

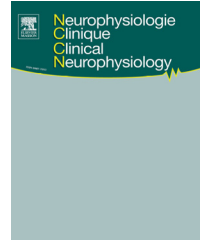


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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Continuous EEG monitoring in children in the intensive care unit (ICU)



Surveillance EEG continue de l'enfant en unité de soins intensifs (USI)

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KEYWORDS

Child EEG monitoring;
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DSA: density spectral array;
CSA: compressed spectral array;
Status epilepticus;
Electroclinical seizures;
Subclinical seizures

Summary Pediatric EEG in the intensive care unit (ICU) requires specific technical requirements in order to yield relevant data depending upon clinical scenario: diagnosis of electroclinical or subclinical seizures, their quantification before and after therapeutic changes and sometimes evaluation of severity of cortical dysfunction. The urgent nature of these indications implies the rapid set-up of the EEG system by qualified staff and possibility of maintaining the electrodes in place during long periods of time. Various techniques are available today for EEG monitoring, the interpretation of which depends on the contribution of an experienced physician. Among recent techniques, those most commonly used are trend curves obtained via signal analysis such as amplitude EEG (a-EEG) and density spectral array (DSA) or compressed spectral array (CSA). Trend curves enable the digital creation of a display graph containing several hours of transformed and compressed EEG recorded data. Visualized on one sole display graph, these trend curves can facilitate the identification of very slow changes in EEG background activity and their variation (alertness cycles, changes linked to treatment administrations) as well as seizure patterns and their quantification. In this chapter, we propose a brief overview of monitoring techniques, followed by a review of the various data yielded by EEG monitoring as well as the relevance of this type of management; finally, detailed clinical indications will be discussed after thorough analysis of the literature.

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Abbreviations: ICU, intensive care unit; PICU, pediatric intensive care unit; NICU, neonatal intensive care unit; a-EEG, amplitude-EEG; DSA, density spectral array; CSA, compressed spectral array; CEEG, continuous EEG; TBI, traumatic brain injury.

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MOTS CLÉS

EEG de l'enfant ;
Monitoring EEG ;
Soins intensifs ;
EEG d'amplitude
(a-EEG) ;
DSA : *density spectral
array* ;
CSA : *compressed
spectral array* ;
État de mal ;
Crises
électro-cliniques ;
Crises infracliniques

Résumé L'EEG chez l'enfant effectué en unité de soins intensifs (USI) nécessite des conditions techniques spécifiques afin de répondre de façon la plus efficace à la demande d'objectiver selon les cas, le diagnostic de crises électro-cliniques ou infracliniques, leur quantification avant et après modification thérapeutique, et parfois, l'évaluation de la gravité de l'atteinte corticale dans diverses situations comportant un risque neurologique. Le caractère urgent de ces indications implique l'installation rapide par un personnel qualifié et la possibilité de maintien en place des électrodes durant de longues périodes. Diverses techniques sont actuellement disponibles, permettant le monitoring EEG, mais son interprétation impose la contribution d'un médecin expérimenté. Parmi les techniques récentes, les courbes de tendance par analyse du signal les plus utilisées sont l'amplitude EEG (a-EEG) et le contenu fréquentiel (*density spectral array* [DSA] ou *compressed spectral array* [CSA]). Les courbes de tendance permettent de créer un affichage graphique de plusieurs heures d'enregistrement des données EEG transformées et condensées dans le temps. Visualisées sur un seul graphe, ces courbes de tendance facilitent l'identification des évolutions très lentes de l'activité de fond et leur variation (cycles de vigilance, modifications liées aux administrations de traitement) ainsi que les patterns de crises et leur quantification. Dans ce chapitre une mise au point est d'abord établie concernant les techniques de monitoring puis sont revus les différentes informations apportées par le monitoring ainsi que l'intérêt de ce type de prise en charge et enfin, les indications cliniques détaillées sont rapportées après une analyse précise de la littérature.

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Summary of guidelines

The summary of guidelines are:

- EEG in the ICU is quite specific because it needs to be performed in close partnership with the medical team and healthcare professionals for monitoring, but also sometimes for its set-up and interpretation;
- continuous EEG is indicated for the detection and quantification of clinical and subclinical seizures and assessment of cortical dysfunction;
- if standard EEG does not yield sufficient information in situations of unexplained worsening of neurological state or disorders of vigilance, continuous EEG can help evaluate the severity of the acute brain injury and its prognosis as well as indicate a diagnosis of subtle seizures, regardless of initial etiology;
- the set-up must include at least 8 EEG electrodes and an ECG;
- ideally, cup electrodes are preferable to needle electrodes;
- ideally, it is recommended to perform a synchronized video recording with the EEG;
- set-up should be performed by EEG technicians experienced in ICU patients;
- interpretation can be done at a distance via electronic transmission (tele-EEG);
- in the absence of neurophysiology personnel on-call, the prescribing critical care/anesthetist physician can be trained to recognize certain EEG patterns;
- trend curves can be used, but raw EEG data should be easily accessible;
- the process for EEG results transmission must be explicitly described: the neurophysiologist must know the names and phone numbers of the persons to be reached, and

contact info for the neurophysiologist must be communicated to the healthcare team;

- during opening hours the EEG device and set-up should be checked twice a day;
- the report form must be written by an EEG-experienced physician for all EEG recordings, including trend curves for any 24-hour period (forensic evidence).

Full-length guidelines

Introduction

This chapter concerns EEG in the pediatric intensive care unit (PICU), excluding neonatal intensive care unit (NICU). It complements the chapters dedicated to adults in the ICU and newborns in the NICU. References were searched in PubMed using the keywords "EEG, ICU ± child" and limited to articles in French and English published in the last 10 years.

Practice of EEG is different in the PICU from that used in the neurology/neuro-pediatric care units, where EEG monitoring is planned at the request of a neurologist or neuro-pediatrician and under constant surveillance by EEG technicians (to varying degree). In the ICU, persons not directly related to the neurophysiology or neurology departments can sometimes manage requests, recordings and even EEG interpretation.

These differences are due to the specific urgent indications of EEG in the ICU: diagnosis of electroclinical or subclinical seizures, quantification before and after therapeutic changes, or more rarely the assessment of cortical dysfunction in various situations carrying a neurological risk.

The risk of neurological damage exists for most patients hospitalized in the ICU. It is more important if the primary pathology is neurological, but other organ failures such as anoxia, hypoxia or metabolic disorders can have an

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