

Bispectral index monitoring during neuromuscular blockade in infants and children

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Introduction: Despite their adverse effect profile, neuromuscular blocking agents (NMBA's) are occasionally required in the care of critically ill infants and children in the Pediatric ICU setting. When such medications are used, clinical assessment of the depth of sedation becomes impossible. Therefore, physiologic parameters such as heart rate and blood pressure are frequently used to judge the depth of sedation and the need for changes in the sedative regimen. Although the Bispectral Index (BIS monitor, Aspect Medical, Newton, MA) has been shown to provide a judge of the depth of sedation during anesthetic care, there are limited data regarding its use in the Pediatric ICU setting. The current study prospectively evaluates BIS numbers during the use of NMBA's and evaluates the accuracy of the bedside nurse's decision regarding the need for supplemental sedation.

Methods: This study was approved by the hospital's IRB and verbal consent obtained from a parent. Patients admitted to the Pediatric ICU who required use of a continuous infusion of a NMBA were considered eligible for inclusion. All patients were receiving a continuous infusion of either midazolam or propofol with supplemental doses of midazolam, fentanyl, or morphine as needed. The BIS sensor was applied to the patient's forehead and the monitor started. The actual BIS number from the monitor was download into a bedside computer every 10 seconds. The monitor was concealed from the bedside nurse and no clinical decision was made based on the number. Supplemental doses of midazolam, fentanyl, or morphine were administered according to the usual nursing routine that included the use of vital sign changes as means of judging the need for supplemental sedative or analgesic agents. For the purpose of the study, based on data from its intraoperative use, the defined goal, indicative of the appropriate level of sedation, was a BIS number of 50-70. Oversedation was defined as a BIS number less than 50 and undersedation was defined as a BIS number greater than 70. The risk of oversedation and undersedation when using propofol versus midazolam was analyzed using a chi square analysis with a Yates' correction.

Results: Seven patients ranging in age from 12 months to 8 years have been enrolled in the study. There were 4 boys and 3 girls. The duration of continuous neuromuscular blockade use varied from 20 to 116 hours for a total of 390 hours. From the 390 hours of neuromuscular blockade use, there were 112,374 BIS values recorded by the bedside computer. The BIS number was 50 to 70, 47% of the time. The BIS value was ≤ 49 , 42% of the time and greater than 70, 11% of the time. There were 82 supplemental doses of sedative or analgesic agent administered during this time. When these doses were given, the BIS number was greater than 70, 58% of the time; 50 to 70, 33% of the time, and ≤ 49 , 9% of the time. Patients receiving propofol were more likely to have a BIS number less than 50 and less likely to have a BIS number greater than 70 than patients receiving midazolam ($p < 0.01$).

Conclusion: During the use of NMBA's, physiologic parameters including heart rate and blood pressure may not be an accurate means of judging the depth of sedation. In the current study, we noted that the depth of sedation was appropriate to maintain a BIS number of 50 to 70, only 47% of the time. A significant percentage of time (42%), the patient's BIS number was less than 50, indicative of oversedation. The risk of oversedation was greater with propofol when compared to midazolam. During a smaller percentage of the time (9%), the BIS number was greater than 70 or indicative of inadequate sedation. There was little or no correlation of the BIS number with the time that supplemental sedation was administered indicating the inaccuracy of using heart rate and/or blood pressure as a means of judging the depth of sedation and the need for supplemental sedative or analgesic agents. Given the adverse effects associated with oversedation and the potential for awareness with undersedation, BIS monitoring may be helpful in guiding the depth of sedation during the use of NMBA's.