



EDITORIAL

Neuromonitoring of the extremely preterm infant[☆]

Neuromonitorización en el neonato prematuro extremo

Juan Arnaez^{a,b,*}, Alfredo Garcia-Alix^b^a *Unidad de Neonatología, Complejo Asistencial Universitario de Burgos, Burgos, Spain*^b *Neurología Neonatal, Fundación NeNe, Spain*

The systemic physiological monitoring of ill preterm infants combined with advances in respiratory care, the treatment of infection and the optimization of nutrition have reduced morbidity and mortality in these patients in the past 40 years. However, and despite these advances, brain injury and its impact on long-term neurodevelopment will continue to be one of the main challenges in neonatal medicine in upcoming years.¹

Although the aetiology of brain injury is multifactorial, damage usually results from a combination of hypoxic-ischaemic insults, inflammatory processes and oxidative stress in an immature brain that is undergoing complex maturation events that render it highly vulnerable to these stressors. In this context, neuromonitoring allows early detection of the impact on the brain of multiple insults that may take place in the intensive care setting with the main purpose of guiding the management of these patients and, in so doing, increasing the number of patients with normal neurodevelopmental outcomes. In addition, neuromonitoring is helping us elucidate the physiology of the transition to extrauterine life and understand the physiological changes

associated to the care delivered by the health care team in collaboration with families.

At present, in addition to the neurologic examination and neuroimaging techniques, the 2 main approaches used for continuous neurologic monitoring are the assessment of the cortical electrical activity by amplitude-integrated electroencephalography (aEEG) and monitoring of the cerebral regional oxygen saturation (crSO₂) by near-infrared spectroscopy (NIRS), known as cerebral oximetry. Both of these neuromonitoring modalities, each with its strengths and weaknesses, are being widely adopted in the care of preterm infants on account of the growing evidence in support of their benefits.^{2,3}

The current issue of ANALES DE PEDIATRÍA includes two articles related to the use of these neuromonitoring modalities in extremely preterm infants. On one hand, the article by Cordeiro et al.⁴ describes the experience of a level III neonatal unit with the different types of electrodes used for aEEG/cEEG monitoring in preterm infants less than 28 weeks of postmenstrual age. Based on criteria that included the need to prepare the scalp, time required for placement, possibility of repositioning, risk of cutaneous lesions, sterility of the method and durability of the setup, the authors concluded that disposable self-adhesive wet gel electrodes with pre-attached lead wires were most suitable for electroencephalographic monitoring in extremely preterm newborns.

This study, which did not actually have a comparative design, analysed the use of the different types of electrodes by 2 experienced neonatologists and neonatal intensive care

[☆] Please cite this article as: Arnaez J, Garcia-Alix A. Neuromonitorización en el neonato prematuro extremo. *An Pediatr (Barc)*. 2021;95:395–396.

* Corresponding author.

E-mail addresses: juan.arnaez@neurologia neonatal.org (J. Arnaez), alfredoalix@gmail.com (A. Garcia-Alix).

nurses and reviewed the experience of the research team with the use of self-adhesive wet gel electrodes with a pre-attached wire. However, due to the lack of similar or comparative studies in the previous literature and the uncertainty in everyday practice as to which type of electrode is most suitable for this vulnerable population, the information provided by this study can be useful for the purpose of monitoring cortical electrical activity in extremely preterm infants. We ought to highlight that this research involved neonatologists and neonatal nurses. The latter, being responsible for care delivery at the bedside, are the health professionals that confront the difficulties and implement practical solutions to manage to monitor this special subset of neonatal patients.

The other article analyses the impact of a potential confounder (bilirubin) on $crSO_2$ readings through a case series. Cerebral regional oxygen saturation monitoring allows the continuous, safe and noninvasive assessment at the bedside of the level of haemoglobin saturation in brain tissue and reflects the balance between the O_2 delivered to the tissue and its uptake. The care of extremely preterm neonates in the first 72 h of life guided by neuromonitoring reduces the burden of hypoxia and hyperoxia, and a phase II randomised controlled trial found that use of NIRS was associated with a decreasing trend in the incidence of severe brain lesions and all-cause mortality.³

In this issue, Rodríguez et al.⁵ present a small series of 4 extremely preterm infants with multifactorial cholestatic jaundice in whom the increase of serum bilirubin levels was associated with a concurrent reduction in $crSO_2$ values, which suggested that the concentration of bilirubin in the skin can affect the measurement of regional oxygen saturation levels. As the authors noted, this association, while found occasionally in adult patients with liver disease, had not been described in neonatal patients before. If the role of serum bilirubin as a confounder is corroborated in studies specifically designed to explore this issue, the observation of Rodríguez et al will have proven quite relevant, as it would have shed light on a weakness of currently available systems and invited caution in the interpretation of $crSO_2$ readings obtained in preterm infants with hyperbilirubinaemia. Based on the available information, it was not possible to determine whether a particular form of bilirubin (conjugated or unconjugated) or both acted as chromophores capable absorbing light in the infrared range. Other questions also remain to be resolved, such as the correlation between bilirubin levels and $crSO_2$ and the level of the former from which readings of the latter are affected. Knowledge of these details could lead to the introduction of

correction factors for compensation in the algorithms used in the measurement of $crSO_2$.

Research on practical aspects that facilitate or hinder neuromonitoring in extremely preterm infants is of great value for everyday practice in the NICU setting. The pressing need to improve neurodevelopmental outcomes in this population is a driving force for the development and application of different methods for monitoring the central nervous system, which in turn allows more individualised care guided by brain physiology. However, given the complexity of cerebral insults in extremely preterm infants, a single monitoring modality will not suffice to detect the full spectrum of pathophysiological changes that threaten the integrity of the brain. Multimodal neuromonitoring with simultaneous measurement of different parameters will probably provide a more comprehensive picture of brain physiology and disturbances as well as their response to therapeutic interventions. In any case, we still need to establish the clinical relevance, reliability and accuracy of each neuromonitoring modality, in isolation and in combination with others, and resolve technical aspects by, for instance, comparing different systems, sensors and electrodes or the sites where they are placed, and identify potential artefacts and confounders in each modality.

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