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INVITED EDITORIAL COMMENTARY

Neuromonitoring: No Longer a Spectator Sport

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Seizure diagnosis is a fundamentally challenging issue in neurocritical care. The vast majority of seizures detected by electroencephalography (EEG) are nonconvulsive [1], yet the yield of scalp EEG is limited without concomitant intracranial recordings [2, 3]. Because these intracranial recordings may not be appropriate or feasible in all patients, a variety of imaging modalities have been promulgated as "electro-radiologic" evidence of diagnosing status epilepticus, including diffusion-weighted or perfusion imaging [4–6]. While these imaging modalities may lack specificity, [F-18] fluorodeoxyglucose positron emission tomography (FDG-PET) hypermetabolism has been a more recent imaging modality demonstrating promise not only because of its spatial information and its temporal response to anesthetic burst suppression [7], but due to its dose-dependent metabolic association with spike burden [8].

In this issue of *Neurocritical Care*, Akbik and colleagues [9] provide a significant advance on the use of FDG-PET imaging for patients with status epilepticus by demonstrating that serial assessment of FDG-PET before and during anesthetic burst suppression may differentiate between status epilepticus and inflammatory conditions such as encephalitis. In the authors' case series, this "PET sandwich" reveals that FDG-PET hypermetabolism is pharmacologically suppressed by anesthesia when associated with an ictal pathophysiology. Alternatively, FDG-PET hypermetabolism is static, even in the face of burst suppression, when associated with a nonictal inflammatory condition.

While utilizing anesthetic burst suppression for diagnostic intent is not without risk, it represents a continued shift of neuromonitoring away from passive "reading" and toward a paradigm of active "pharmacodiagnostic testing," i.e., evaluating treament responsiveness [10]. Indeed, the Salzburg EEG criteria for nonconvulsive status epilepticus [11] share this predicate that a comprehensive approach to diagnosing nonconvulsive status epilepticus includes assessing intermediate EEG patterns for the modulatory effect of anti-seizure medication on the EEG [12]. While a diagnostic trial of anti-seizure medication may be inconclusive when underlying deficits or a prolonged postictal period obscure a clinical or EEG response, Akbik et al. provide examples in which FDG-PET resolves the potential uncertainty. The "PET sandwich" adds value by serving as a treatment-responsive diagnostic biomarker of ictal hypermetabolism.

No doubt, there are challenges to a new paradigm in which neuromonitoring is "no longer a spectator sport." Do we broadly give a trial of anti-seizure medication to every patient with periodic or rhythmic patterns on the ictal–interictal continuum? When inconclusive, do we then proceed to a PET sandwich with burst suppression? Even escalation of non-anesthetic anti-seizure medications may have a risk, and burst suppression at a minimum requires ventilatory support. Nevertheless, we have evidence from multiple modalities of neuromonitoring that high-frequency periodic discharges are at greatest risk of inducing exhaustive hyperglycolysis [8], hypermetabolism [2], and hypoxia [13] of brain parenchyma. Perhaps in this setting, an anti-seizure medication trial should routinely be performed. In other patients, for example, with encephalitis and already requiring mechanical ventilation, imaging with serial PET during burst suppression may serve as a form of active

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pharmacodiagnostic testing [10] intended to validate treatment response before committing to a prolonged course of therapy with inherent risks.

Future studies will need to be performed ascertaining whether nonanesthetic seizure medications can provide similar diagnostic information as anesthetic burst suppression, and to what degree other neuroimaging modalities or EEG features can provide clinical evidence of a meaningful diagnostic response. The current study, as such, is proof of principle that an *active* approach to seizure diagnosis is an emerging paradigm for precision neurocritical care, drawing lessons from other aspects of neurocritical care, which already require iterative management and reassessment for improved diagnosis and understanding.

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