A Prospective Study of Diagnostic Accuracy in Electroencephalography Predicts Delayed Cerebral Ischemia

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Abstract

Delayed cerebral ischemia is a common, disabling complication of subarachnoid haemorrhage. Preventing DCI is a key focus of neurocritical care, but interventions carry risk and cannot be applied indiscriminately. While retrospective studies have identified continuous EEG measures associated with DCI, no study has characterized the accuracy of cEEG with sufficient rigor to justify using it to triage patients to interventions or clinical trials. Aneurysmal subarachnoid haemorrhage impacts 600,000 patients worldwide annually, conferring 40% mortality.1 Delayed cerebral ischemia, a common, disabling complication, usually occurs 4–14 days after onset. Despite tripling the odds of a poor one-year outcome, DCI often goes unrecognized, limiting opportunities for intervention. Accurately identifying impending DCI would help target therapies to patients most likely to benefit. However, conventional monitoring methods are intermittent, only modestly accurate, and commonly examine only large vessel vasospasm, one of many mechanisms upstream of DCI. Electroencephalography provides a continuous measure of cerebral function with robust, predictable responses to ischemia. Several small studies have proposed criteria for predicting DCI based on changes in continuous EEG spectral features, including decreasing alpha-to-delta power ratio or relative alpha power variability (RAV). Other findings associated with cerebral ischemia include epileptic form discharges, rhythmic and periodic "ictal-interictal continuum" patterns, and isolated alpha suppression. Intracranial electrocorticography suggests that cortical spreading depolarization's may be a phenomenon underlying cEEG changes and DCI itself. No study to date has assessed the diagnostic accuracy of cEEG for DCI following the Standards for Reporting of Diagnostic Accuracy Studies. Prior studies employed retrospective, unblended analysis of cEEG and clinical data, and small cohorts. Continuous EEG analysis in these studies was performed off-line, outside of real-time clinical practice and employed variable DCI definitions. Therefore, the generalizability of previously proposed cEEG criteria for predicting DCI remains uncertain. We prospectively assessed the sensitivity and specificity of cEEG performed as part of routine medical care for predicting DCI, following STARD criteria. We applied a consensus definition of the primary outcome, DCI, using a blinded, adjudicated process, and pre-specified which cEEG findings constitute an alarm for impending DCI. To ensure generalizability, we recruited a large number of consecutively monitored patients. In this prospective study we assessed the diagnostic accuracy of cEEG performed according to an institutional clinical care guideline18 for consecutive patients with SAH within a single Neurosciences Intensive Care Unit over 2.5 years. The clinical guideline recommends cEEG begin within 48 hours of admission and continue for 10 days, among high clinical or radiologic grade patients. This institutional guideline recommends prophylactic antiseizure medication until ruptured aneurysms are secured.