Early Electroencephalography Dynamics After Cardiac Arrest

To the Editor:

With interest we read the article published in a recent issue of *Critical Care Medicine* by Rossetti et al (1), in which they confirm that early electroencephalography (EEG) contributes to outcome prediction of postanoxic coma. We concede the importance of external validation of previously reported EEG findings. However, we are surprised that the authors suggest to be the first acknowledging the role of timing, value of the EEG in addition to other predictors, and prediction of good (instead of poor) outcome, since these topics have been the core of many publications on EEG for outcome prediction of postanoxic coma since 2012 (2–5). We also wish to comment on their conclusions regarding EEG reactivity and definitions of patterns and timing.

As in their previous reports, the authors claim high predictive values of EEG reactivity. However, although explained in more detail than in previous publications (4), criteria for presence/absence of reactivity are still poorly defined and the EEG phenomena in actually observed EEG reactivity are not described at all. Interobserver variability is not reported. Despite the authors' claim of multimodal analyses, they present reactivity as an isolated EEG determinant, although the background EEG pattern may already contain overt and sufficient information for reliable prognostication. Indeed, a reactive EEG may represent a continuous background pattern with physiologic rhythms, whereas a nonreactive EEG may be severely disturbed.

The authors use the term "highly malignant EEG patterns," indicating "suppression or burst suppression with or without epileptiform discharges." This is a heterogeneous, vaguely defined group consisting of divergent EEG patterns indicating encephalopathy of various severity. Consequently, outcome prediction of coma after cardiac arrest based on such category was never without false positives neither in previous reports (5) nor in the current publication (1). Additionally, definitions of "early" and "late" EEG are unclear. This is especially remarkable, since the authors stress the relevance of timing, both for background pattern and for reactivity. For reproduction of the authors' data and eventual decisions regarding continuation or withdrawal of life-sustaining therapy, methodology and definitions should be very clear and false positive rates for poor outcome prediction ideally negligible. For example, an EEG background pattern with persistent isoelectricity, low voltage, or burst suppression with identical bursts at 24 hours after cardiac arrest was as reliable as absent somatosensory evoked potential responses for prediction of a poor outcome (2, 3).

The authors confirm that the largest EEG differences between patients with good and poor outcomes appear within 24 hours. They assume that this may result from confounders in later stages. We strongly argue that these relatively large early differences reflect true differences in cerebral recovery. Interruption of cerebral perfusion leads to disappearance of any measurable EEG activity within 10–40 seconds in everyone. This represents massive synaptic arrest. Consequently, EEG activity is severely disturbed or absent in the first hours after cardiac arrest in almost all patients. In patients with sufficient cerebral recovery, this improves on time scales of hours, whereas absence of relevant cerebral recovery within 24 hours represents irreversible brain damage.

Prof. van Putten disclosed that he is the cofounder of Clinical Science Systems. The remaining authors have disclosed that they do not have any potential conflicts of interest.

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The authors reply:

We thank Hofmeijer et al (1) for their interest in our study. We are sorry that they feel we claimed to be the first outlining time-related good outcome electroencephalography (EEG) features in post-cardiac arrest (CA) patients. In our recent article published in *Critical Care Medicine*, especially in the introduction and the richly referenced discussion—including four studies from Hofmeijer's group (2), we indeed explain our intention to expand previous findings by 1) including heterogeneous populations from Europe and North America, 2) analyzing specific EEG features, and 3) putting them into the context of several other clinical, biological, and neurophysiologic