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Unified EEG terminology and criteria for nonconvulsive status epilepticus

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Summary

The diagnosis of nonconvulsive status epilepticus (NCSE) relies largely on electroencephalography (EEG) findings. The lack of a unified EEG terminology, and of evidence-based EEG criteria, leads to varying criteria for and ability to diagnose NCSE. We propose a unified terminology and classification system for NCSE, using, as a template, the Standardised Computer-based Organised Reporting of EEG (SCORE). This approach integrates the terminology recently proposed for the rhythmic and periodic patterns in critically ill patients, the electroclinical classification of NCSE (type of NCSE) and the context for the pathologic conditions and age-related epilepsy syndromes. We propose flexible EEG criteria that employ the SCORE system to assemble a database for determining evidence-based EEG criteria for NCSE.

KEY WORDS: Criteria, Database, Diagnosis, EEG, Nonconvulsive status epilepticus, Standardized terminology.

EEG is indispensable for the diagnosis of nonconvulsive status epilepticus (NCSE) because the clinical signs (if any) are most often subtle and nonspecific (Shorvon, 1994). Although several proposals for a revised terminology and EEG classification of NCSE have been published, currently there are no evidence-based EEG criteria for NCSE (Hirsch et al., 2005, 2013; Kaplan, 2007; Sutter & Kaplan, 2012). Similar EEG patterns can be recorded in various pathologic conditions, leading to substantial confusion in the literature.

Recently a European consensus statement has been published for Standardised Computer-based Organised Reporting of EEG (SCORE; Beniczky et al., 2013). SCORE offers an ideal template to integrate the various clinical and electrographic aspects of NCSE and related EEG patterns such as periodic discharges and rhythmic delta. In addition to providing a unifying terminology, this could yield a structured database for determining evidence-based EEG criteria for NCSE.

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EEG Patterns in Critically Ill Patients

The revised terminology for rhythmic and periodic patterns in critically ill patients (RPPs) with coma/stupor can be implemented as a special template in SCORE (Hirsch et al., 2013). The specific features to be scored can be grouped as follows (for detailed definition of these terms, please see Hirsch et al., 2013):

1 *Name of the pattern:* Periodic Discharges, Rhythmic Delta Activity, or Spike-and-wave/sharp-and-wave plus subtypes.
2 *Morphology:* sharpness, number of phases, triphasic morphology, absolute and relative amplitude, polarity.
3 *Location:* generalized (including any bilateral synchronous pattern), lateralized, bilateral independent, multifocal.
4 *Time-related features*: prevalence, frequency, duration, daily pattern duration and index, onset (sudden vs. gradual), and dynamics (evolving, fluctuating, or static).
5 *Modulation:* stimulus-induced versus spontaneous.

We added two new entries containing the features in the current version of SCORE (Beniczky et al., 2013):

Table 1. Working clinical criteria for nonconvulsive status epilepticus

Patients without known epileptic encephalopathy
EDs > 2.5 Hz, *or*
EDs ≤ 2.5 Hz or rhythmic delta/theta activity (>0.5 Hz) AND one of the following:
EEG and clinical improvement after IV AED[a], *or*
Subtle clinical ictal phenomena during the EEG patterns mentioned above, *or*
Typical spatiotemporal evolution[b]
Patients with known epileptic encephalopathy
Increase in prominence or frequency of the features mentioned above, when compared to baseline **with** observable change in clinical state
Improvement of clinical and EEG[a] features with IV AEDs

Modified from Kaplan (2007).
EDs, epileptiform discharges (spikes, poly spikes, sharp-waves, sharp-and-slow-wave complexes); IV AEDs: intravenous antiepileptic drugs.
[a]If EEG improvement occurs without clinical improvement, or if fluctuation without definite evolution, this should be considered possible NCSE.
[b]Incrementing onset (increase in voltage and change in frequency), or evolution in pattern (change in frequency >1 Hz or change in location), or decrementing termination (voltage or frequency).

6 *Semiology.*
7 *Effect of intervention (medication).*

EEG and clinical features in patients without coma/stupor are to be scored using the terminology of the current version of SCORE. This is suitable for all age groups: a special template is available for neonates. The clinical signs (semiology) and EEG patterns are selected from the predefined lists and are logged in the chronologic order (Beniczky et al., 2013).

Working Criteria for NCSE

During the buildup phase of the NCSE database we recommend using the working criteria listed in Table 1. These are flexible recommendations, as exceptions may occur. The nomenclature and database will allow additional study on the EEG patterns in a given clinical context, regardless of whether a given pattern was deemed to represent NCSE or not.

Electroclinical and Etiologic Classification of NCSE

Based on the EEG features scored as described, and based on the clinical context, the diagnostic conclusion NCSE can be drawn, and further classified according to:

1 Type of NCSE (electroclinical classification). Two major categories are to be distinguished: with and without coma/stupor (Bauer & Trinka, 2010). The following subtypes are proposed for NCSE without coma/stupor: (1) with generalized onset (absence SE: typical, atypical, and myoclonic absence SE); (2) with focal onset (with vs. without impairment of consciousness, aphasic NCSE); (3) Unknown whether focal or generalized (e.g., autonomic SE).
2 Etiology: symptomatic (i.e., known) and cryptogenic (i.e., unknown). The symptomatic cases can be further classified as: (1) acute; (2) remote; (3) progressive; (4) NCSE in age-related electroclinical syndromes (Sutter & Kaplan, 2012).

Future Perspectives

Implementation of a unified, comprehensive terminology for the diagnostic features related to NCSE would facilitate multicenter studies. It can potentially improve the quality of the diagnostic workup by preventing use of ambiguous terminology.

A comprehensive database containing the unified terminology would make it possible to infer diagnostic criteria with a chosen sensitivity and specificity. Such a database would be a valuable research tool, for example, by searching for specific conditions and then extracting the original recordings for further analyses.

Disclosure

The authors have no relevant conflicts of interest.

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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