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Editorial

Innovation, Autonomy, and Access: Who Will Shape the Future of Neurosurgery?

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Neurosurgery has always existed at the intersection of innovation and necessity. We embrace new technologies because our specialty demands precision, creativity, and a willingness to push the boundaries of what is possible. Yet as the pace of technological and structural change in medicine accelerates, we should also ask a more fundamental question: Who will shape the future of neurosurgical care?

This month's contributions approach that question from two very different directions.

In the Socioeconomic Journal Club, Khalifa Elmagarmid examines the extraordinary advances occurring in robotics, artificial intelligence, augmented-reality navigation, brain-computer interfaces, and automated surgical systems—and the growing challenge of making those advances accessible.

His opening anecdote captures the issue remarkably well. At a spine course, a surgeon from Brazil learns that a robotic-assisted instrumentation platform costs more than $2 million. His response, "oooof."

That reaction may be humorous, but the underlying problem is not. The benefits of innovation are not distributed evenly. Robotics remains concentrated in North America, Europe, and academic centers, while AI adoption within the United States is greater at larger, teaching, and system-affiliated hospitals. Some hospitals remain sufficiently isolated from this technology to have been described as residing in "AI deserts."

And purchasing the technology is only part of the challenge. Implementing AI responsibly increasingly requires validation systems, monitoring, audit infrastructure, governance committees, and mechanisms to address liability and equity. Those additional requirements themselves carry costs that large academic systems may absorb much more readily than smaller or rural hospitals.

Elmagarmid therefore leaves us with an important distinction: the question is not simply whether we can develop extraordinary technology, but whether that technology will ultimately be accessible to the physicians and patients who could benefit from it.

Dr. Gantwerker approaches the changing landscape of medicine from another direction: physician autonomy.

His President's Message is intentionally provocative, but at its core is an argument that neurosurgeons should recognize the value of their expertise and remain willing to challenge systems that interfere with their ability to care appropriately for patients.

As Dr. Gantwerker points out, functioning trauma, stroke, spine, and oncology programs depend upon neurosurgical expertise. That expertise represents years of training, sacrifice, judgment, and responsibility that cannot simply be reduced to another line on a healthcare system's balance sheet.

His message also transcends party politics. He argues that physicians should be prepared to challenge policies regardless of their political origin rather than expecting either party to solve the structural problems facing medicine.

Taken together, these articles raise an important question for our profession:

What kind of neurosurgical ecosystem are we building?

We should certainly embrace innovation. Neurosurgery should continue to lead the development of robotics, artificial intelligence, navigation, neuromodulation, brain-computer interfaces, and technologies we have not yet imagined. But innovation cannot be measured solely by what a technology can do.

We must also ask whether it meaningfully improves patient care, whether the evidence justifies its cost, whether physicians outside a handful of major centers can realistically access it, and whether implementation enhances rather than diminishes physician judgment.

The same principle applies to the larger healthcare system. Efficiency, standardization, and cost containment can be legitimate goals. But they cannot become substitutes for clinical judgment or mechanisms that progressively distance decisions about patient care from the physicians actually providing it.

California neurosurgeons experience these tensions perhaps more than most. Our members practice in large academic medical centers, integrated healthcare systems, community hospitals, private practices, and underserved regions. A technology or healthcare policy that functions well in one environment may be impractical—or even counterproductive—in another.

Our responsibility, therefore, is not to resist change. It is to help shape it.

We should remain enthusiastic about technologies that allow us to treat patients more safely and effectively. At the same time, we should insist upon evidence, accessibility, responsible implementation, and preservation of the professional judgment that allows those technologies to be used wisely.

The future of neurosurgery will undoubtedly be more technological. It will likely also be more regulated, more consolidated, and more data-driven.

The challenge is ensuring that it remains physician-led and patient-centered.

Namath S. Hussain, MD, MBA, FAANS, FACS

Editor, CANS Newsletter

Building for Our Future:

President's Message: Bless this Mess: Changing Our Way of Doing Things, Because It's Hard

Brian Gantwerker, MD

"Ubi solitudinem faciunt, pacem appellant"

(Where they make a desert they call it peace)

-Tacitus, circa 98 AD, attributed to Calgacus of the Caledonian (Scottish) tribes

The current landscape of healthcare may be better called a hellscape. One might call it that despite our repeated calls for stability for physician reimbursement and the current administration hunting for fraud and waste while giving the very perpetrators openly doing it a raise. By openly mining for fraud and abuse where there is some but not the giant pustulant ulcerated abscess that is the megamergers of healthcare systems and separate-in-name-only insurers (that all share the same clearinghouses) we see the current head of CMS and the secretary (espousing the wonders of liver) aren't really serious about making things efficient or better value.

In fact, if anything they have telegraphed, they really, really want things to get worse. One of two things will happen, in all likelihood.

Outcome 1: Medicare-for-All. That is, a state-run and owned healthcare system behemoth. This will be a monstrous bureaucratic kaiju that will be funded solely by taxpayer dollars, possibly run by the current MAC administrators that currently run the different Medicare jurisdictions. They would just scale up. No, it's not that simple, but that would be the pitch. Hospitals would close and consolidate, and likely no one would get rich. Insurance companies would still exist. My guess is that the top income earners would still get to have some form of private insurance and not have to wait in the enormous lines that truly socialized medicine would bring in this country of 340 million. A truly two-tiered system, it would be anything but equitable. Truly outcomes may not be great, but it would likely be cheaper. Quality would definitely suffer and our processes would likely stagnate or possibly break down. We would never come back from that, but it would be the law of the land. People would point fingers at each other, but we would all be to blame for not being able to put on our big boy/girl/person pants and see things for what they are - a giant grift at taking away physician autonomy wrapped in a bill of goods.

Outcome 2: Medicare Advantage-for-All. Like #1, but people (insurers, hospitals execs, investors) will make obscene amounts of money. Same terrible outcomes for the rest of us and unfair advantages all around. Same blame to go around. Same reasons to be mad.

If you have lived long enough and figured out how corporations have essentially captured our government, our regulatory bodies, and even in some cases our judicial system, you will see pretty much which way the wind blows. So, what to do?

Don't comply.

In other words, the biggest thorn in the side of this effort will be to wipe the board clean of people who won't go along with the plan. We all remember "the disruptive physician." Doctors were sent to anger management when they called out terrible things done to patients, not just when they wanted a more curved Penfield #1. Crossing the Rubicon began for me when a charge nurse did not want to tell the head of the ICU that one of the nurses gave a patient a medication she was not supposed to that could have caused harm (thankfully did not) and wanted it to just go away. I did not comply. I told the head of the ICU and the head critical care doc. Thankfully, I was not labeled a disruptive physician, but there are those that have been.

If the system lays waste and makes medicine a desert of sameness, of compliance, of cookbook medicine and protocols, then truly we will get the radioactive wasteland they want, make money off of it, and blame physicians all the same.

When you hear other physicians, be it your CMO, your chairperson, or PD, or other person getting very chummy with administration, with hospital executives or politicians, take them for a cup of coffee. Understand their motivations. If they just want to move their career upwards, that's fine, but maybe, just maybe, they should do so somewhere else. Building a culture of cohesion at your home base, your practice, your program means that you are in it together. It also means that those who are out for themselves and not down for the cause should be - well - out.

Aspirations for career advancement are good. We all want to go somewhere. Many of us want to go far in our organizations, the PAC, or even Congress. Our patients and colleagues should never, ever, be a means to that end. If you are good enough, canny enough, and circumstances come together, then shoot your shot, by all means. We can all name people in our spheres though, that have never really seen themselves as part of a society of

colleagues. That is not to say we advocate for some sort of neurosurgical kibbutz or commune. Rather, realizing - finally - that neurosurgery, like all of medicine, needs to circle its wagons. We are all on our own individual trek. One may want to end up CEO of their group, another run for state assembly, yet another just hang their shingle and be left alone and just work. All of us want to take care of patients the best way we know how. No one went into Neurosurgery to be a billionaire. We all love hard work, the toil, the challenge, the sweat equity of doing hard cases, and being very honest, the respect it all brings.

We deserve just compensation for the years of training, of missed opportunities, income, birthdays, funerals, turning back from the airport and cancelled trips, and for the stress and worry over "Did I really put enough knots on that shunt tie?" or "Did I cross thread that last set screw?" That has value as does getting someone well again. As St. Thomas Aquinas said, our work has a just price. One of our biggest mistakes and, therefore, the biggest threat to the final nail in the coffin of physician autonomy, is that realization of our value. You can't have a trauma center without a neurosurgeon. You can't have a stroke center without a neurosurgeon. You can't have a decent spine center without a neurosurgeon, nor a comprehensive oncology center without a neurosurgeon. Our skills come with a price tag. If you decide you won't be told what you are worth, nor how to take care of patients, which you spent 7+ years fellowship learning, how unmanageable and how "disruptive" have you become.

So, if you think being a good little boy/girl/person will bring you consummate good fortune "look not behind thee." You must tell the story as it is. You must tell them all is not well. Tell the administration that the operating room is not working efficiently, or that your patient got a tongue laceration from the ET tube. If we all decide not to go along, a small act of rebellion sets things into motion. And, if we all rebel a bit, those small disruptions slowly converge and make it a lot less harder to smooth the board.

Because, if they had it their way, they would lay waste the entire landscape and call it beautiful. And, when people ask why is it all so desolate and they can't find a decent neurosurgeon anywhere, and why their mom will die of a cerebellar hematoma or their child may not make it because their shunt is malfunctioning, they will most certainly blame us. It is our job to not let that happen and to push back every way against the political nihilism masquerading as "value, efficiency," and "cost containment" when they have known exactly how to bring that to heel for decades.

After all, the tells are all there. You have a congressman, a physician himself, telling doctors they shouldn't be allowed to leave medicine for a set period of time. Rather than fixing the system, he advocates for something resembling indentured servitude. (I got called to the carpet for making those comments on that thread. Sorry, not sorry - I would do it again). You have a current candidate for governor refusing to enforce the outcomes of the No Surprises Act when insurers refuse to pay saying "doctors should stop gouging patients." (His wife is a doctor, by the way). These two people are from the two different political parties, so stop saying either one is going to save us.

As I have written many times before, and yes, you will soon be free of my dogmatic repetition as my presidency draws to a close, stop waiting for a savior. Call balls and strikes. Moreover, call BS. Take your own party to task when they bungle it. When the other party does well, toast it. But also call it out if they are doing it for the wrong reasons, especially if they are doing it for social media attention instead of actually trying to fix something because its hard work, not popular, or doesn't look good on a bumper sticker.

We could all do well with working on things that don't fit on bumper stickers. We have all seen what bumper sticker sloganeering and siloed, calcified thinking has gotten us: where we are right now.

Chazak (strength),

Brian

Socioeconomic Journal Club

Khalifa Elmagarmid, Medical Student

While at a cadaveric neurosurgery spine course a couple months ago, I had the chance to see a demonstration of robotic spine surgery. At the course, a surgeon from Brazil asked about the price of this robotic-assisted instrumentation technology, and was told above $2 million, to which he replied, "oooof." Although the future is exciting, with robotics, AI-based prediction, BCI, augmented-reality navigation, and automated surgical systems, the truth is these technologies are not accessible to many.

A 2021 survey found that nearly half of neurosurgeons reported clinical experience with robotics, with adoption concentrated in Europe (54%) and North America (51%). Use was significantly lower outside academic centers, with cost of acquisition and maintenance among the major barriers (Stumpo et al., Neurosurgical Review, 2021).

This pattern extends beyond robotics. The poorest third of the world performs only about 6% of major operations, while the benefits of AI in surgery have been predominantly demonstrated in high-income countries (Sadler et al., Cancer, 2023; Kewalramani et al., Lancet, 2024). The same divide exists within the United States. An analysis of 2,720 hospitals found that clinical and operational AI adoption was higher in larger, teaching, system-affiliated hospitals and lower in rural and for-profit hospitals. Two-thirds had adopted at least one clinical AI tool, while roughly one in eight non-adopting hospitals were classified

as “AI deserts” more than 50 miles from the nearest hospital using AI in any capacity (Vo et al., JAMIA, 2026).

There is also a data problem. AI models trained on local data consistently outperform models imported from other populations. Despite this, many low- and middle-income countries lack the EHR infrastructure and surgical volume needed to generate those datasets. Surgical volume is estimated at roughly 877 operations per 100,000 people in these settings, compared with approximately 10,000 in high-income countries (Akras et al., Journal of Clinical Neuroscience, 2026; Valli et al., EClinicalMedicine, 2026). Therefore, another barrier to entry is not only the cost but also the clinical value of an “AI” model to a rural hospital.

With all this in mind, technology is moving faster than the systems needed to evaluate it. A 25-year review identified 93 neurosurgical devices cleared through non-510(k) FDA pathways, with approvals increasing substantially after 2013 and an average clearance time of 451 days. Pathways such as the De Novo pathway have also played a crucial role in the recent uptick in novel surgical devices including intra-operative robotic assistive technologies (Schindler et al., World Neurosurgery, 2026; Lee et al., NPJ Digital Medicine, 2024).

We are now also building systems to manage these systems: AI governance committees, validation pipelines, monitoring dashboards, audit trails, and registries. Recently published reviews argue that liability, override authority, post-market monitoring, and equity auditing should be incorporated into AI systems from the beginning (Cella et al., Nature Reviews Urology, 2026). But this creates another problem. The infrastructure required to deploy AI safely is itself expensive. A large academic health system may be able to support dedicated governance teams and validation infrastructure. A rural hospital on the other hand may struggle to do so.

Neurosurgery will continue to develop technologies that are extraordinary, the recent success of Precision Neuroscience led by a neurosurgeon is a testament to that. The question is not whether these technologies work. It is whether the technology being built will ever be accessible.

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