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EDITORIAL

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EEG for outcome prediction after cardiac arrest: when the quest for optimization needs standardization

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Early outcome prognostication of comatose patients following cardiac arrest represents a daunting task; several clinical, biochemical, radiological, and neurophysiological parameters have been intensively evaluated recently, in the context of growing popularity of targeted temperature management or therapeutic hypothermia (TH) in the last decade [1, 2]. Among these potential predictors, EEG represents a relatively cheap, noninvasive tool available at the bedside, but the assessment of its exact role has to deal with the influence of timing, lingering pharmacological sedation, temperature, and not least the expertise of interpreters and the sometimes confusing taxonomy of the findings.

In this issue, Dr. Sivaraju and colleagues report their effort to assess the prognostic significance of continuous EEG (cEEG) data in 100 patients treated with TH at 32–34 °C [3]. They reviewed all EEG recordings in the form of 5-min extracts taken at predefined intervals from the acute event (6, 12, 24, 48, and 72 h). Blinded to patients' identity and outcome, they applied the recently published standardized American Clinical Neurophysiology Society (ACNS) critical care EEG terminology [4], correlating their data with those of other clinical investigations.

The principal findings are that suppression-burst at any time (but not a discontinuous recording), and a low voltage (<20 μV) background after 24 h, have a false positive rate of 0 % for poor prognosis, defined as a Glasgow outcome scale (GOS) of 1–3 at hospital discharge, suggesting that in this cohort assessment at 24 h heralds the best prognostic value, despite the probable concomitant use of sedation (mostly midazolam, further details not given) and TH. As the authors acknowledge, other groups have reported different results regarding the temporal dynamics of evolution of the cEEG [5]; furthermore, the ACNS terminology puts a threshold between suppression-burst and discontinuous background at 50 % of relative suppression, which could prove tricky to label with certainty in specific borderline situations (in other words: EEG signals represent a continuous, not a discrete variable).

Conversely, normal voltage (>20 μV) at any time is related to a good outcome in 71 % of patients, confirming earlier data along the same lines [6]. Considering the delicacy in reliably deciding upon a voltage amplitude around 20 μV in some patients [7], other groups concentrated rather on background reactivity to stimuli, which if present during TH has been reported to herald good prognosis in as much as 86 % [8], while lack of reactivity portended a poor prognosis in a much higher rate (99 % in [9]). This last figure contrasts with a predictive value of 86 % in this study (it was, however, not indicated when reactivity was assessed), pinpointing the lack of standardization of its testing (in this series with auditory and peripheral painful stimuli; in the aforementioned papers applying also vigorous pressure to the nipples) and its scoring [7, 10]. In the same context, identical bursts, recently reported to perfectly correlate with poor outcome [11], in this study show an overlapping significance with that of suppression-burst; the authors postulate that use of midazolam versus propofol might generate different burst types, and that those induced by propofol might be compatible with good outcome. Again, the difficulties in generalizing the findings are evident.

Coming to clinical prognosticators, lack of corneal reflexes had the lowest false positive prediction of poor outcome (0 %); the false positive rate regarding occurrence of myoclonus was 14 %, especially if a normal voltage was observed, broadly confirming other recent observations [12, 13]; false positivity for the lack motor response was identical, also in line with previous reports [12]. Finally, the authors propose a two-step approach for outcome prognosis, starting with EEG at 24 h and completing it with corneal reflexes at 72 h.

This is a single-center analysis performed in an environment with the highest expertise for cEEG interpretation, potentially limiting its generalizability; the poor outcome rate of 71 % is higher than that in other recent series [5, 12], but outcome assessment at discharge might have underestimated the recovery of some patients, especially for those in the inhomogeneous category of GOS (or CPC) = 3. Finally, it does not consider biochemical or somatosensory evoked potential (SSEP) variables. Despite the aforementioned limitations, this study is very important, especially for those interpreting EEGs: it shows indeed that the ACNS scoring criteria have a definite place in this clinical setting. Before wide implementation of decisions upon intensive care withdrawal based solely on EEG at 24 h and corneal reflexes, the present findings definitely need to be validated in a larger cohort, as the authors themselves rightfully conclude. In fact, another recent study showed that inter-rater agreement in a similar clinical context was substantial for suppressed background and burst-suppression, moderate for "benign" EEG features, and fair for reactivity [7], highlighting that real-life EEG scoring of a whole tracing may prove more challenging than scoring selected EEG pages. One practical question somewhat paradoxically arising from this cEEG study relates to its usefulness and cost-effectiveness in postanoxic patients, which has indeed been recently challenged [14, 15].

The next step appears to be the consequent integration of the standardized ACNS nomenclature of EEG findings with other predictors [7]. For the time being, a multimodal approach including the maximum available data from different, potentially complementary sources (i.e., clinical, neurophysiologic, biochemical, and radiological) remains mandatory in order to minimize a potentially deleterious effect of the ominous "self-fulfilling prophecy" [1, 2, 12], which is always somewhat inherent to observational studies in this setting.

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