Bispectral Index in Pediatrics: Fashion or a New Tool

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The authors in an editorial write that the bispectral index (BIS), as calculated from a computer program developed by Aspect Medical Systems, Inc. Newton, MA, is becoming the gold standard for assessing depth of anesthesia in adult patients. The BIS reference is derived from a large database of EEG traces obtained in adult patients receiving propofol and inhalation agents such as isoflurane, desflurane and sevoflurane. The database is regularly updated and the software is changed accordingly. The calculation of BIS is proprietary and hence kept secret, but the elements included in the algorithm are known. The index presented takes into account the frequency content of the EEG signal (the proportion of rapid to slow waves decreases with increasing hypnotic concentration), the synchronization of the wave form (ranging from virtually none in awake patients to a higher degree of synchronization with increasing depth of anesthesia), and percentage of burst suppression (increases with depth of anesthesia). The BIS is displayed as a dimensionless number between 0 (deep anesthesia) and 100 (fully awake) with 40 – 60 being suitable for surgical anesthesia in adults.

The BIS has well known limitations in adults. First, the BIS is insensitive to narcotics, it reflects only one component of the triad of anesthesia, namely hypnosis, and not analgesia or muscle relaxation. Therefore it is not surprising that the specificity of BIS for predicting the response to noxious stimuli such as laryngoscopy or surgical incision under balanced anesthesia is low. Second, the BIS algorithm was validated mainly against propofol alone or combined with volatile agents currently in use, isoflurane, desflurane and sevoflurane. The index is not evaluated against ketamine, and has a much higher value for a given MAC with halothane as compared to sevoflurane. These drawbacks are not surprising as the EEG tracings with these agents are very different from those obtained using propofol and the more recent volatile agents.

The BIS monitor was developed to decrease the incidence of awareness under anesthesia. As such, it would be useful when volatile anesthetics are used, and would also help in reducing recovery time. However, the BIS was conceived as a monitor for adults and not for pediatric use. The question is does it work in the pediatric patient? But first we must recognize that awareness is as yet poorly described or understood in children. EEG tracings in young children differ from those in adults. From infancy to adulthood, the amplitude of the EEG decreases and the dominant frequency increases. However, the effects of anesthetic agents on EEG tracings are comparable throughout life. BIS values recorded in pediatric patients are inversely correlated with endtidal sevoflurane and isoflurane. BIS values are better correlated with sevoflurane concentration than with heart rate and blood pressure in preschool children. In infants the endtidal sevoflurane corresponding to a BIS value of 50 is higher than with that for children aged over two years. In infants during recovery, BIS changes are less progressive and exhibit an on-off profile, whereas changes are more progressive in older children and adults. Thus, BIS guided anesthetic appear to be only helpful in children over three years of age.

Specific limitations of the index have been observed in children. BIS values describe a paradoxical profile during inhalational induction in children, and are correlated neither with clinical events nor with clinically assessed depth of anesthesia. The typical BIS during rapid inhalational induction with sevoflurane shows an early and abrupt drop after loss of consciousness followed by an increase with deepening anesthesia. The nadir of BIS is usually observed 120 – 180 s after the beginning of induction which reflects the very low EEG frequency observed around the second minute of induction. This subsequent increase in BIS reflects the shift of EEG to a higher frequency. Also, BIS displays a paradoxically high value during seizure activity, a special concern in children anesthetized with high concentration of sevoflurane. Thus, one of the potential uses of the BIS monitor in children may be to avoid deep levels of anesthesia, BIS below 20. Such monitoring would help reduce the risk of possible brain function impairment associated with deep anesthesia in young children.

Comments: Perhaps the use of BIS monitoring seems most promising during sedation procedures in children. The prerequisite to correctly interpret BIS changes is to be aware of specific effects of anesthetic agents on the EEG and to know the specific EEG changes associated with anesthesia. One must also remember that under balanced anesthesia, (narcotics are used in the majority of patients), the BIS does not reflect the adequacy of the analgesics administered. Much more study is needed to evaluate the usefulness of BIS monitoring in children.