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Amplitude-Integrated EEG: It's not just for babies

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Amplitude integrated EEG (aEEG) is a filtered and time compressed form of EEG which has been used extensively for neuromonitoring early after neonatal hypoxic-ischemic brain injury to identify electroencephalographic seizures and background patterns to determine brain injury severity (1–3). The technique is often performed and interpreted by bedside providers, which puts real-time cerebral monitoring in the hands of the ICU providers. More abnormal aEEG background patterns are predictive of worse neurodevelopmental outcomes (1–3), thus aEEG is used to prognosticate outcomes and to stratify brain injury severity to guide treatment decisions (4). More recently, aEEG background patterns have been associated with short-term outcome after adult cardiac arrest (5–8).

In this issue of PCCM, Bourgoin et al. bridge the age gap by evaluating the association of aEEG background patterns during the first 48 hours of pediatric post-arrest care with short-term outcomes (9). Thirty children resuscitated from an in- or out-of-hospital cardiac arrest underwent clinically indicated two-channel aEEG instituted by an ICU nurse or physician. The first 24 hours of aEEG was retrospectively scored in three-hour epochs by a neurophysiologist using the Hellstrom-Westas neonatal aEEG criteria (1). Using this classification system, patients were assigned a 24-hour aEEG score of eight (normal in all eight epochs) to 32 (most abnormal in all eight epochs). This summary 24-hour aEEG score was associated with neurologic outcome at discharge (OR 1.33; 95% CI [1.09-1.62], p= 0.004). The area under the receiver operated characteristic curve for an aEEG score of 15 was 0.91 (95% CI [0.81-1.00], impressively high for a noninvasive test that can be performed at the bedside.

While the summary score describes the 24-hour period as a single time point, it does not describe the granularity of patient level changes over time. To address this, the authors adeptly showed each patient's aEEG background classification following return of spontaneous circulation (ROSC) (9) (Figure 3). Notably, only one patient who had a burst-suppression pattern had a good outcome, and only one patient whose aEEG background normalized over time had a poor outcome. Most patients did not change background categories over time, and no patient transitioned from a burst-suppressed or flat background to a less severe pattern.

Following pediatric cardiac arrest, normal or generally slow EEG backgrounds within the first 12 hours after ROSC (10) and the presence of sleep spindles within 24 hours after ROSC are associated with favorable neurologic outcome at hospital discharge (11). Consistent with the Bourgoin study, worse EEG background categories are associated with increasing odds of death and unfavorable neurologic outcomes at hospital discharge (12).

aEEG provides several benefits over full montage EEG. First, full montage EEG initiation may be delayed due to early post-arrest care. Second, trained critical care providers (nurses and physicians) can quickly apply the device. This advantage can overcome the lack of EEG Technologist availability for EEG lead placement; only 35% of 61 large US and Canadian children's hospitals reported having an EEG Technologist in-house at all times.(13) Third, conventional full-montage EEG interpretation requires specialized training and is therefore generally interpreted by electroencephalographers who may not be continually available at many institutions. ICU providers can be trained to accurately interpret aEEG background, thus bringing EEG for early prognostication to the patient's bedside (14).

Bourgoin et al.'s findings are an important addition to the literature demonstrating how a well-known tool for injury stratification following neonatal hypoxic-ischemic brain injury can be applied to pediatric cardiac arrest. However, there are differences. The authors used the Hellström-Westas aEEG criteria created for neonatal aEEG (1). As the authors note, generalizability to pediatric age groups is uncertain and a pediatric-specific scoring system may be more reliable for predicting outcomes. Additionally, EEG assessment using a non-processed full-montage EEG incorporates more granular details from the whole brain that may not be identified using aEEG. Additionally, post-arrest confounders such as sedation (most patients were treated with midazolam or morphine) and targeted temperature management may sometimes impact the association between aEEG background patterns and outcomes,(15) and further understanding of these relationships is needed.

Despite those limitations, this work by Bourgoin et al. is a fantastic first step in defining a role for aEEG in pediatric post-arrest prognostication. They have opened the door for future work which will hopefully define replicable pediatric post-arrest aEEG scoring systems and evaluate whether these aEEG background patterns are predictive of longer-term outcomes. This work will provide pediatric cardiac arrest researchers the ability to stratify early post-arrest brain injury severity which will enhance future clinical trials of neuroprotective strategies and post-arrest care. Ongoing research is likely to continue to show that aEEG is not just for babies.

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