ICU
MANAGEMENT & PRACTICE

Diagnosing Non-Convulsive Seizures in the ICU: Tackling the Top Challenges

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One clinical factor complicating the work of ICU physicians and nurses is the difficulty of diagnosing nonconvulsive status epilepticus (NCSE)—an invisible condition that must be managed aggressively to prevent lasting damage to the brain. Because the prevalence of NCSE among neurological patients can reach up to 60%, and because it becomes increasingly hard to manage the longer it goes untreated, neuro-ICUs tend to medicate for non-convulsive seizures even in cases where they are not yet confirmed. If they don't, and they miss the diagnosis altogether, the consequences to the patient range from neuronal injury to long-term neurological disease and increased mortality.

Patient health outcomes are the greatest reason to address this diagnostic difficulty. But both missed diagnoses and overtreatment for suspected seizures diminish the ability of hub-and-spoke institutions to triage patients and apply resources appropriately. A new brain monitor with rapid-electroencephalography (Rapid-EEG), which can be applied and interpreted by any front-line clinician, is now helping to identify *and exclude* the presence of non-convulsive seizures at the point of care in minutes (Hobbs et al. 2018). This technology has allowed my institution to assess more patients at locations convenient to them and transfer only those who truly need more aggressive neurological care to our "hub" hospital. With rapid-EEG, as with other point-of-care technologies before it, we are expanding patients' access to clinical expertise and providing them with more appropriate care.

Challenge #1: A lack of awareness

When a patient has an abnormal neurological exam, the first question we ask is, "is this a stroke?" A patient with fever, altered mental status, tachycardia with increased respiratory rate: "could this be an infection?" This automatic response to certain indicators can be traced to the many public and academic campaigns to raise awareness around stroke and sepsis.

"Time is brain" is a maxim widely understood to apply in instances of stroke. Yet even though it applies just as powerfully to NCSE, another highly prevalent and treatable source of brain injury, there have been no comparable campaigns for this condition. Why? The answer may boil down to a longstanding technological gap: the lack of tools to make the diagnosis or rule it out early enough in the patient workup.

Challenge #2: A lack of expertise

The lack of tools is better understood as a lack of expertise. In the neuro-ICU, at least, conventional EEG machines are highly accessible. But even here—and certainly in satellite clinics where many of our patients present first—the limiting factor is the expertise needed to take an EEG and interpret the results.

Before rapid-EEG, the assessment of non-convulsive seizures required the interpretation of an EEG by an epileptologist, neurologist, or trained EEG technician. This limitation has made it effectively impossible to meet the guidelines recommending continuous EEG for patients with suspected non-convulsive seizure activity in 15 minutes or less, as a conventional EEG typically takes hours (or days, depending on the time of day and week) to deliver results (Yazbeck et al. 2019).

Without the ability to accurately and quickly diagnose NCSE, a broad-scale awareness campaign similar to those around ischemic stroke or sepsis makes little sense. Wider availability of rapid-EEG changes that calculus.

Challenge #3: A lack of confidence

The brain monitor equipped with rapid-EEG does produce a raw EEG—imaging that still requires expertise to read. But this monitor also uses sonification and artificial intelligence to convert that raw data into a clear yes/no for NCSE. Any nurse, resident, or advance practice clinician can immediately determine the presence or absence of NCSE, passing along the raw EEG to an expert when necessary.

Challenge #4: Barriers to adopting new technology

This last challenge consists of three interrelated challenges: a human resistance to change, the cost of purchasing and operating the new technology, and the systems integration lift.

Point-of-care ultrasound provides a useful example of each of these objections. When ultrasound was first becoming available for use by emergency physicians, there was substantial fear about the learning curve ahead. Now, of course, the use of ultrasound by those physicians is fairly standard. Gaining confidence in reading a point-of-care ultrasound image takes considerably more training and judgment than the yes/no answer delivered with rapid-EEG, but there is likely to be some resistance nonetheless.

As with point-of-care ultrasound, the cost and logistics of implementing brain monitoring with rapid-EEG will likely be weighed institution by institution. When ultrasound was proven to generate value and improve patient care, however, it was adopted widely. Still, investments had to be made in training, workflow adjustment, and data/equipment integration in order for hospitals to realise its promised savings and quality improvements.

With rapid-EEG, the training and data integration aspects are largely negligible (training can be completed in about an hour; the EEGs are stored and transmitted via the cloud). But it will still fall to each ICU to incorporate this monitoring into the patient workup and embed the technology logically in the ICU's operational workflow.

What is gained

Due to the risk and prevalence of NCSE—and due also to the consequences of its under- and overtreatment—overcoming the challenges above will benefit patients, improve physician confidence, and lead to better health outcomes.

One recent case illustrates some of these benefits. At one of our satellite sites, a young woman had come in with questionable non-convulsive status but without any history of seizures or epilepsy. She had been intubated and medicated in the field by EMS and was thus anesthetised when she arrived at the emergency department. Even after treatment, though, rapid-EEG showed she was actively seizing. That information meant that they knew to follow the status epilepticus guidelines and treat her with anti-epileptic drugs. Despite all those interventions, she kept on having seizures overnight, and the critical care physician called our neuro-ICU to request continuous EEG monitoring. The patient was transferred to our institution, where we increased the aggressiveness of her treatment, and she finally came out of status. Without rapid-EEG, the patient's NCSE might have gone undiagnosed, and she would certainly not have received such a timely escalation of care.

Stepping back from individual patients, there may be even greater gains for health care in the ability of front-line providers to rule out NCSE. If a patient comes in with hyperkinetic movements to the ICU, even without a history of brain injury, we initially suspect seizure activity. Rapid-EEG allows us to immediately exclude that diagnosis, avoiding unnecessary medications that can further deteriorate patients' mental status and possibly lead to mechanical ventilation. Avoiding *unnecessary* escalation would also prevent unnecessary transfers, which would mean substantial cost savings for the institution.

What might be gained in the future

Translating brain activity data into a yes/no alarm for NCSE is an application of artificial intelligence that has an immediate impact on care, especially considering how often these seizures coincide with conditions common to the ICU (Herman et al. 2015). What might be next? Could we use AI to analyse not just patterns of seizure activity but patterns of ischemia in the brain? What about patterns of delirium or patterns of brain dysfunction that are not necessarily related to seizures?

These possibilities are years or even decades away. But the point-of-care brain monitoring, we are finally able to perform demands only that we confront a few challenges before we can provide our patients with better, more effective care.

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