EDITORIAL

Amplitude-Integrated Electroencephalography: A Runaway Horse?

Can J Neurol Sci. 2012; 39: 267-268

The use of amplitude-integrated electroencephalography (aEEG) is becoming established in many neonatal intensive care units in advanced economies,[1] including Canada. The potential applications of aEEG have been discussed in several papers, and advertised by vendors of commercial machines. Therefore, the paper by Appendino et al from Toronto,[2] in this issue of the Canadian Journal of Neurological Sciences, is a timely wake up call for Canadian neonatologists, pediatric neurologists, and pediatric clinical neurophysiologists to collectively develop national guidelines for aEEG monitoring in neonates. A brief overview of the salient issues may help to kick-start the process.

In 1969, Maynard et al described a device, they called 'cerebral function monitor' (CFM) to assess brain activity continuously yet conveniently and cost-effectively in a number of acute clinical settings.[3,4] The limitation to one channel, paper output, problems with pens and ink, and the challenges of recognizing artifact on-line, discouraged general clinical acceptance of the CFM at that time.

In 1983, Bjerre et al described the use of the CFM in neonates with severe asphyxia;[5] however, widespread usage had to await electronic miniaturization and digital technology, so that aEEG monitors (aEEG is the commonly used term for the tracing from CFM) could be conveniently incorporated with other instruments at the bedside. Additionally, many neonatal intensive care units did not have ready access to timely 24/7 prolonged conventional video-EEG monitoring and interpretation. Hence, many neonatologists began to use aEEG monitors to assess brain activity continuously on-line in selected critically ill neonates.

With use, the literature on the interpretation and classification of aEEG waves and patterns, including normative data on term and pre-term infants, has been expanding as well. Readers are directed to recent references for details.[6-11] Many commercially available aEEG monitors now allow for various display options, including showing the time compressed aEEG alongside initially single, and more recently two-channel "raw" EEG source tracing. Several conventional video-EEG machines also offer the option of displaying EEG signals continuously in an aEEG format. The automated analysis of aEEG signals is the subject of "intense ongoing research".[1,11,12]

The introduction of hypothermia for neonatal hypoxic ischemic encephalopathy was a major impetus for aEEG.[6] Amplitude-integrated electroencephalography performed at < 6 hours of age was used to screen subjects for entry to a clinical trial on therapeutic hypothermia for neonatal hypoxic ischemic encephalopathy.[13] However, reservations have been expressed about using aEEG to select neonates for (hypothermic) neuroprotective interventions; one study also suggested that the aEEG did not add to the information provided by the modified Sarnat staging.[9,14,15]

The prognostic significance of aEEG patterns in term and pre-term neonates who have suffered hypoxic ischemic and other neurological 'injuries,' is another area of clinical discussion.[6,8,9,16,17] Nevertheless, the conventional EEG with the full 'neonatal' array of electrodes,[1,18] is still the clinical neurophysiologic gold standard for prognostication.[6]

There is a large body of literature on the use of aEEG for clinical and electrographic seizure detection in the neonate. Space does not permit adequate discussion of this important subject. The relevant issues have been summarized in three recent papers.[1,6,12] The sensitivity of aEEG for neonatal seizure detection is currently limited;[1] conventional video-EEG monitoring remains the gold standard for not only diagnosing neonatal seizures and excluding non-epileptic events but also for accurately quantifying electrographic seizures, assessing their duration and studying their evolution and spatial distribution.[1,6,12] The American Clinical Neurophysiology Society suggests that an aEEG can be a useful initial complementary tool, if conventional EEG monitoring is not readily available. Conventional EEG monitoring (ideally video-EEG) should commence as soon as possible to refine the diagnosis, should seizures be suspected.[1]

More recently, aEEG has also been used to monitor older children and adults with encephalopathy, seizures, and inborn errors of metabolism.[19-21] The horse is out of the stable!

The impact of aEEG on neonatal practice, in the retrospective studies from Toronto[2] and Ann Arbor[22] can be summarized as follows: (i) Reduction in the number of 'repeat' EEGs on the same neonate, increase in the number of conventional EEGs, and no change in the number of neurology consultations in the Toronto study, and (ii) fewer patients diagnosed clinically with seizures without electrographic confirmation, no change in anti-epileptic drug use and no change in the number of neuroimaging studies in the Ann Arbor one. These preliminary data will be reassuring to the more conservative amongst us.

Amplitude-integrated electroencephalography may well prove to be a good screening tool for the cost-effective use of conventional EEG, as Maynard et al intended it to be.[3] Nonetheless, well designed studies, ideally free of industry bias, are needed to identify evidenced-based indications for monitoring, and ensure cost-beneficial care.

We must not be blind-sided by the "unintended consequences" of unwise use of new technology.[23] Therefore, Canadian guidelines for aEEG are overdue. The recent guideline on neonatal EEG monitoring from the American Clinical Neurophysiology society,[1] provides an excellent starting point for a Canadian effort.

Note

1. Only a select number of references from the many available through electronic searches have been cited. We apologize if we have omitted to cite any seminal ones.
2. Reference numbers 1,3,6,12 and 23 should be 'core' reading on the subject; references 8 and 9 are also very informative.

Acknowledgements

The authors thank Drs. Fenella Kirkham (UK), Molly Seshia (Canada) and Jerry Yager (Canada) for reviewing the manuscript.

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