female with a recent history of upper respiratory tract viral illness was brought into the emergency department after being found by a neighbor to be lethargic, confused, and with evidence that she had urinated herself. Upon arrival she was found to be febrile with a neurological exam revealing aphasia, right gaze preference, left facial droop, and left hemiparesis. Point of care EEG revealed status epilepticus. The patient was subsequently loaded with Ativan and Keppra and transferred to the Neuro ICU for further management. Overnight, a blind lumbar puncture was unsuccessful. An ultrasound guided LP was subsequently performed successfully.

A lumbar puncture revealed predominantly lymphocytic pleocytosis with 12/uL nucleated cells and 82 mg/dL protein level. She was subsequently continued on IV acyclovir given the CSF evidence of a likely viral or tick-borne encephalitis.

Case 2

A 59-year-old female with a history of Stage 4 small cell lung cancer with extensive metastases presented with one week of confusion, staring spells, and intermittent aphasia. The patient also had a recent hospitalization of grade 3 immune effector cell-associated neurotoxicity syndrome (ICANS). The patient was found to be disoriented, inattentive, and lethargic without evidence of focal deficits. An MRI brain did not reveal any abnormalities. Given the patient's encephalopathy and poor cooperation, we opted for an ultrasound-guided lumbar puncture to reduce the number of punctures and avoid the use of sedating medications. An ultrasound guided lumbar puncture was subsequently performed revealing an elevated CSF protein of 109 mg/dL with minimal pleocytosis. Subsequent CSF analysis ruled out infectious etiologies and the patient was started on dexamethasone 10 mg every 6 hours for treatment of recurrent Grade 3 ICANS.

Conclusion

In conclusion, ultrasound-guided lumbar puncture offers considerable advantages over traditional techniques, including higher success rates, increased efficiency, and more patient comfort, especially in patients with higher BMIs and abnormal anatomy. These benefits make ultrasound guidance useful for LPs in the neuro ICU, where precision, speed, and patient comfort define the standard of care. ●

References

1. Shaikh F, Brzezinski J, Alexander S, et al. Ultrasound imaging for lumbar punctures and epidural catheterisations: systematic review and meta-analysis. *BMJ*. 2013;346:f1720. doi:10.1136/bmj.f1720
2. Perlas A, Chaparro LE, Chin KJ. Lumbar neuraxial ultrasound for spinal and epidural anesthesia: a systematic review and meta-analysis. *Reg Anesth Pain Med*. 2016;41(2):251–260. doi:10.1097/AAP.0000000000000418
3. Gottlieb M, Holladay D, Peksa GD. Ultrasound-assisted lumbar punctures: a systematic review and meta-analysis. *Acad Emerg Med*. 2019;26(1):85–96.
4. Evans DP, Tozer J, Joyce M, Vitto MJ. Comparison of ultrasound-guided and landmark-based lumbar punctures in inexperienced resident physicians. *J Ultrasound Med*. 2019;38(3):613–620.
5. Ferre RM, Sweeney TW. Emergency physicians can easily obtain ultrasound images of anatomical landmarks relevant to lumbar puncture. *Am J Emerg Med*. 2007;25(3):291–296.
6. Stiffler KA, Jwayyed S, Wilber ST, Robinson A. The use of ultrasound to identify pertinent landmarks for lumbar puncture. *Am J Emerg Med*. 2007;25(3):331–334.

Age	BMI	Reason for US Guidance	Unguided Attempts	Guided Attempts	Technical Difficulties
83	27	Failed blind LP	3	1	none
59	23	Encephalopathy	0	3	Poor initial marking due to drooping skin
25	21	Encephalopathy	0	1	none
79	34	Failed blind LP	2	1	none

Table 1: *Characteristics of recent patients from our center's Neuro ICU who underwent ultrasound-guided lumbar puncture*

Making a Case for Ketamine in Pediatric Status Epilepticus

By Nicolas Chiriboga, MD, and Renad Abu-Sawwa, PharmD, BCPPS

Status epilepticus (SE) is one of the most common neurological emergencies in children, with 23 cases per 100,000 children and a mortality of up to 7%.[1] Children are at a particularly elevated risk for refractory status epilepticus (RSE), with up to 40% of pediatric cases developing RSE.[2] Furthermore these cases have a greater mortality, with a rate as high as 44%.[3] It is therefore imperative to appropriately diagnose and treat these patients in a timely manner. The selection of medications to treat SE in children is of the utmost importance, as particular pediatric populations are especially vulnerable to the adverse effects of certain antiseizure medications (ASMs) (e.g. valproic acid) and anesthetic infusions (e.g. propofol).

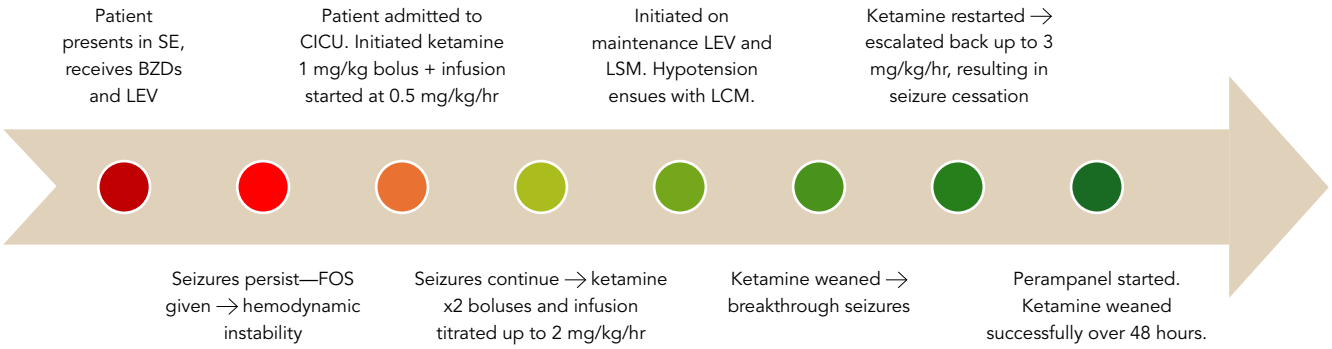
The use of ketamine for SE has gained renewed interest in the realm of pediatric neurocritical care in recent years. These efforts culminated in a meta-analysis we published earlier this year, featuring the possible role of ketamine in the management of SE in children.[4] The following patient case highlights the advantages of ketamine as a potentially safer alternative to traditional GABAergic anesthetic infusions (e.g., benzodiazepines, propofol, and barbiturates) in a patient population particularly vulnerable to their deleterious adverse effects.

A 2-year-old male with a history of hypoplastic left heart syndrome status post Norwood procedure presents to the hospital with right-sided focal seizures. Despite receiving multiple doses of benzodiazepines (BZDs) and a loading dose of levetiracetam (LEV) in the ED, his seizures persist. In an attempt to control his seizures, he then receives a loading dose of fosphenytoin (FOS) which leads to severe hypotension and hemodynamic instability. An epinephrine infusion is initiated, and the patient is admitted to the cardiac ICU (CICU), where he continues to have episodes of right arm shaking and eye deviation every 2-3 minutes.

A multidisciplinary discussion ensues between the neurocritical care team and the cardiac critical care team about the risks and benefits of escalation of therapy with anesthetic infusions. Of note, the moment of intubation (and initiation of positive pressure ventilation) poses a particular risk because of the patient's unique physiology. Therefore, the decision is made to trial ketamine without intubation. He receives a 1 mg/kg bolus of ketamine and is started on a ketamine infusion at 0.5 mg/kg/hr. Two additional 1 mg/kg boluses are administered due to persistent seizures, and his infusion is uptitrated by 0.5 mg/kg/hr increments until achieving a rate of 2 mg/kg/hr. At that point his clinical seizures subside, and his EEG is negative for subclinical seizures. His vital signs stabilize and remain normal, except for some intermittent mild hypertension and tachycardia. During this time, he remains on 4 L of 25% FiO2. He is initiated on maintenance LEV and lacosamide (LCM). Upon administration, the LCM results in profound hypotension and is subsequently discontinued. Ketamine is weaned 48 hours later, but due to breakthrough seizures is again restarted and escalated to 3 mg/kg/hr with resultant seizure cessation. After consultation with the epilepsy service, the decision is made to start perampanel (PER) via gastrostomy tube. After 48 hours of PER therapy, ketamine is weaned again over the course of 48 hours without further seizure recurrence. A few days later, the patient is discharged home with fewer than two short seizures a day, on a maintenance ASM regimen of PER and LEV, and a planned follow-up outpatient visit with pediatric neurology.

This patient case highlights the clinical implementation of ketamine based on our recent meta-analysis supporting the use of ketamine for pediatric SE.[4] In this study published in *Epilepsia*, we demonstrated that the addition of ketamine resulted in cessation of SE in 51% of cases. While this is similar to the

> "The use of ketamine for SE has gained renewed interest in the realm of pediatric neurocritical care in recent years."



clinical effectiveness of other infusions, there is an additional safety benefit, as none of the included studies reported significant side effects with the use of ketamine. Only minor and/or rare side effects were reported, including increased oral secretions, hypertension, and delirium.

When evaluating the specific patient factors from the case above in the context of our meta-analysis, a few noteworthy details should be highlighted. First, in terms of seizure types, most patients had focal seizures with secondary generalization in three of the included studies,[5,6,7] which was the case for the patient presented here. Second, some patients receiving ketamine never required intubation. In the largest cohort included in the meta-analysis, Jacobwitz and colleagues found that 4% of patients who received ketamine were not intubated.[8] Although this is not a large number, it is more notable to recognize that most patients were already intubated before ketamine initiation, and that other anesthetic infusions ubiquitously require intubation. Meanwhile, a study by Ilvento et al. found that the majority of patients from their cohort did not require intubation.[9] In the case above, one of the biggest benefits of ketamine for this patient was circumventing the need for a potentially risky intubation. In addition, given his cardiovascular history and episodes of profound hemodynamic instability with other ASMs that required vasopressors and admission to the CICU, there was concern that other anesthetic infusions could exacerbate his cardiovascular pathophysiology. Of note, in the aforementioned study by Jacobwitz et al., only 35% of patients receiving ketamine developed hypotension, of whom 92% developed hypotension prior to ketamine initiation (with their hemodynamics eventually stabilizing after the initiation of ketamine).[8] These considerations factored into the decision to trial ketamine in the case presented above. While ketamine proved effective in this case, the potential risks and benefits of ketamine for patients with SE and concurrent underlying cardiovascular disease should be evaluated on a case-by-case basis.

Although our meta-analysis distilled the available literature for ketamine in pediatric SE, it is important to recognize that the quality of evidence of the studies included remains low, with no clinical trials currently available. The only clinical trial attempted thus far was halted due to poor recruitment.[8] Nevertheless, ketamine remains a promising option for pediatric patients, but more research is necessary to better elucidate its role in the treatment of pediatric SE and RSE, ideally with randomized controlled trials. ●

References

1. Barzegar M, Mahdavi M, Galegolab Behbehani A, Tabrizi A. Refractory convulsive status epilepticus in children: Etiology, associated risk factors and outcome. *Iranian Journal of Child Neurology*. 2015;9(4):24–31. Available from: https://journals.sbmu.ac.ir/ijcn/article/download/7173/7809
2. Chin RFM, Neville BGR, Peckham C, Bedford H, Wade A, Scott RC. Incidence, cause, and short-term outcome of convulsive status epilepticus in childhood: Prospective population-based study. *The Lancet*. 2006;368(9531):222–229. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(06)69043-0/fulltext
3. Sahin M, Menache CC, Holmes GL, Riviello JJ Jr. Outcome of severe refractory status epilepticus in children. *Epilepsia*. 2001;42(11):1461–1467.
4. Chiriboga N, Spentzas T, Abu-Sawwa R. A systematic review and meta-analysis of ketamine in pediatric status epilepticus. *Epilepsia*. 2024.
5. Gaspard N, Foreman B, Judd LLM, Brenton JN, Nathan BR, McCoy B, et al. Intravenous ketamine for the treatment of refractory status epilepticus: A retrospective multicenter study. *Epilepsia*. 2013;54(8):1498–1503. Available from: https://pubmed.ncbi.nlm.nih.gov/23758557/
6. Rosati A, L'Erario M, Ilvento L, Cecchi C, Pisano T, Mirabile L, Guerrini R. Efficacy and safety of ketamine in refractory status epilepticus in children. *Neurology*. 2012;79(24):2355–2358. Available from: https://pubmed.ncbi.nlm.nih.gov/23197747/
7. Rosati A, L'Erario M, Bianchi N, Olivotto S, Battaglia D, Darra F, et al. KETASER01 protocol: What went right and what went wrong. *Epilepsia Open*. 2022;7(3):532–540.
8. Jacobwitz M, Mulvihill C, Kaufman M, Gonzalez AK, Resendiz K, MacDonald JM, et al. Ketamine for management of neonatal and pediatric refractory status epilepticus. *Neurology*. 2022;99:e1227–e1238.
9. Ilvento L, Rosati A, Marini C, L'Erario M, Mirabile L, Guerrini R. Ketamine in refractory convulsive status epilepticus in children avoids endotracheal intubation. *Epilepsy & Behavior*. 2015;49:343–346. Available from: https://moh-it.pure.elsevier.com/en/publications/ketamine-in-refractory-convulsive-status-epilepticus-in-children

Business of Neurocritical Care: Understanding Physician Benefits

By Ryan Hakimi, DO, MS, NVS, RPNI, CPB, FNCS, FCCM, FAAN

In general, when most neurointensivists look into selecting a job, we focus on the job requirements (schedule, call, support from APPs and trainees, title, etc.), income (base salary, wRVU bonus structure, quality bonus, etc.), and work environment (collegiality of team members, geographic location, academic affiliation, type of medical center, etc.). We rarely put much thought into the physician benefits (PBs). This is in part due to the fact that PBs are rarely emphasized by employers in the recruitment process, and in many cases we are only made aware of them after signing an offer letter. However, the level of PBs can vastly impact one's total compensation package (TCP).

Although no such report exists for neurointensivists, the 2021 American College of Physicians: Physician's Preparedness Report highlighted the variability in financial planning amongst internists, hospitalists, and internal medicine specialties.

Here we will discuss the retirement benefits component of PBs as they pertain to one's TCP. The details below apply to most centers but there are variations from one employer to another.

Retirement Benefits

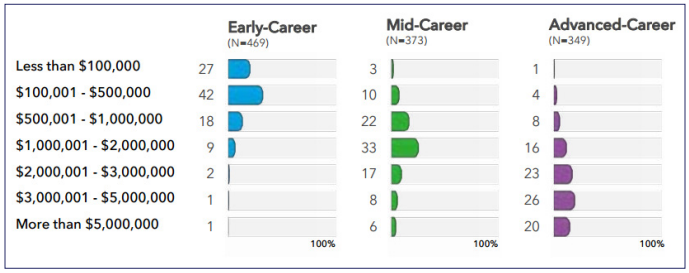
401(a)/401(k)

Basics: The 401(a) is an employer-sponsored retirement plan similar to a 401(k). The key difference is that a 401(a) is limited to government agencies (e.g., state and county hospitals), non-profit organizations, and educational institutions (e.g., university medical centers), whereas 401(k)s are associated with private companies. The employer sets the eligibility requirements but makes participation mandatory in an attempt to help their employees save money for retirement and reduce their tax burden.[1] 401(a) plans are often referred to as "free money" as they do not require any contribution from the employee. Depending on the situation, some employees are allowed to make additional contributions to their 401(a) plan at which

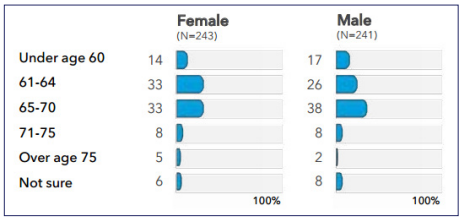
For purposes of this report, results are expressed by career stage, representing years in practice and age bands:

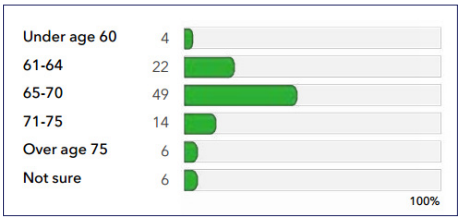
	Years in Practice	Physician Age Bands
Early-Career	0-16	30s and 40s
Mid-Career	~17-30	40s, 50s, 60s
Advanced-Career	~30+	60s, 70s, 80s

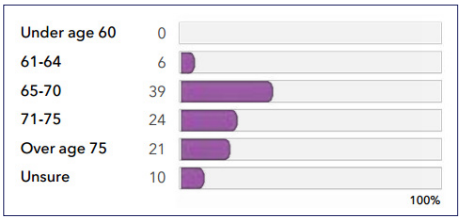
What is the approximate value of your current retirement savings portfolio?



At what age to you plan to retire?







point most physicians will be saving between $0.30 to $0.40 on every dollar that they are contributing. In other words, by making a contribution you will already be receiving a 30-40% up front return (money that would have gone to taxes had you not contributed). The investment options are set by the employer but usually include stocks, mutual funds, and bonds from large investment firms. The employer may also set a vesting period (a minimum duration of employment required to keep the funds).

Tax advantages: The employer contributes pre-tax dollars, which unlike personally-held brokerage accounts, means that you will not be taxed on interest, dividends, or capital gains on a yearly basis. You will pay regular income tax on qualified withdrawals which may begin as early as age 59 ½ but can be postponed until age 70. Most physicians begin qualified withdrawals once they retire, at which point they are in a comparatively low-income tax bracket as they are no longer earning a physician's salary and thus will have a lower tax burden on the portion that is withdrawn annually. If for some reason the money is withdrawn prior to age 59 ½, there is a 10% penalty plus income tax based on your current tax bracket at the time of withdrawal. For 2024, the annual contribution limit is $69,000.

403(b)

Basics: The 403(b) is a tax-favored retirement plan for employees of public schools, 501(c)(3) tax-exempt organizations, cooperative hospital organizations, or religious institutions. 501(c)(3) tax-exempt hospitals, often referred to as charity hospitals, are not-for-profit hospitals who meet a list of federal criteria and are exempt of federal tax. Cooperative hospital organizations, like credit unions, are co-owned and operated by their members for mutual benefit.[2] Most health systems offer an employer match (another source of "free money") for a fraction of the maximum allowed annual contribution ($23,000 for those under age 50 and $30,500 for those over 50). The same rules as in 401(a) plans apply for withdrawals.

Tax advantages: The tax advantages of the 403(b) can be thought of in two buckets. The first centers on "free money" from an employer match (if offered). For example, if an employer offers a 5% match that means that you would take 5% of your salary (pre-tax) and contribute it to your 403(b) plan and the employer would also add 5%. Because you will not pay taxes on the 5% that you contribute, your total reduction in your take-home salary will only be reduced by 3-3.5% (based on a 30-40% total annual tax burden) as opposed to 5%, yielding an up-front return of 1.5-2% on this component. This, coupled with the employer contribution of 5%, would yield a 6.5-7% up-front return even prior to the accumulation of tax-free capitalized interest during your years of employment and prior to taking a withdrawal.

457b

Basics: Like the 403(b), 457b plans are tax-deferred retirement plans, but they are limited to state and local government agencies or tax-exempt organizations as classified by the IRS.[3] The same rules as in 401(a) plans apply for withdrawals.

> "In the end, financial planning is a personal decision, and how much and with whom you choose to invest should be made by carefully reviewing the fine print associated with each investment."

Tax advantages: These plans are offered by some health systems and allow you to put away the same dollar limits imposed by a 403(b) plan. When offered together with a 403(b) plan, individuals under 50 can cumulatively set aside $46,000 annually, while those over 50 may set aside up to $61,000. In practice, if you were to set aside $61,000 in one year, your take home salary would only be reduced by $36,600 to $42,700 per year (based on a 30-40% annual tax burden). Of course, the secondary gain would be that your retirement account would be earning tax-free capitalized interest on that $61,000 as well.

Some people are leery of investing through their employer, as they are not certain how long they will be staying with the organization and are concerned about a perceived lack of portability and the number of investment options. It is important to note that you may continue to hold monies in these plans even after leaving your place of employment. However, you are always eligible to roll over the funds into a traditional IRA with the same investment firm or a different one of your choosing, all while maintaining their tax-free status. It is important to remember that large organizations negotiate extremely low operational expense rates for their plans (often below 0.5%). In contrast, individually invested monies in the same exact investment tool such as a mutual fund have a much higher expense ratio (often around 1%). Therefore, it is often financially worthwhile to maintain funds through your prior employer's retirement accounts if you are satisfied with the allocations in which they are invested.

In the end, financial planning is a personal decision, and how much and with whom you choose to invest should be made by carefully reviewing the fine print associated with each investment. ●

References

1. Internal Revenue Service. *Retirement plans FAQs regarding 403(b) tax-sheltered annuity plans*. Accessed July 6, 2024. https://www.irs.gov/retirement-plans/retirement-plans-faqs-regarding-403b-tax-sheltered-annuity-plans
2. U.S. Securities and Exchange Commission. *Investor.gov*. Accessed July 6, 2024. https://www.investor.gov
3. Internal Revenue Service. *Non-governmental 457(b) deferred compensation plans*. Accessed July 6, 2024. https://www.irs.gov/retirement-plans/non-governmental-457b-deferred-compensation-plans

Tricks of the Trade: A Stepwise Approach to Managing Post-TBI Agitation

By Christine Picinich, MS, AGACNP-BC, CCRN

Introduction

Patients with traumatic brain injury (TBI) commonly develop agitation during their recovery. Post-TBI agitation (PTA) can be caused by localized injury to the frontal lobe, temporal lobe, hippocampus, thalamus, hypothalamus, cingulate gyrus, or amygdala,[1,2] or it could also result from a more widespread injury (e.g., diffuse axonal injury [DAI]). PTA has been linked to impairments in memory, attention, and emotional regulation, with potential symptoms including aggression, restlessness, disinhibition, and emotional lability.[1] This behavioral complication of TBI may create safety issues for patients and staff while interrupting care. In severe cases, it can lengthen hospitalization and impact functional recovery.[2]

PTA can occur immediately after an injury, after the return of consciousness, or in a delayed fashion. Symptoms may be transient or long lasting and can exacerbate preexisting psychiatric conditions.[2,3] PTA may also occur in isolation or in conjunction with other symptoms associated with delirium, such as deficits in attention and awareness.[4] Further, it is important to recognize that agitation in patients with TBI may have a treatable underlying cause such as pain, discomfort, or anxiety. For these reasons, the evaluation and management of PTA is nuanced and requires thoughtful consideration. Nurses that care for TBI patients should receive focused education on PTA as they spend the most time with patients, are responsible for reporting their assessments, and exercise discretion when administering as needed medications. Frontline team members such as advanced practice providers may initially respond to patient concerns, and should be prepared to evaluate and manage PTA.

> “It is important to recognize that agitation in patients with TBI may have a treatable underlying cause such as pain, discomfort, or anxiety.”

Although most literature on PTA originates from the rehabilitation setting, some insights may be translatable to the acute phase of care. PTA can be challenging for hospital clinicians to manage without clear guidance, and the following stepwise approach may help guide evaluation and management of PTA in the acute care setting.

Step 1: Assess Agitation

There are several tools that can be used to assess PTA. However, as TBI patients can exhibit many different cognitive symptoms, it is important to distinguish PTA from other syndromes. For example, patients with PTA may exhibit additional signs of delirium, which should be assessed using a validated tool.[4,5] The Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) is perhaps the most widely used tool to assess for delirium in the ICU,[6] though it may have some limitations in patients with severe neurological injury. A recently developed tool called the Fluctuating Mental Status Examination (FMSE) may be a more reliable way to identify delirium in neurocritically ill patients, especially those with aphasia or other severe neurologic deficits.[7] On the other hand, some TBI patients may also develop signs of agitation as part of paroxysmal sympathetic hyperactivity (PSH), an entity which is distinct from delirium and PTA and which is typically associated with more pronounced autonomic symptoms.[1]

Once other syndromes have been considered, agitation should be assessed and monitored using a validated scale. For example, the Richmond Agitation-Sedation Scale (RASS) is often used and documented by bedside ICU nurses.[8] While it is not specifically for TBI patients, it can be used with intubated and non-intubated patients alike irrespective of their neurological deficits, and can be repeated multiple times in a shift to monitor for changes. Meanwhile, the Agitated Behavior Scale (ABS) is a tool that was developed to assess agitation in the acute and subacute period after TBI,[9] with assessments often completed once per day and

scores monitored by the treatment team to trend agitation over time or evaluate a patient's response to various interventions. The Rancho Los Amigos Scale[10] is another commonly used tool that assesses agitation while also monitoring other cognitive and behavioral symptoms throughout a patient's post-TBI recovery.

Step 2: Address Confounding Conditions

As many factors can impact agitation in TBI patients, it is important to consider a range of potentially confounding conditions. This includes pain, excessive stimulation from the environment, metabolic disturbances, infection, hypoxemia, urinary retention, nausea, sleep deprivation, or constipation.[1,4] Pain should be assessed and treated prior to treating agitation. Potential neurologic complications such as mass effect, hydrocephalus, and seizures should also be assessed and treated if identified.[1,4] A thorough history should be obtained to identify any preexisting psychiatric conditions and medication regimens that may need to be reinstituted.[3] Because PTA can also mimic acute intoxication or substance withdrawal, clinicians should review toxicology reports and obtain relevant social history. Trauma patients often have a variety of overlapping conditions and risk factors that contribute to behavioral complications, so a broad differential should be considered in the diagnostic evaluation of agitation in a TBI patient.

Step 3: Implement Non-Pharmacologic Interventions

As medications can worsen PTA, clinicians should maximize behavioral and environmental modifications to reduce PTA when able.[1-3] For example, patients with impaired memory can benefit from frequent reorientation and being surrounded by familiar objects and people. Staff should speak slowly, allow time for responses, and focus on one topic at a time.[1,5] Patients with attention and concentration deficits can benefit from less stimulation (e.g., noise, light, touch), limited distractions, and frequent breaks to rest.[1] It is also important to ensure that eyeglasses and/or hearing aids are easily accessible to patients who use them.

Impulsive patients may benefit from verbal and written reminders. Restraints should be avoided whenever possible to reduce anxiety and fear, which may exacerbate distress and agitation. Mittens may be a better-tolerated alternative when patients are likely to pull on important lines, drains, or tubes.[1,5] Sleep quality should be assessed daily to ensure patients are getting adequate rest at night. Initiating a nighttime routine, darkening the room, reducing noise, clustering care, and avoiding unnecessary interruptions at night can improve sleep.[4] Mobility in the ICU is important and can help to reduce delirium.[5] While many of these recommendations are sensible, they may be easy to overlook when working in a busy clinical environment. Bedside nurses are especially well-positioned to optimize non-pharmacologic interventions to reduce PTA and should be involved in multidisciplinary discussions.

Step 4: Review and Reduce Offending Medications

Many medications that are commonly used to care for TBI patients can worsen agitation. It is important to review all ordered medications and reduce or discontinue agents with unfavorable side effect profiles. It is also important to make medication changes in a stepwise fashion, so that responses can be adequately assessed.

For example, levetiracetam is a commonly prescribed antiseizure medication that may worsen agitation in some patients.[11] Switching to another antiseizure medication under the guidance of a neurologist may therefore be helpful in addressing agitation. Similarly, benzodiazepines may worsen agitation, are a known risk factor for delirium, and are associated with worse outcomes in TBI patients.[3,4] As a result, this class of medications should ideally be avoided when treating PTA. However, high doses of benzodiazepines may be needed to control seizures or elevated intracranial pressure in some cases. In these circumstances, benzodiazepines should eventually be weaned when it is deemed safe to do so, albeit in a gradual way to prevent withdrawal. On the opposite end of the spectrum, neurostimulants such as methylphenidate and amantadine may improve PTA in some cases or make it worse in others.[1-4] If neurostimulants do worsen PTA, they should be discontinued.

Step 5: Pharmacologic Management of PTA

If previous steps are insufficient in managing PTA, medications may be needed to ensure patient and staff safety. It is important to highlight that there are limited data to guide pharmacologic management of PTA,[1-3] and more research is needed to evaluate outcomes when using various classes of medications. In the meantime, clinicians are left to extrapolate data and tailor regimens based on individual characteristics and responses to therapy. For moderate-to-severe PTA, there are several categories of medications to choose from, each with varying mechanisms (Table 1).[1-3,12] Consultation with a pharmacist is recommended when prescribing medications for PTA as there are many caveats regarding dosage, monitoring, and drug-drug interactions.

Summary

Agitation is a common behavioral complication of TBI, and thoughtful assessment is required to distinguish PTA from other related syndromes. Nurses and other healthcare workers that care for TBI patients should receive education on PTA. Validated tools should be used to assess agitation and monitor response to therapies. It is important to evaluate and treat confounding conditions such as pain, and behavioral and environmental interventions should be optimized before starting medications to treat agitation. In parallel, other medications that can worsen agitation should be reduced or discontinued. For ongoing moderate-to-severe PTA, several categories of medications are available with varying mechanisms, and consultation with a pharmacist is highly recommended. Although there are limited data to guide practice, a stepwise approach may help

Table 1: *Pharmacologic agents used to manage post-TBI agitation*

Category	Medication	Pros	Cons	Contraindications
Stimulant	Methylphenidate	May reduce aggression in some cases	Hypertension, tachycardia May worsen aggression in some cases	Seizures, PSH
Dopamine agonist	Amantadine	May reduce irritability in some cases; may improve wakefulness & cognition	May worsen agitation in some cases	Seizures, PSH
Antiepileptic	Valproic acid	May reduce agitation	Risk for liver dysfunction, thrombocytopenia, hyperammonemic encephalopathy	Liver dysfunction, pregnancy, drug-drug interactions
	Carbamazepine	May reduce agitation	Risk for liver dysfunction, hyponatremia, Stevens-Johnson syndrome	Liver dysfunction, drug-drug interactions
	Gabapentin	May treat agitation, withdrawal, neuropathic pain, and PSH	Can cause sedation, decrease mental status	Renal impairment requires dose reductions
Antipsychotic	Haloperidol	Rescue for severe agitation; IV/IM options available	Should be used for rescue only, associated with worse outcomes	Prolonged QTc
Atypical antipsychotic	Quetiapine	Rescue or scheduled maintenance medication for agitation; may reduce insomnia	May cause oversedation; only enteral option available	Prolonged QTc, orthostatic hypotension
	Olanzapine	Rescue or scheduled maintenance medication for agitation; oral, dissolvable, and IM options available	May cause oversedation	Prolonged QTc
Beta-blocker	Propranolol	May improve restlessness; can be helpful for PSH; associated with improved outcome	Can cause bradycardia, hypotension	Bradycardia, hypotension, heart block
Central alpha agonist	Clonidine	May treat agitation, withdrawal, hypertension, PSH	Can cause sedation, bradycardia, hypotension	Hypotension, bradycardia
	Guanfacine	Fewer cardiovascular effects, can help with agitation, inattention, delirium; may improve cognitive outcome in TBI	Can cause hypotension, limited data for agitation, no data for PTA	Hypotension, bradycardia
Antidepressant	Trazodone	Can be helpful for sleep-wake cycle regulation	Anticholinergic effects, risk of serotonin syndrome	Prolonged QTc
	Buspirone	Non-sedating, can be helpful for agitation and anxiety	Delayed effect (2-3 weeks)	Seizures

PSH: Paroxysmal sympathetic hyperactivity, PTA: Post-TBI agitation

guide evaluation and management of PTA. However, patient responses to interventions may vary, so patients should be closely monitored. More research is needed to better understand PTA in the acute care setting. ●

References

1. Capizzi A, Woo J, Verduzco-Gutierrez M. Traumatic brain injury: An overview of epidemiology, pathophysiology, and medical management. *Med Clin North Am*. 2020;104(2):213–238. doi: 10.1016/j.mcna.2019.11.001
2. Rahmani E, Lemelle TM, Samarbafzadeh E, Kablinger AS. Pharmacological treatment of agitation and/or aggression in patients with traumatic brain injury: A systematic review of reviews. *J Head Trauma Rehabil*. 2021;36(4):E262–E283. doi: 10.1097/HTR.0000000000000656
3. Robert S. Traumatic brain injury and mood disorders. *Ment Health Clin*. 2020;10(6):335–345. doi: 10.9740/mhc.2020.11.335
4. Roberson SW, Patel MB, Dabrowski W, et al. Challenges of delirium management in patients with traumatic brain injury: From pathophysiology to clinical practice. *Curr Neuropharmacol*. 2021;19(9):1519–1544. doi: 10.2174/1570159X19666210119153839
5. Reznik ME, Slooter AJC. Delirium management in the ICU. *Curr Treat Options Neurol*. 2019;21(11):59. doi: 10.1007/s11940-019-0599-5
6. Ely EW, Inouye SK, Bernard GR, et al. Delirium in mechanically ventilated patients: Validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). *JAMA*. 2001;286(21):2703–2710. doi: 10.1001/jama.286.21.2703
7. Reznik ME, Margolis SA, Moody S, et al. A pilot study of the Fluctuating Mental Status Evaluation: A novel delirium screening tool for neurocritical care patients. *Neurocrit Care*. 2023;38(2):388–394. doi: 10.1007/s12028-022-01612-1
8. Sessler CN, Gosnell MS, Grap MJ, et al. The Richmond Agitation-Sedation Scale: Validity and reliability in adult intensive care unit patients. *Am J Respir Crit Care Med*. 2002;166(10):1338–1344. doi: 10.1164/rccm.2107138
9. Wilson HJ, Dasgupta K, Michael K. Implementation of the Agitated Behavior Scale in the electronic health record. *Rehabil Nurs*. 2018;43(1):21–25. doi: 10.1002/rnj.297
10. Lin K, Wroten M. Ranchos Los Amigos. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448151/
11. Strein M, Holton-Burke JP, Stilianoudakis S, et al. Levetiracetam-associated behavioral adverse events in neurocritical care patients. *Pharmacotherapy*. 2023;43(2):122–128. doi: 10.1002/phar.2760
12. Jiang S, Hernandez M, Burke H, et al. A retrospective analysis of guanfacine for the pharmacological management of delirium. *Cureus*. 2023;15(1):e33393. doi: 10.7759/cureus.33393

When the Algorithm (and Education) Aren't Enough: Clinical Judgment in the Neuro ICU

By Jordan Yakoby, EdD, DNP, ACNP-BC, CCRN, CNE, FNYAM, FCCM, FNCS

In my view, modern healthcare is plagued by two critical issues: the excessive reverence of protocols at the expense of sound clinical judgment and a looming educational crisis. Algorithms, protocols, and checklists guide many aspects of care, especially in the care of patients suffering from stroke or other cerebrovascular diseases. These protocols provide consistency, promote safety, and reflect evidence-based best practices. Yet, in the neuro ICU, where subtle changes may signal catastrophic deterioration, there remains no substitute for expert clinical judgment. Nurses and advanced practice providers (APPs) are often the first to detect these early warning signs, which are not always captured by a score, guideline, or imaging study. In these moments, when the 'algorithm' isn't enough, clinical judgment becomes the most vital tool we possess. At the same time, neurocritical care professionals have known for some time how difficult it is to recruit and retain qualified professionals in this important specialty.

Pattern Recognition and the Subtle Decline

While protocols reduce variation and improve care standardization, over-reliance on them can lead to delays in care or poor outcomes. Protocols are written with the average patient in mind, but neuro ICU patients are often anything but average. Additionally, much of the critical care literature is difficult to generalize to the neurocritically ill patient population. For example, ventilator weaning protocols may not fully capture the likelihood of tolerating extubation in a patient with a posterior fossa hemorrhage and brainstem compression who is otherwise doing well on minimal settings. In such cases, providers must adapt care to the specific clinical scenario and not the other way around.

> "In these moments, when the 'algorithm' isn't enough, clinical judgment becomes the most vital tool we possess."

With time, APPs and bedside nurses develop a form of expert intuition with experience - the recognition that a patient "doesn't look right," even when vital signs are stable and the Glasgow Coma Scale or NIHSS are unchanged. For example, a patient with a subarachnoid hemorrhage may show signs of delirium like a delay in response time, agitation, confusion, or changes in mood or affect—any of which could be potential indicators of cerebral edema, delayed cerebral ischemia, vasospasm, or hydrocephalus. These findings may not trigger any algorithmic intervention (such as the order to "notify provider for a GCS change ≥ 2" at this author's hospital), but timely recognition and advocacy by the nurse or APP can prompt re-imaging, adjustment of monitoring, or escalation to neurosurgical or neurointerventional consultation.

Case Reflection: When Checklists Fall Short

A middle-aged patient recovering from decompressive craniectomy for malignant edema following intracranial hemorrhage was initially 'stable'—awake and following simple commands, though with left hemiparesis, neglect, and homonymous hemianopia. However, overnight, the bedside nurse noted slight restlessness and difficulty engaging the patient during routine neurologic assessment. As per the NIHSS, the exam was still technically within baseline. Nonetheless, the nurse escalated the concern to the APP, who ordered a repeat CT head. Head CT revealed subtle hydrocephalus and evolving perihematomal cerebral edema, leading to the initiation of hyperosmolar therapy. Clinical vigilance, not protocol adherence, led to a much-needed escalation in care.

Teaching the Gray Areas

It seems that year after year it becomes more and more difficult to recruit and retain professionals who can move past the earlier stages of clinical judgment development and thus be able to think beyond what our protocols require. In neurocritical care, the line between a stable and decompensating patient is often thin, and not always evident on paper. In my time as an educator and seasoned professional, I have often lamented that new graduate professionals of all 'disciplinary stripes'—nurses, physicians, advanced practice providers, and others—are often linear thinkers. 'If this, then that' goes the thinking. Indeed, Patricia Benner, a prominent nursing theorist identified this in her Novice to Expert theory as the prevailing pattern of thought in the early stages of a nurse's development,[1] which I would argue applies to other disciplines as well.

A few recent events inspired me to renew my calls for hospital leaders, such as neuro ICU medical directors, lead/supervising APPs, nurse managers, and hospital nurse educators to do more to properly orient new nurses and APPs to the neuro ICU. Hopefully, heeding my call will remedy the problems described at the outset. First, a colleague recently recounted the challenge of a new graduate physician assistant (PA) who has had difficulty transitioning from student PA to practicing professional. From failing to recognize the importance of a patient's subtle neurologic change to difficulty applying the knowledge gained from the NCS Advanced Practice Provide Orientation Course© to real bedside clinical practice, their orientation has been marred with challenges. And in my own hospital, there have been several instances of new graduate nurses (or nurses new to the neuro ICU) requiring multiple extensions to their orientation or even transfer to a lower acuity unit due to difficulties meeting the defined outcomes of their orientation program.

In each of these cases, I have asked myself rhetorically, 'are we serving these professionals the best we possibly could?' I have previously written, both here in Currents and elsewhere, about the need for pre-licensure programs to step up their game and improve educational outcomes to prepare clinicians who are more 'practice ready.' Keeping this in mind, I can only wonder if we are not doing enough to identify knowledge and practice gaps and taking the right steps to remediate. I heard seasoned clinicians say many times to a more junior colleague, "you need to read more." Perhaps, though, the issue is more translational rather than purely knowledge based. Clinical judgment is not innate. For nurses and APPs new to neurocritical care, structured orientation programs with increasing clinical exposure, real-time feedback, and case-based learning are essential. Exposure to uncertainty is a must. For this reason, perhaps we should be using more simulation-based techniques to onboard these new graduate professionals.

It is true that not every hospital has the same level of resources. However, it is important to recognize that simulation is not limited to state-of-the-art manikins. In fact, high-fidelity simulation is not dependent on the modality, nor is it exclusive to a specific kind of patient simulator; modality and fidelity are distinct concepts in healthcare simulation.[2] Case studies,[4] standardized patients,[3] and role play[5] have long been a mainstay in health professions education and can be effective teaching-learning practices if carefully designed and implemented. Video recording of these sessions with guided review and debriefing can be instrumental in remediating knowledge and practice gaps.[6]

Simulation-based training, especially high-fidelity, can immerse new clinicians in these gray areas. Scenarios involving delayed herniation, occult seizures, or subtle clinical changes challenge clinicians to interpret nuanced findings, synthesize multiple data points, and act decisively when protocols are silent. The orientation of new staff should include more simulated scenarios to teach new graduates, both RN and APP alike, the nuances of each scenario and how to manage them. Learning to properly assess, diagnose, and manage these high stakes scenarios in the low-risk simulation environment can be the difference between life and death later on.

To address the dual crises of overreliance on protocols and inadequate preparation of new graduates, simulation must be embedded within every orientation program— not just as an afterthought or optional enrichment, but as a foundational component of training. It should focus on common yet high stakes neurocritical care scenarios that demand real-time interpretation of nuance, not rote adherence to flowcharts.

Simulation should help new RNs and APPs not just memorize what to do, but also learn how to think. Sometimes the best outcomes begin with a hunch. And in the neuro ICU, that can make the difference between irreversible decline and meaningful recovery.

A Call to Action

Beyond this, I would urge the Neurocritical Care Society to partner with hospital systems to develop and pilot a neurocritical care orientation program embedding these and other principles. Such an initiative could represent the foundation of an impactful research study while also potentially leading to better clinical outcomes. ●

References

1. Benner, P. (1982). From novice to expert, *American Journal of Nursing, 82*(3), 402-407.
2. Carey, J., & Rossler, K. (2023). The how when why of high fidelity simulation. *StatPearls*. StatPearls Publishing.
3. Chen, S.H., Chen, S.C., Lee, S., Chang, Y, & Yeh, K. (2017). Impact of interactive situated and simulated teaching program on novice nursing practitioners' clinical competence, confidence, and stress. *Nurse Education Today, 55*, 11-16.
4. Englund, H. (2020). Using unfolding case studies to develop critical thinking skills in baccalaureate nursing students: A pilot study. *Nurse Education Today, 93*, N.PAGN. PAG. doi: 10.1016/j.nedt.2020.104542
5. Kim, E. (2018). Effect of simulation-based emergency cardiac arrest education on nursing students' self-efficacy and critical thinking skills: Roleplay versus lecture. *Nurse Educator Today, 61*: 258-263. doi: 10.1016/j.nedt.2017.12.003.
6. Strand, I., Gulbrandsen, L., Slettebø, Å., & Nåden, D. (2017). Digital recording as a teaching and learning method in the skills laboratory. *Journal of Clinical Nursing (John Wiley & Sons, Inc.)*, *26*(17-18), 2572-2582. doi:10.1111/jocn.13632.

A Looming Crisis in Neurocritical Care Due to Hospital Closings

By Peter J. Papadakos, MD, FCCM, FAARC, FCCP

Over the last few years, many hospitals and clinics have been forced to close due to staffing, low reimbursement rates, and increasing operational costs. This healthcare crisis has especially affected rural areas in the US: more than 20 percent of our nation's rural hospitals (or 430 hospitals across 43 states) are near collapse, and about 41 percent of rural hospitals operate at a negative margin, meaning they lose more money than they earn from operations. Since 20 percent of Americans live in a rural county, this would greatly impact patient care in both the short and long term. While the immediate medical consequences are obvious, the impact on supporting services such as pharmacies and clinics will also be substantial. Rural areas will be left without routine primary care, maternity care, or emergency care.

The downstream effects will undoubtedly be felt in neurocritical care, too. With a loss of routine primary care services there will be an increase in untreated hypertension, diabetes, heart disease, sleep apnea, asthma, and many other diseases. The consequences of this will likely lead to an increase in patients with stroke, subarachnoid hemorrhage, and status epilepticus. Meanwhile, patients with acute issues such as traumatic head injury and seizures will be unable to receive early resuscitation and stabilization, and they will lose access to organized networks that can ensure timely transfers to larger referral hospitals. Importantly, rural patients will also lose access to early stroke interventions that have greatly impacted mortality and morbidity worldwide.

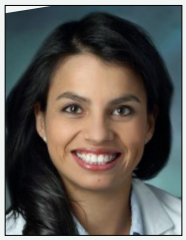
> "This downstream loss of rural care will rapidly affect the financial health of large referral hospitals and create bed shortages which will disrupt our operations and our ability to provide world-class neurocritical care."

Our ICUs will now have to care for more patients who are excluded from early treatments because they arrive outside of the therapeutic window required for positive outcomes. I predict that this will cause an increase in ICU lengths of stay because of patients who require longer-term mechanical ventilation and ultimate placement in long-term care facilities. This downstream loss of rural care will rapidly affect the financial health of large referral hospitals and create bed shortages which will disrupt our operations and our ability to provide world-class neurocritical care. This influx of patients will also greatly affect staff wellness and may lead to burnout and staff losses in an already stressed system.

As a group of dedicated health professionals who provide care to a diverse patient population, we must act now. We need to contact our local, state, and federal elected officials and inform them that this is a recipe for disaster. Our institutions should also act to create urban-rural partnerships to provide clinical assistance to struggling facilities. For example. some services such as expensive imaging may be more easily provided by mobile imaging vans, which would mean that rural hospitals would not need to invest in high-priced technology. Other technology can also play a role in aiding rural health care, such as virtual access to specialists and shared electronic medical records that can improve health care delivery. We all appreciate that early access to primary care and close follow-up can decrease the need for expensive critical care services, so we need to lend our voices to prevent future admissions to our ICUs. ●

Global Health Helps Achieve the Unimaginable

By Lucia Rivera Lara, MD, and Jose Kuzli, MD

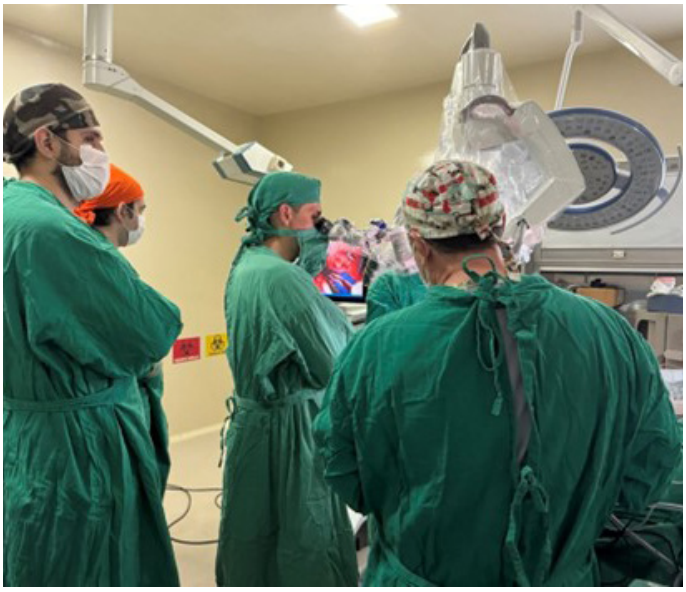


"Alone we can do so little, together we can do so much" – Helen Keller

The power of a team that Helen Keller so famously described was the exact feeling we experienced this past spring during a medical mission at the Hospital Nacional de Itauguá in Paraguay. Organized with the Solidarity Bridge Neurosurgery and Neurology Institute, our multidisciplinary team consisted of neurosurgeons Dr. Richard Moser and Dr. Nirav Patel, neuro-anesthesiologists Dr. Grace Kim and Dr. Deepak Sharma, neurointensivist Dr. Lucia Rivera Lara, surgical technician Carlos Vazquez, team leader Lindsay Doucette, and team chaplain Mary Sanchez. Our host was Dr. Jose Kuzli, the Director of Neurosurgery and Neurology at Hospital Nacional de Itauguá, who welcomed our team and introduced us to the staff.

Our week-long stay at Hospital Nacional de Itauguá was full of momentous events. No fewer than six complex high-grade arteriovenous malformation (AVM) surgeries were performed by Dr. Kuzli and Dr. Patel. These surgeries might not have been possible without the guidance of Dr. Patel, a cerebrovascular neurosurgeon at Brigham and Women's Hospital in Boston, MA, and the rest of the team. Dr. Sharma and Dr. Rivera Lara gave daily lectures on stroke and neurocritical care to residents, fellows, and attendings, with additional lectures at conferences for regional neurosurgery and critical care societies. Dr. Sharma and Dr. Rivera Lara also conducted daily neurocritical care rounds with trainees, as well as multiple hands-on training sessions on transcranial Doppler and optic nerve sheath ultrasound. Patients' families were extremely grateful for their care and the opportunity for their loved ones to undergo complex vascular neurosurgical procedures, and they shared many stories about their journeys to find access to neurosurgical care with Mary Sanchez and Dr. Richard Moser, who was the leader of the mission.

"Before this program started, these types of complex AVM cases were sent to other countries to get done," Dr. Kuzli said. "This program has allowed for significant growth in vascular neurosurgery, not only through improvements in surgical technique but also with equipment donations. We saw our outcomes further improve after the multidisciplinary collaboration with neuro-anesthesiologists Dr. Kim (from



Brigham and Women's Hospital in Boston, MA) and Dr. Sharma (from the University of Washington in Seattle, WA). Dr. Kim and Dr. Sharma left their fingerprint of excellence with our anesthesiologists. Furthermore, given that we do not have expertise in neurocritical care, we invited Dr. Lucia Rivera Lara (from Stanford University in Palo Alto, CA) to give neurocritical care conferences and neurocritical care rounds with training in neuromonitoring. This created a spark in young physicians who are eager to learn more. This project has had a great impact on our trainees and their future. I hope it continues to grow, and I hope the team—neurosurgery, neuroanesthesia, and neurology—comes to Paraguay more often, at least twice a year."

There was widespread agreement with the positive impact of the program. "I felt overjoyed to share my knowledge in neurology and neurocritical care," Dr. Rivera Lara added, "as well as very privileged to have the opportunity to learn from and share ideas with a group of very compassionate, smart, and driven doctors from Paraguay. They all wanted to learn as much as possible; they came to daily lectures even on holidays, asked questions, and stayed late. They truly wanted to help their patients, even though they understood that their capabilities are limited by the lack of resources such as medicines, imaging, infrastructure, and staff. For example, for the management of blood pressure in acute hemorrhagic stroke, they do not have access to labetalol or nicardipine drips; they have to use nitroglycerine or nitroprusside instead. For the management of acute stroke, they have alteplase but do not have access to thrombectomy or perfusion imaging. Sometimes, even getting a computed tomography angiography (CTA) scan is not possible. It makes you really appreciate the huge opportunity we have to treat our patients with the best medications and latest technology and, more importantly, work harder to overcome global health disparities."

Why Get Involved in Global Health?

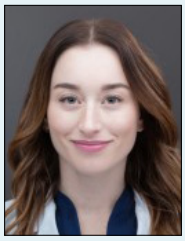
Neurological disorders are the leading cause of mortality and disability worldwide, which emphasizes the enormous public health impact of these conditions.[1] Disability associated with neurological disorders is disproportionately higher in lower- and middle-income countries, not only due to limitations in treatment and rehabilitation but also due to limited access to specialized care. This gap in access calls for an army of neurologists, neurointensivists, neurosurgeons, neuroanesthesiologists, pharmacists, nurses, and philanthropists to work together to identify effective approaches for the prevention, treatment, and rehabilitation of neurological disorders worldwide. After all, as Helen Keller said, together we can do so much—so let us all work together to overcome global health disparities. ●

Reference

1. Global, regional, and national burden of disorders affecting the nervous system, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet Neurology*. 2024;23(4):344-81.

Conference Spotlight: International Stroke Conference 2025

By Phoebe Johnson-Black, MD



At February's International Stroke Conference in Los Angeles, the biggest news was presented at the opening session: thrombectomy is no better than medical management for medium-vessel occlusions (MeVOs). Three randomized-controlled trials, ESCAPE-MeVO, DISTAL, and DISCOUNT, found no clinical benefit with thrombectomy for distal- or medium-vessel occlusions (D/MeVOs).

1. Endovascular Treatment for Distal-/Medium-Vessel Occlusion (D/MeVO)

Since 2015, when multiple trials found benefit from early thrombectomy in large vessel occlusion, the indications for endovascular therapy (EVT) have expanded at a rapid pace, with benefit demonstrated in the extended window in 2018 and in large-core infarcts in 2023. The field may be nearing the limitations of clot retrieval (at least with existing technology), with three trials now failing to show benefit for medium- or distal-vessel occlusions. Importantly, one of the three trials, ESCAPE-MeVO, also demonstrated higher mortality in the thrombectomy group (13.3% vs. 8.4% in the medical management group; adjusted hazard ratio 1.82 [95% CI, 1.06-3.12]). All three trials showed numerically higher rates of symptomatic ICH.

DISTAL, presented by Marios Psychogios (University Hospital Basel, Basel, Switzerland), was a randomized, open-label European trial that randomized 543 patients with D/MeVO (M2, M3, M4, A1, A2, A3, P1, P2, P3; patients with dominant M2 occlusions were excluded) presenting within 24h of last known well time (LKWT) to EVT plus medical management (MM) or MM alone. Primary outcome was distribution of modified Rankin Scale (mRS) scores at 90 days. Common OR for improvement in mRS was 0.90 (95% CI 0.67-1.22, p=0.50). There was no difference in mortality (15.5% with EVT vs. 14% without), and a numerically higher rate of symptomatic ICH (5.9% vs. 2.6%) did not reach statistical significance.

ESCAPE-MeVO, presented by Mayank Goyal (University of Calgary, Calgary, AB, Canada), was a randomized, open-label, blinded-endpoint trial which enrolled 530 D/MeVO patients in the US, Canada, and Europe. Patients with distal and medium vessel occlusions (M2, M3, A2, M3, P2, P3; no exclusion for dominant M2) presenting within 12h of LKWT were randomized to EVT plus MM or MM alone. The primary endpoint was functional independence (mRS 0-1) at 90 days. Functional independence was achieved by 41.6% of the EVT group and 43.1% of the MM only group (adjusted risk ratio 0.95 [95% CI, 0.79-1.15]; p=0.61). Rates of mRS 0-2 were also similar between the two groups (54.1% in the EVT group vs. 58.8% in the MM only group), but mortality was higher in the EVT group (13.3% vs. 8.4% in MM only, HR 1.82 [95% CI, 1.06-3.12]), as were rates of serious adverse events, recurrent stroke, stroke progression, and symptomatic ICH.

DISCOUNT, presented by Frédéric Clarençon (Pitié-Salpêtrière Hospital, Paris, France), was an open-label, randomized controlled trial in France comparing medical management with or without thrombectomy in D/MeVO stroke patients. Trial results are not yet published. The trial was stopped early after a planned interim analysis of 163 patients (from an anticipated 488 enrolled patients) showed lower rates of good clinical outcome (mRS 0-2) at 90 days with EVT. A modified intention-to-treat population of 163 patients with 3-month follow-up data yielded a 90-day mRS of 0-2 in 60% of the EVT group and

> "The field may be nearing the limitations of clot retrieval (at least with existing technology), with three trials now failing to show benefit for medium- or distal-vessel occlusions."

77% of the MM only group, leading to an OR of 0.42 for good functional outcome (p=0.024). Mortality was lower in the thrombectomy group (3% vs. 7%), but rates of at least one serious adverse event (39% vs. 31%) and symptomatic ICH (12% vs. 6%) were higher in the thrombectomy group.

2. MIND Trial Preliminary Results

During the opening session, results of the Minimally Invasive Surgery for Deep and Lobar Intracranial Hemorrhages (MIND) Trial were presented by David Fiorella (Stony Brook University Hospital, Stony Brook, New York). Results are not yet published. MIND was a multicenter, open-label randomized controlled trial of patients with moderate to large volume supratentorial ICH (20-80 cc) presenting within 24h of symptom onset. Patients were randomized 2:1 to minimally invasive surgery with the ARTEMIS device within 72h or medical management. The MIND trial was stopped early after the results of ENRICH were released, with 236 patients enrolled. The majority of enrolled patients (71%) presented with deep ICH, while 29% presented with lobar ICH. Primary outcome was ordinal mRS at 180 days.

Minimally invasive surgery (MIS) did not improve outcome at 180 days (OR for intention-to-treat population 1.03, 95% CI 0.62-1.72), though an early functional outcome benefit was seen at 30 days. This early beneficial effect may be attributable to reduced rates of symptomatic progression of perihematomal edema in the surgical group (2.6% vs. 13.4% in the MM group). There were also trends toward shorter hospital lengths of stay and lower intubation rates in the MIS arm. Surgical evacuation with the ARTEMIS device was effective, with a rate of hematoma evacuation of 81%. Mortality was low overall (7.2% in the MIS group vs. 9.8% in the MM group), with a trend toward decreased mortality in the MIS group among patients with lobar hemorrhage (8.3% vs. 22.7%).

Of note, the ENRICH trial showed that MIS for hematoma evacuation improved 6-month functional outcomes in patients with lobar hemorrhages; enrollment for deep hemorrhages was stopped early due to lack of benefit in this subgroup. The MIND trial failed to show a benefit for MIS evacuation for a mixed group of patients with more than twice as many deep as lobar hemorrhages. These results reinforce the lack of measurable benefit for hematoma evacuation in deep ICH.

3. Thrombolysis – Extending the Window and "Chasing" Thrombectomy

Late-Breaking Science trials were presented during ISC's Closing Main Event. The most notable of these were trials related to thrombolysis. Two trials, ANGEL-TNK and PEARL, showed improvement in clinical outcome with thrombolysis administered after thrombectomy for large vessel occlusion stroke. The HOPE trial demonstrated efficacy and safety of alteplase in an extended time window between 4.5 to 24 hours for patients with salvageable tissue on perfusion imaging.

"Of note, the results of two negative studies of thrombolytics following EVT, POST-TNK and POST-UK, were released in JAMA in February 2025. Stay tuned for upcoming summaries of these trials in *Currents*."

HOPE was a prospective, open-label, randomized controlled trial in China, enrolled 372 patients with acute ischemic stroke with mismatch indicating tissue at risk on perfusion imaging. Patients were randomized to alteplase or standard medical management between 4.5 and 24h after symptom onset. Among patients receiving alteplase in this late window, 40% achieved good functional recovery (mRS 0-1 at 90 days), compared to 26% with standard care. However, the study's generalizability may be limited by population differences, including higher rates of intracranial atherosclerosis in China.

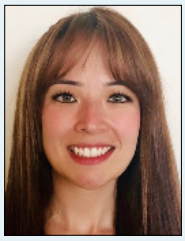
ANGEL-TNK was a prospective, open-label, blinded-endpoint, randomized controlled trial in China which enrolled 256 patients with LVO stroke presenting between 4.5 and 24h after LKWT who were successfully revascularized with EVT. Patients were randomized to intra-arterial TNK or standard medical management; none had received thrombolysis prior to EVT. The primary outcome was mRS 0-1 at 90 days. Rates of functional independence were higher in the TNK group (40.5% vs. 26.4% in the MM group, p=0.02). Rates of symptomatic ICH were similar in both groups at 48h (5.6% in the TNK group vs. 6.2% in the MM group).

PEARL was a multicenter, open-label trial in China which randomized 324 patients to intra-arterial alteplase vs. standard medical management after EVT for anterior circulation LVO presenting within 24h of LKWT. Primary outcome was mRS 0-1 at 90 days, and 42% received intravenous thrombolysis prior to EVT. The intervention group had higher rates of functional independence at 90 days compared with the medical management group (45% vs. 30%; RR 1.45, 95% CI 1.08-1.96, p=0.01). Rates of ICH and mortality were numerically but not statistically higher in the intervention group.

Of note, the results of two negative studies of thrombolytics following EVT, POST-TNK and POST-UK, were released in JAMA in February 2025. Stay tuned for upcoming summaries of these trials in *Currents*. ●

The Magnetic Power of Future: The Iseult CEA 11.7 T MRI

By Shane Musick, MD, and Nilufer Yalcin, MD



What is the Iseult CEA 11.7 T MRI?

The Iseult CEA 11.7 Tesla (T) MRI machine marks a significant leap forward in magnetic resonance imaging, offering unmatched magnetic field strength. It was built through a collaborative effort from the French Alternative Energies and Atomic Energy Commission (CEA), together with Alstrom Magnets and Superconductors and Siemens Healthineers, all under the umbrella and framework of the French-German consortium Iseult. This MRI machine operates at a strength of 11.7 T, making it the most powerful MRI machine for human imaging produced thus far. This feat marks the culmination of nearly 20 years of research and development under the Iseult project, with the goal of building a "human brain explorer" that investigates the brain at an unprecedented scale.

The first in vivo human brain images using this MRI were unveiled on April 2, 2024, and they are game-changing. Compared to standard 3 T and even 7 T MRIs, the 11.7 T images boast a vastly higher signal-to-noise ratio (SNR), enabling superior spatial and temporal resolution. Within just 5 minutes of scanning, this machine achieved an incredible resolution of 0.19 mm in-plane and 1 mm slice thickness (0.19 x 0.19 x 1 mm^3). To put this into perspective, a typical 3 T MRI would need around 15 times longer to reach a similar resolution—an impractical timeframe for clinical use.

The specs of the 11.7 T MRI include a 5 m long and 5 m tall cylinder, a magnet that weighs a whopping 132 tons in total, 182 km of superconducting wires, and 7,500 L of superfluid liquid helium to cool the magnet at -271.35 C. Achieving the specs underlying this machine required new methodology specifically related to the cryogenic setup for cooling the superconducting coils.

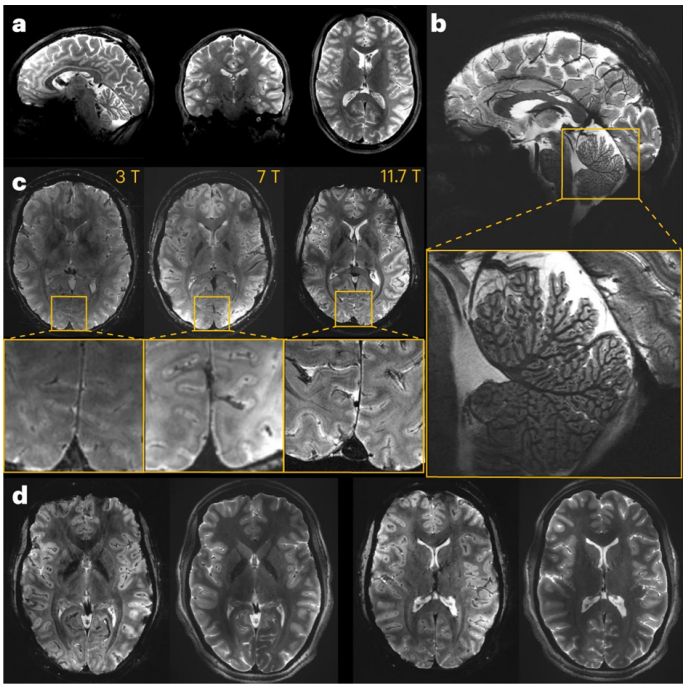
Importantly, in addition to obtaining comparison images with this MRI to 3 T and 7 T, the researchers also assessed safety of the 11.7 T MRI at longer scanning intervals. To ensure these powerful magnetic fields were innocuous, they assessed 20 patients scanned at 11.7 T for 1.5 hours versus another 20 subjects with no magnetic field utilized. They assessed vital signs like blood pressure and heart rate, performed cognitive tests, balance tests, and assessments of genotoxicity evaluating chromosomal damage prior to and after scanning. There were no significant differences between the two groups in any of the studied metrics, implying safety and tolerability even with longer scanning durations.

Potential Applications in Neuroscience and Neurocritical Care

The implications of this high-powered MRI are vast. As the authors noted in their paper published in Nature Methods in October 2024: "It brings to the fingertips of the neuroscience and medical community an opportunity to explore the brain in more detail. The higher resolution and the contrasts that ultrahigh-frequency MRI provides will certainly open a window of opportunity to better understand certain neurological conditions, and develop new disease biomarkers or therapeutic means." Nicolas Boulant, the head of the Iseult project, has set a goal of thoroughly investigating neurodegenerative diseases by 2026-2030. With the MRI's submillimeter resolution, there is the ability to detect previously unknown chemical species, including tracking the precise distribution of lithium and other metabolic compounds.

This MRI's power could also transform the field of epilepsy and epilepsy surgery. Currently, 15-40% of patients with refractory

> "The Iseult CEA 11.7 Tesla (T) MRI machine marks a significant leap forward in magnetic resonance imaging, offering unmatched magnetic field strength."



a: *In vivo 3D T2 variable flip angle turbo spin-echo acquisition at 11.7* ***b:*** *In vivo T2*-weighted 2D GRE sagittal* ***c:*** *T2* weighted 2D GRE axial images acquired at 3 T (left), 7 T (middle) and 11.7 T (right) with identical acquisition times (4 min 17 s).* ***d:*** *The 11.7 T T2*-weighted 2D GRE axial images. Image Source: Boulant, N., Mauconduit, F., Gras, V. et al. In vivo imaging of the human brain with the Iseult 11.7-T MRI scanner. Nat Methods (2024). https://doi.org/10.1038/s41592-024-02472-7.*

epilepsy remain undiagnosed after undergoing conventional 1.5 T and 3 T MRI scans, as small cortical malformations like focal cortical dysplasia often escape detection due to their small size and subtle appearance. Studies have shown that 7 T MRI can identify significantly more of these malformations, thereby allowing for targeted interventions. The 11.7 T MRI could take this a step further, uncovering even more elusive lesions such as small cavernomas, subtle abnormalities linked to tuberous sclerosis complex, dysembryoplastic neuroepithelial tumors, and gangliogliomas. This could pave the way for more patients with refractory epilepsy to benefit from surgical treatments, which could greatly improve outcomes.

Beyond potentially advancing our understanding of the brain, this MRI could offer important clinical benefits for neurocritical care in the future. Its ability to accurately measure small molecules and metabolites such as lactate, pyruvate, and glutamate may have significant clinical applications. MR spectroscopy is currently used sparingly in the Neuro ICU—primarily for distinguishing between tumors and similar-looking plaques or lesions—while intracerebral microdialysis remains the preferred method for measuring these compounds in at-risk tissues. However, microdialysis is invasive and depends heavily on precise probe placement. With the enhanced resolution of the 11.7 T MRI, it might become possible to non-invasively calculate lactate-to-pyruvate ratios or measure other metabolites, potentially aiding in the early detection of injured or at-risk brain tissue and enabling more timely interventions.

This MRI could also offer more sensitive detection of cerebral microbleeds, which would be valuable for diagnosing diffuse axonal injury following traumatic brain injury. Understanding the distribution pattern of these microbleeds might also provide crucial insights into the causes of larger spontaneous brain hemorrhages. Paired with magnetic resonance angiography (MRA), this technology could provide a more accurate assessment of vasospasm, potentially improving the management of aneurysmal subarachnoid hemorrhage. It may also prove useful in evaluating other challenging cerebrovascular conditions like vasculitis, reversible cerebral vasoconstriction syndrome, arterial dissection, and fibromuscular dysplasia.

While the Iseult 11.7 T MRI offers exceptional imaging capabilities, there are major barriers preventing its use in standard hospital settings in the immediate future. First, it is associated with a very high cost and requires specialized infrastructure, including prohibitively large magnets and cooling systems which would make installation exceedingly challenging and expensive. Safety requirements are also more stringent at ultra-high magnetic fields, which necessitates specialized training for staff and extensive safety protocols. Additionally, while this technology holds great promise for researchers, particularly in neurology and oncology, its potential clinical applications are still emerging. For now, the Iseult 11.7 T MRI is likely to remain limited to research settings until its infrastructure requirements and costs can be supported and broader clinical uses can be established.

Conclusion

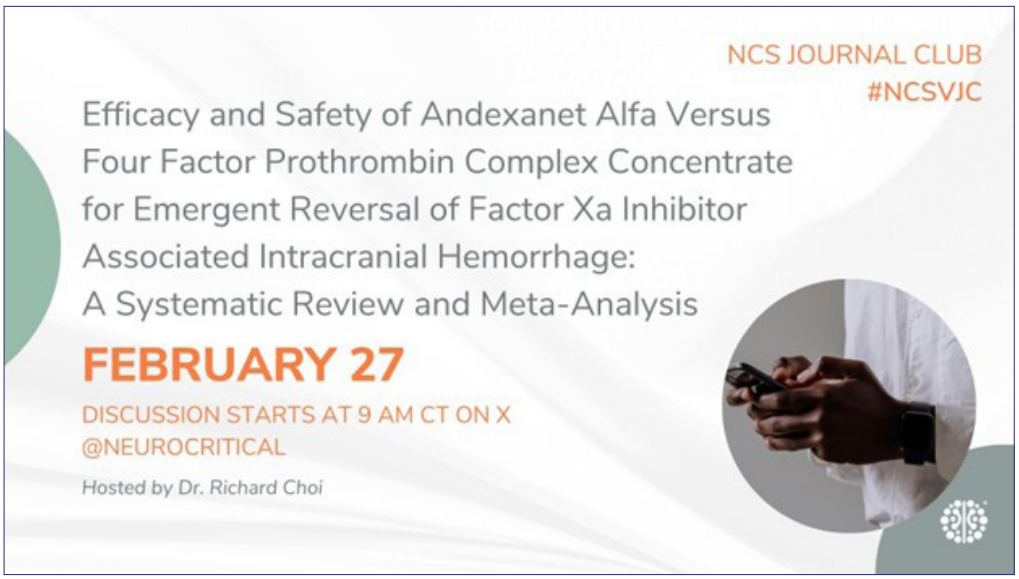
In summary, the Iseult 11.7 T MRI machine has the potential to bring significant advances to neuroscience by enabling researchers and clinicians to explore the brain's microstructures, chemical environments, and functional dynamics in greater detail. As a possible tool in the future practice of neurocritical care, it could support earlier diagnosis, improved monitoring, and more precise interventions for conditions such as stroke, neurotrauma, and neurodegenerative diseases, potentially reshaping our understanding and treatment of the brain. Although widespread clinical use may be limited for now due to its high cost and substantial infrastructure demands, there is cause for excitement for the continued development of this promising technology. ●

References:

1. Boulant N, Mauconduit F, Gras V, et al. In vivo imaging of the human brain with the Iseult 11.7-T MRI scanner. *Nat Methods*. 2024. doi:10.1038/s41592-024-02472-7.
2. Boulant N, Quettier L; Iseult Consortium. Commissioning of the Iseult CEA 11.7 T whole-body MRI: current status, gradient-magnet interaction tests and first imaging experience. *MAGMA*. 2023;36(2):175–189. doi:10.1007/s10334-023-01063-5.
3. CEA (French Alternative Energies and Atomic Energy Commission). A world premiere: the living brain imaged with unrivaled clarity thanks to the world's most powerful MRI machine. April 2, 2024.

Changing Names: The #NCSTJC Is Now the Neurocritical Care Society Virtual Journal Club (#NCSVJC)

By Eric Lawson, MD



Link to the full thread: **https://x.com/neurocritical/status/1895135366396490056**

Link to the article: **https://link.springer.com/article/10.1007/s12028-024-02130-y**

To more accurately reflect the #NCSTJC expansion into other social media platforms, such as LinkedIn and Bluesky, we have updated the name to the Neurocritical Care Society Virtual Journal Club (#NCSVJC). Please join us monthly on X for the discussions with expansion to other social media platforms coming soon!

The February 2025 edition of the #NCSVJC was hosted by Dr. Richard Choi and again featured his unique #Tweetorial style of breaking down a journal article. The discussion was centered on the article "Efficacy and Safety and Andexanet Alfa Versus Four Factor Prothrombin Complex Concentrate for Emergent Reversal of Factor Xa Inhibitor Associated Intracranial Hemorrhage: A Systematic Review and Meta-Analysis," which was published in October 2024 in the Neurocritical Care Journal.

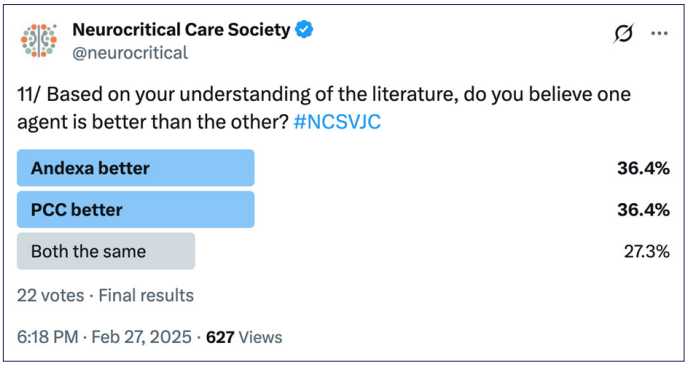
Dr. Richard Choi kicked off the discussion with a review of Direct Oral Anticoagulants (DOAC), reminding participants they are now the preferred agent to reduce stroke risk in atrial fibrillation given their ease of use and decreased risk of bleeding. Their mechanism of action works either on thrombin or factor Xa.

When a major hemorrhage does occur in a patient taking a DOAC, Dr. Choi reminded us that it is important to undo the

coagulopathy as soon as possible, linking to the 2022 AHA Guidelines on spontaneous ICH. Dabigatran has its own antidote, idarucizumab. The factor Xa inhibitors have many alternatives, including Andexanet alfa and 4-factor PCCs.

Dr. Choi reminded participants that the debate for which is better (Andexanet alfa vs 4-factor PCCs) is still a hotly debated topic and the authors of this month's journal article attempted to answer the question by performing a meta-analysis which included a total of 16 studies. The authors found that anticoagulation reversal favored the use of Andexanet alfa, but that mortality data was limited by heterogeneity. They also noted more thromboembolic events in the Andexanet alfa group. Of the analyzed secondary outcomes, there were longer hospital stays in the Andexanet alfa group, and no difference in other outcomes between the two groups.

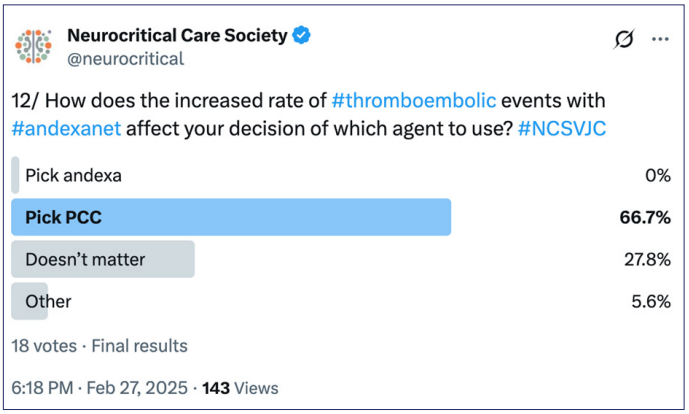
The first question directly to participants asked if Andexanet alfa is available at their institution. The responses were fairly split with equal numbers having it available versus not.



> Given these findings, no one said they would select Andexanet alfa, and a majority stated they would select PCCs.

> The discussion on this meta-analysis by Sarhan et al. reflects the underlying sentiment for many clinicians that the literature is not decided on which agent for anticoagulant reversal is superior.

In the next poll, participants were asked which agent they understood to be better. The responses were equally divided between Andexanet alfa and PCC, which likely reflects the undetermined nature of the literature .



To better understand why participants are choosing a particular agent, the next poll asked if the increased rate of thromboembolic events with Andexanet alfa affected decisions on which agent to choose. Given these findings, no one said they would select Andexanet alfa, and a majority stated they would select PCCs.

To round out the discussion, the final question was: "Does the data from this paper change your preference of agent, and why?" @NG_Panos responded stating: "No this paper doesn't change my mind. We need a RCT using a code ICH protocol (reverse within 60min) to compare both agents…" @rkchoi also directly weighed in stating: "I think we do need more data. I am curious to see what the FDA will end up deciding."

The discussion on this meta-analysis by Sarhan et al. reflects the underlying sentiment for many clinicians that the literature is not decided on which agent for anticoagulant reversal is superior. This is further reflected by the varying use of Andexanet alfa across institutions.

Be sure to tune in to the next #NCSVJC! ●

The Sixth Neurocritical Care Regional Meeting in the Middle East and Africa

By Yasser B. Abulhasan, MBChB, FRCPC, FNCS

Introduction

The year 2025 is a big one for the MENA region. Although it is exciting to write about the milestones we've already achieved, it is even more important to recognize our current endeavors and further build on educational and research opportunities for future meetings. Overall, the MENA region boasts neurocritical care workshops and other educational resources as part of two major critical care conferences, along with further standalone workshops in the region. The region's first critical care conference of the year was the 20th International Pan Arab Critical Care Medicine Society conference, which took place in Kuwait on February 1-3, 2025, in parallel with the 6th edition of the Neurocritical Care Regional Meeting in the Middle East and Africa Chapter of the Neurocritical Care Society. The second conference with a major neurocritical care presence took place in Dubai from May 9-11, 2025 and was followed by a Brain Death Determination workshop in Cairo, Egypt.

The Sixth Regional Meeting in Kuwait

This flourishing conference was attended by 1564 delegates. Of the 99 speakers, 60% were international, 23% were regional, and 17% were local, representing 27 countries in total. There were also 14 pre-conference workshops and courses from January 30-31, which included ENLS version 6.0, a Traumatic Brain Injury workshop, and a 20-hour Neuro-Ultrasound Skills and Interpretations workshop that spanned both pre-conference days. These three neurocritical care workshops were attended by a total of 147 multidisciplinary healthcare providers.

The four neurocritical care sessions focused on: (1) guidelines, with topics including targeted temperature control, non-invasive ICP monitoring, and seizure prophylaxis following TBI, as well as SAH beyond 2023; (2) neurocritical care topics in women, with an emphasis on SAH, ICH, and cerebral and venous sinus thrombosis during pregnancy, as well as neurological complications of eclampsia; (3) neurological complications of

critical care conditions including the management and prognosis of septic encephalitis, mechanical ventilation after brain injury, and coma outside the Neuro-ICU; and (4) hot topics in acute stroke, with a focus on blood pressure management, osmotic therapy, space occupying infarcts, and dysphagia after ischemic stroke. Accepted abstracts submitted to the Regional Meeting were simultaneously **published online in Neurocritical Care**.

Pre-Conference Workshops

Three workshops were conducted over two pre-conference days. ENLS version 6.0 was presented to a multidisciplinary audience of 68 participants (46% physicians, 44% nurses, and 10% healthcare workers in training). It was a pleasure to be one of the **first 3 sites globally** to teach version 6.0 on January 30, 2025.

The Traumatic Brain Injury (TBI) workshop was conducted over a half-day and was attended by 53 multidisciplinary healthcare workers. This workshop focused on the critical care management of severe TBI, emphasizing basic concepts, practice updates, and advanced innovations in care. The workshop was led by an expert panel including physicians, pharmacists, and nurses. Attendees learned about TBI-related epidemiology, medical and surgical management, advanced neuromonitoring techniques, and neuro-recovery strategies.

The Neuro-Ultrasound Skills and Interpretations workshop was attended by 26 physicians and took place over two full days. Participants received a combination of didactic lectures on core principles for ultrasound insonation and hands-on training in the assessment of cerebral hemodynamics. The workshop offered 20 hours of continuing medical education credit qualifying towards certification in various North American and European certification tracks. Several months later, a further 20 hours were offered in Dubai on May 9 and 11, 2025.

Acknowledgements

It is with great pleasure that I acknowledge the societies and individuals who contributed to this meeting. First, the partnership between the International Pan Arab Critical Care Medicine Society (IPACCMS) and NCS remains strong, as evident by this sixth edition of the regional meeting in the MENA region. Reflecting our other ongoing partnerships, both the Indian Society of Neurocritical Care and the Deutsche Gesellschaft für NeuroIntensiv- und Notfallmedizin (DGNI) endorsed this meeting, in addition to a new partnership with the Latin American Brain Injury Consortium (LABIC) that was announced during the open chapter meeting on February 2, 2025.

I would like to thank and commend the voluntary efforts of all the following speakers and moderators of the neurocritical care sessions and workshops: Tamer Abdelhak, Yasser B. Abulhasan, Eiman Al-Hashemi, Ayham Alkhachroum, Abdullah Al Jadidi, Sana Alkhawaja, Ghusn Al Sideiri, Saud Alzaid, Mark Angle, Omar Ayoub, Ahmad Bayrlee, Jamil Dibu, Michael Diringer, Ryan Hakimi, Alya Hasan, Jennifer C. Munoz Pareja, Saef Izzy, Sarah Livesay, Aarti Sawal, Gene Sung, Fabio S. Taccone, Walter Videtta, Paul Vespa, Susan Yeager, Lucie Young, and Waleed Yousef.

Additionally, I would like to acknowledge Jennifer C. Munoz Pareja and Lucie Young for co-directing the ENLS course, Saef Izzy and Saud Alzaid for co-directing the TBI workshop, and Aarti Sawal for directing the Neuro-Ultrasound Skills and Interpretations workshop. A sincere thank you goes to Abdulrahman Al-Fares (conference chairman) and team, and Hussain Al Rahma (IPACCMS president) for their tireless efforts and support towards organizing the 6th Regional Meeting with me.

> “Over the years, neurocritical care tracks and sessions have been strongly represented in major critical care conferences across the region.”

Global Partnership Milestones

Since 2011, the NCC-MENA chapter of IPACCMS has been one of NCS’s foremost global partners, and NCS leadership has participated in the open annual NCC-MENA chapter meeting. Over the years, neurocritical care tracks and sessions have been strongly represented in major critical care conferences across

the region. ENLS was first offered in 2016, then in 2018, 2019 (in-person), 2021 (hybrid), and 2022-2025 (in-person). In October 2018, NCS confirmed the first Mid-East/Africa member to represent the region on its Board of Directors. In April 2019, the 1st NCC Middle East/Africa Regional Meeting was conducted in-person in Dubai, followed by the hybrid format 2nd and 3rd Regional Meetings during the pandemic, and the in-person 4th, 5th and 6th Regional Meetings over the past three years—these were conducted in conjunction with the 15th, 17th, 18th, 19th and 20th editions of the ECCC, UAE, and the 20th IPACCMS conference in Kuwait, respectively. In 2023, the first NCS Brain Death Determination workshop with certification was conducted in the UAE. In 2025, the first Neuro-Ultrasound Skills and Interpretations workshop with a certification route was conducted in person in Kuwait.

> "The diligent planning and voluntary efforts of everyone who contributed over the years has resulted in the advancement of neurocritical care across the region, which has helped spread the global mission and vision of NCS."

Our Mission

Overall, neuroscience representation within critical care in our region is strong and continues to expand. The diligent planning and voluntary efforts of everyone who contributed over the years has resulted in the advancement of neurocritical care across the region, which has helped spread the global mission and vision of NCS.

The Emirates Critical Care Conference in Dubai and Brain Death Determination Workshop in Cairo

On May 9-11, 2025, we were pleased to welcome you all in Dubai for the **21st Emirates Critical Care Conference**. This was followed by an NCS-endorsed Brain Death Determination workshop in Cairo, Egypt on May 12, which was the first time an in-person workshop was conducted by NCS experts in Egypt and led to certification upon completion of all requisites. Stay tuned for a recap of these and other events in the region! ●

"Seizure Code Strategy": Improving Treatment Times and Clinical Outcomes in Patients with Urgent Epileptic Seizures

By Camilo Espinosa-Jovel, MD, and Clio Rubinos, MD, MS, FACNS

Dive deeper into this article on the NCS Podcast!

Epileptic seizures are among the leading causes of visits to emergency services, with nearly one million annual visits in the United States.[1] These patients may present with isolated seizures, seizure clusters, or status epilepticus.[2] Among these, status epilepticus is associated with the highest morbidity and mortality and is recognized as a neurological emergency. However, seizure clusters and isolated seizures can also lead to complications requiring immediate interventions.[2,3] To address this, the term "urgent epileptic seizure" has been adopted to encompass these three clinical scenarios and facilitate their quick identification for timely treatment.[4]

Current evidence highlights time to treatment and adequate medication dosing as critical determinants of patient outcomes, underscoring the importance of prompt therapeutic action.[5] Nevertheless, delayed treatment times and subtherapeutic dosing remain common.[6] Therefore, classifying patients under the term "urgent epileptic seizure" may help trigger a sense of emergency to medical staff and achieve faster treatment times.

While some centers in high-income countries have implemented effective protocols and order sets for managing urgent seizures,[7,8,9] these initiatives face significant barriers in lower- and middle-income countries. Challenges include the absence of prehospital care infrastructure, a lack of electronic medical records, limited availability of intravenous antiseizure medications, and variability in hospital treatment practices.[10,11,12] As a result, there may be an increased risk of complications including prolonged seizures, increased hospital stays, and an increased likelihood of patients developing functional limitations or progressing to more refractory states of status epilepticus.

Recognizing these challenges and following the success of other groups in implementing protocols with highly favorable outcomes,[4] Dr. Camilo Espinosa and his team at Hospital de Kennedy in Bogota, Colombia, developed a comprehensive approach to improving outcomes in patients with urgent epileptic seizures. Their multidisciplinary strategy integrates neurology, emergency medicine, intensive care, nursing, and prehospital care to ensure rapid and coordinated treatment. Drawing inspiration from the "time is brain" concept in stroke management, the team implemented a "seizure code" protocol, emphasizing the critical importance of early intervention in seizure management.[13,14] The seizure code strategy aligns with evidence showing that the therapeutic window for epileptic seizures is even shorter than that for acute stroke. These seizure code protocols have proven highly beneficial, particularly in lower-income populations, where simple and cost-effective interventions have yielded very favorable results.

"Drawing inspiration from the "time is brain" concept in stroke management, the team implemented a "seizure code" protocol, emphasizing the critical importance of early intervention in seizure management."

> By prioritizing rapid treatment and coordinated care, this initiative offers a scalable model for improving functional outcomes and reducing the burden of seizures in resource-limited settings.

A recent publication by Dr. Espinosa's team demonstrated the efficacy of the seizure code strategy.[14] The implementation of this protocol led to markedly improved outcomes, including:

- A reduction in the time to administer benzodiazepines from 100 minutes to 20 minutes ($p = 0.063$)
- A decrease in the time to administer antiseizure medications from 155 minutes to 39 minutes ($p = 0.071$)
- Decreased rates of prolonged hospital stays from 48% to 36% ($p = 0.047$)
- Decreased in-hospital seizure recurrence for patients with seizure clusters from 27% to 4.9% ($p < 0.001$)
- A decrease in mortality from 5.3% to 0.4% ($p = 0.007$)

This seizure code strategy has also served as the foundation for collaborative efforts across several Latin American countries. Over time, groups in Argentina, Chile, and Mexico have begun implementing seizure code protocols, tailoring them to their specific demographic and economic context. In July, an academic meeting in Mexico City brought together physicians from across the region to share their experiences and strategies. This event, which was supported by pharmaceutical partnerships, facilitated discussions on optimizing this protocol while generating new research ideas. One main objective is to establish the first Latin American consensus on managing urgent seizures, with a focus on improving prehospital care quality, a critical area of need in the region.

While significant challenges remain, the seizure code strategy highlights the potential of collaborative, evidence-based approaches to improving outcomes for patients with urgent seizures. By prioritizing rapid treatment and coordinated care, this initiative offers a scalable model for improving functional outcomes and reducing the burden of seizures in resource-limited settings. Additionally, the implementation of a seizure code could also be applied in higher-income countries; despite well-organized educational interventions conducted at sites of recent clinical trials, consistent guideline-recommended dosing of anti-seizure medications remains a work in progress.[15] This serves as one of many potential examples of bidirectional strategies and therapeutic interventions that can be mutually adapted and shared between higher- and lower-income countries. ●

References

1. Pallin DJ, Goldstein JN, Moussally JS, Pelletier AJ, Green AR, Camargo CA Jr. Seizure visits in US emergency departments: epidemiology and potential disparities in care. *Int J Emerg Med*. 2008;1(2):97–105.
2. Galizia EC, Faulkner HJ. Seizures and epilepsy in the acute medical setting: presentation and management. *Clin Med (Lond)*. 2018;18(5):409–413.
3. Leitinger M, Trinka E, Giovannini G, et al. Epidemiology of status epilepticus in adults: a population-based study on incidence, causes, and outcomes. *Epilepsia*. 2019;60(1):53–62.
4. García Morales I, Fernández Alonso C, Behzadi Koochani N, et al. Emergency management of epileptic seizures: a consensus statement. *Emergencias*. 2020;32(5):353–362.
5. Gaínza-Lein M, Sánchez Fernández I, Jackson M, et al. Association of time to treatment with short-term outcomes for pediatric patients with refractory convulsive status epilepticus. *JAMA Neurol*. 2018;75(4):410–418.
6. Sánchez Fernández I, Abend NS, Agadi S, et al. Time from convulsive status epilepticus onset to anticonvulsant administration in children. *Neurology*. 2015;84(23):2304–2311.
7. Cassel-Choudhury G, Beal J, Longani N, et al. Protocol-driven management of convulsive status epilepticus at a tertiary children's hospital: a quality improvement initiative. *Pediatr Crit Care Med*. 2019;20(1):47–53.
8. Xie Y, Morgan R, Schiff L, et al. A computerized standard protocol order entry for pediatric inpatient acute seizure emergencies reduces time to treatment. *J Child Neurol*. 2014;29(2):162–166.
9. Lin TW, Tiwari CM, Shipman CO, et al. Implementation of a standardized order set for the management of status epilepticus in the electronic medical records system: a quality improvement initiative. *American Epilepsy Society Meeting*. 2024.
10. Bhattarai HK, Bhusal S, Barone-Adesi F, Hubloue I. Prehospital emergency care in low- and middle-income countries: a systematic review. *Prehosp Disaster Med*. 2023;38(4):495–512.
11. Rao SK, Mahulikar A, Ibrahim M, et al. Inadequate benzodiazepine dosing may result in progression to refractory and non-convulsive status epilepticus. *Epileptic Disord*. 2018;20(4):265–269.
12. Srivastava K, Suryawanshi VR, Yerrapalam N, Panda BK. Compliance with status epilepticus management protocol and effect on clinical outcomes in children with status epilepticus. *Eur J Hosp Pharm*. 2023;30(3):147–152. doi:10.1136/ejhpharm-2021-002721
13. Trinka E, Cock H, Hesdorffer D, et al. A definition and classification of status epilepticus—report of the ILAE Task Force on Classification of Status Epilepticus. *Epilepsia*. 2015;56(10):1515–1523.
14. Espinosa-Jovel C, Riveros S, Valencia-Enciso N, et al. Seizure emergency code strategy: improving treatment times and hospital outcomes for patients with urgent epileptic seizures. *Epileptic Disord*. 2024. doi:10.1002/epd2.20273
15. Sathe AG, Underwood E, Coles LD, et al. Patterns of benzodiazepine underdosing in the Established Status Epilepticus Treatment Trial. *Epilepsia*. 2021;62(3):795–806.

Artificial Intelligence in Neurocritical Care: Perspectives from National Representatives of the NCS Asia Oceania Chapter

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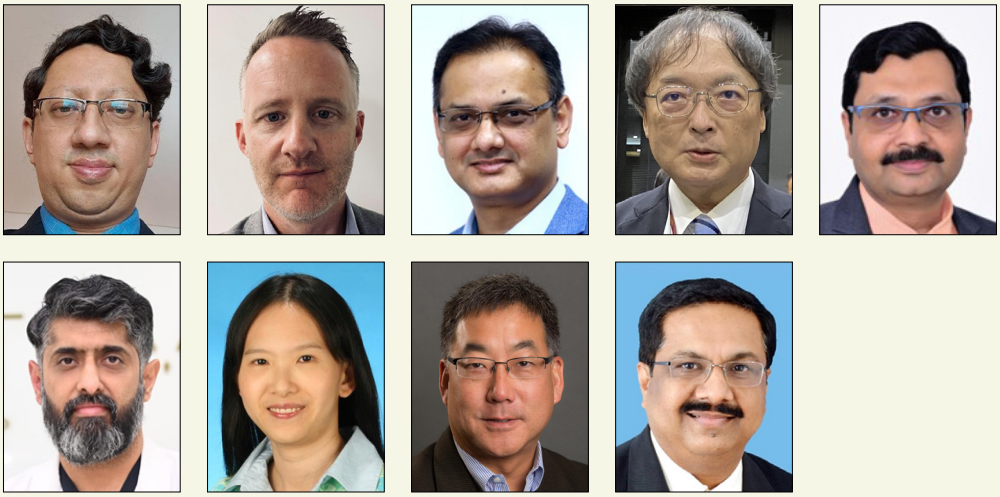

The field of artificial intelligence (AI) and machine learning (ML) has rapidly emerged as a force in clinical medicine and is expected to continue evolving in the future. AI and ML have the potential to revolutionize the delivery of healthcare, facilitate the design and conduct of clinical trials, and enhance patient outcomes. However, adoption of AI and ML applications has varied across different fields of medical science. Significant challenges related to the need for real-time diagnosis and management of patients are especially relevant issues in critical care and neurocritical care, with other limiting factors including pre-existing biases in original data sources, implementation bias while applying AI recommendations, and the "black-box" nature of many AI and ML algorithms. In low- and middle-income countries (LMICs) whose resources are limited, the application of AI and ML is further affected by factors like limited funding, lack of proper infrastructure, lack of technical expertise, and limited access to data. As a result of these unique local factors, algorithms initially trained in higher-income countries may not be generalizable to LMICs.

Here we gather the perspectives of national representatives from the Neurocritical Care Society's (NCS) Asia Oceania chapter, each of which consider the current understanding, applications, and perceived barriers for implementation of AI and ML in neurocritical care in this region, as well as potential ways forward. This overview can help form the basis for future collaborations and larger-scale research to enhance effective utilization of AI and ML in this region.

Australia

As a resource rich country, Australia has access to the required technology and expertise to implement AI in healthcare. Indeed, the use of AI and machine-learning to identify signals not immediately discernible using standard analytics is becoming increasingly common. This can range from real-time AI-assisted decision-support to ML-based prognostic models that can provide accurate estimates of the likely clinical trajectory or outcome for a given patient. However, to date, these approaches have been limited to research settings due to a number of concerns. The main factors limiting the more widespread use of AI/ML relate to the following:

- Regulatory and governance requirements that limit the sharing of data between regions and healthcare providers, which in turn limits the development and validation of AI/ML analytics and outputs
- The absence of datasets of suitable scale and granularity, which leads to the use of data that are often not representative of the Australian population
- Clinician anxiety about the reliability, accuracy, and validity of AI/ML derived outputs
- Medico-legal concerns and the dehumanization of healthcare

Keys to successfully implementing AI/ML analytics in neurocritical care in Australia include greater centralized collection of highly granular physiological, treatment, and

> Indeed, the use of AI and machine-learning to identify signals not immediately discernible using standard analytics is becoming increasingly common.

outcome data; improved access to data repositories and more efficient data linkage, automated data pipelines, cleaning, and curation; infrastructure modernization; increased collaboration between clinicians and AI/ML experts; and support from regional and federal government agencies and funders. In addition, and perhaps most importantly, the implementation of AI in neurocritical care requires ongoing engagement with consumers and clinicians to ensure the outputs generated are patient-focused and meaningful to those with a lived experience in neurocritical care. Moreover, any AI/ML derived interventions will require robust assessment in randomized clinical trials.

India

In recent years, we have observed remarkable expansion and advancement in the deployment of AI in healthcare, and its application in neurocritical care has also escalated. Neurocritical care is a demanding field, requiring constant vigilance and rapid decision-making to manage patients with acute neurological conditions. AI has emerged as a promising tool to assist neurocritical care clinicians by facilitating early prediction of neurological deterioration and enhancing management and ultimate outcomes, and we have already begun implementing AI here for these reasons.

Intracranial pressure (ICP) is among the most widely monitored parameters in neurocritical care given its correlation with mortality and other outcomes. Utilizing AI has enabled continuous ICP monitoring, which can enhance a clinician's ability to promptly address undesirable changes and refine treatment protocols. AI can also aid in the early detection of delirium, the prediction of acute kidney injury, the identification of early seizures after intracerebral hemorrhage, and the overall assessment of seizure risk. From a stroke management perspective, AI has the potential to improve early detection and prognostication, identify high-risk patients, and optimize treatment to reduce morbidity and mortality. Across ICU settings, AI-driven smart pumps have helped optimize medication titration, outperformed conventional scoring systems like APACHE and SOFA in predicting early mortality, aided in brain death confirmation, and predicted sepsis and infections (e.g., CLABSI and C. difficile infections).

Despite its promise, AI poses challenges such as the risk of misdiagnosis, lack of regulatory frameworks, and medico-legal concerns, while questions of accountability, patient autonomy, and the doctor-patient relationship remain unresolved. Addressing these issues is essential for AI's safe and ethical integration into neurocritical care.

Japan

AI is becoming a welcome tool for the standardization and optimization of clinical practice, especially in rural areas. However, current limitations include the following aspects:

- Patients with communication barriers (e.g., those in a comatose state)
- New patients in a first encounter before an established diagnosis
- Promoting and motivating patient education and self-care
- Medico-legal issues
- Building rapport with patients
- Mental health care

Although Japan is one of the leading countries in the development of AI and ML, AI use in the clinical setting remains insufficient. Japan's utilization of AI is high in image analysis (about 20% in all facilities and about 30% in university hospitals), followed by genome medicine, diagnostic and treatment support, surgical procedures, nursing care for patients with dementia, and drug discovery. However, Japan has disparities in the prevalence of electronic health records and ordering systems—the basis for AI in healthcare—which are present in 95% of hospitals with more than 400 beds but only about 60% in small hospitals and clinics

Multilingual AI models are essential for healthcare, and such models have already been produced in Japan. However, in addition to differences in language, AI models should ideally

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consider other differences among individuals and populations including personality, religion, economic status, and so on. NCS and its regional chapters, with their wealth of global and multi-disciplinary specialists, are ideal platforms to discuss the incorporation of AI into neurocritical care. With its robust background and potential to promote AI technology, Japan is keen to contribute and collaborate in the discussion.

Nepal

Although our use of AI and ML in critical care is expanding, critical care clinicians in Nepal have a variable level of knowledge about these technologies. Application of AI and ML has largely been limited to small scale research projects predominantly within the field of radiology, along with the use of some built-in AI features in imaging modalities like ultrasound. Within neurocritical care specifically, clinicians' awareness and perspectives about AI and ML remain unclear.

The major barriers we face are a lack of knowledge among health care workers, a lack of relevant expertise, a lack of capacity to implement AI and ML (including primitive electronic medical recording systems and electronic databases at most centers), a lack of legislation and policy for adapting and implementing AI, and a lack of involvement from policy makers and funding bodies. We need to work to increase awareness among our health care workers and to identify gaps, so that future plans can build towards meeting the needs of our healthcare landscape. Further implementation will need education of health care workers, building infrastructure with increased capacity, more investment from government and policy makers, AI models that are tailored to local needs, and collaborative efforts both locally and at the international level.

Singapore

The potential for AI in revolutionizing healthcare is untapped. While Singapore has adopted technology in some aspects of health care (e.g., electronic medical patient records), we have an unmet need for amalgamating big data into AI algorithms that allow for the alignment of best care practices across the nation.

> "While there is consensus on the need for adapting AI and ML for neurocritical care ... individual nations seem to be at variable stages of adapting and implementing these technologies."

Some of the challenges we face include access to a national database health record and the spread of Singapore's population across different regions with different care needs (e.g., central Singapore has an older population, while the new peripheral regions have a younger population). On an individual level, how do we manage scenarios when clinical management differs from an AI-driven pathway? Would there be medico-legal consequences even if a patient would not do well in either situation?

We would need a consolidated approach to get an AI model that works for Singapore's unique and rapidly aging population, then validating this model across the country's populations, regions, and hospitals—an approach that requires collaborations between local experts, hospitals, and agencies to navigate a complex and rapidly changing AI landscape. If these challenges can be overcome, healthcare could indeed be transformed by the adoption of AI in the very near future.

> "Further implementation will need education of health care workers, building infrastructure with increased capacity, more investment from government and policy makers, AI models that are tailored to local needs, and collaborative efforts both locally and at the international level."

Conclusion

The NCS Asia Oceania chapter and its individual member nations have varying perspectives related to AI and ML. While there is consensus on the need for adapting AI and ML for neurocritical care applications and their potential to improve outcomes, individual nations seem to be at variable stages of adapting and implementing these technologies. Those that have more limited resources appear to be at an early phase, focusing on improving awareness and building capacity, while those with more resources have advanced to work toward overcoming challenges like medico-legal issues, data sharing, and AI tailored to local settings. Well-designed surveys are needed in order to elucidate real-world issues and explore current gaps and barriers related to using AI and ML, while collaborative efforts between member nations and NCS as a whole can help promote the implementation of these technologies, especially in nations with limited resources. ●