Conscious Sedation of Children With Propofol Is Anything but Conscious

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ABSTRACT. *Objective.* **To determine the depth of sedation required for bone marrow aspiration and intrathecal injection of chemotherapeutic agents in children using a bispectral (BIS) index monitor and clinical assessment by an independent observer.**

Methods. **Sixteen children who were undergoing 19 intrathecal chemotherapy and bone marrow aspirations were enrolled in the study. Their ages ranged from 23 months to 190 months with a mean of 79 months. The BIS index was recorded every 5 minutes by an independent observer. The patients received only intravenous propofol for sedation. There were no complications during the procedures.**

Results. **The mean BIS score was 62.8 ± 9.6. The mean low BIS score was 29.7 ± 13.7, indicating a level of deep sedation and/or general anesthesia was necessary to induce the desired stated of consciousness that would permit the practitioner to perform the procedure. The average dose of propofol was 166 ± 47 μg/kg/min. Mean Aldrete score for level of consciousness was 0.9 ± 0.4, indicating a depressed level of consciousness. The mean activity level was 1.0 ± 0.4, indicating impaired movement.**

Conclusions. **Children who undergo conscious sedation with propofol for intrathecal chemotherapy and bone marrow aspiration demonstrate BIS values and clinical assessments consistent with deep sedation. Because of an increased risk of adverse events when children undergo deep sedation, appropriate parental informed consent, age-appropriate resuscitative equipment, and skilled anesthesia personnel should be present for rescue in the event of cardiovascular and respiratory complications from deep sedation.** ***Pediatrics*** **2004; 114:e74–e76. URL: http://www.pediatrics.org/cgi/content/full/114/1/e74;** ***BIS index monitor, sedation, children.***

ABBREVIATIONS. JCAHO, Joint Commission on Accreditation of Healthcare Organizations; BIS, bispectral; EEG, electroencephalogram.

Conscious or moderate sedation has gained wide acceptance as the primary mechanism to expedite the conduct of procedures on children. According to the American Society of Anesthesiology task force on sedation and analgesia, conscious sedation "describes a state that allows the child to tolerate unpleasant procedures while maintaining adequate cardiopulmonary function and the ability to respond purposefully to verbal command and/or to tactile stimulation."[1] Recently, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) revised its standards for anesthesia and sedation.[2] This revision was required by changes in anesthesia and sedation practices, which have moved from the operating room setting to peripheral sites such as ambulatory care clinics. In addition, potent intravenous induction anesthetics, including propofol, have entered the mainstream of sedation practice.

The objective of this prospective study was to determine the level of sedation (conscious vs deep), using a bispectral (BIS) index monitor, provided by experienced anesthesia personnel for bone marrow aspiration and intrathecal injection of chemotherapeutic agents with propofol in children. Propofol was chosen because of its rapid onset, short half-life, and antiemetic effect.

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Received for publication Jan 7, 2004; accepted Feb 4, 2004.

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METHODS

This study was approved by the Medical University of South Carolina Institutional Review Board. Parental informed consent and child assent (when appropriate for age) were obtained for each subject. Sixteen children who were undergoing 19 intrathecal chemotherapy and bone marrow aspirations were enrolled in the study. Their ages ranged from 23 months to 190 months with a mean of 79 months. The majority of patients were connected to an A2000 monitor (Aspect Medical Systems Inc, Newton, MA) before initiation of sedation using a disposable BIS sensor attached to the patient's forehead according to the manufacturer's specifications. An impedance test was performed before initiating data collection. The impedance had to fall within the manufacturer's determined threshold to generate a reliable signal quality and measurement. Hemodynamic monitoring included an electrocardiogram, pulse oximeter, and noninvasive blood pressure cuff and was recorded every 5 minutes. Measurement of the patient's level of consciousness and activity level was performed every 5 minutes using a modification of the Aldrete scoring system (Table 1).

After confirmation of appropriate *non per os* status and normal laboratory values, the patients received intravenous propofol for sedation. One of the investigators was present as an independent observer to evaluate the BIS scores every 5 minutes (Table 2). Anesthesia personnel who administered propofol were blinded to the BIS index. There were no complications throughout the procedures.

Propofol was titrated by intermittent intravenous bolus injection to ensure adequate procedure conditions, still child during lumbar puncture, and intrathecal chemotherapy injection. The airway had to be supported with jaw lift and/or ventilation with a self-inflating bag and face mask intermittently in some of the patients.

Statistical Analysis

Data are reported as mean values with SDs.

TABLE 1. Modified Aldrete Score

Level of Consciousness	Point Value	Activity Level	Point Value
Fully awake	2	No change from preoperative level	2
Arousable on calling	1	Movement impaired	1
Not responsive	0	No movement	0

RESULTS

Sixteen children were enrolled in the study; their ages ranged from 23 to 190 months with a mean of 79 months. The initial presedation BIS index was ≥97 in 15 of 19 sedation procedures. The remaining 4 procedure patients did not tolerate presedation electrode placement. BIS data collection started immediately after the initiation of propofol and continued until the procedure had concluded and the child regained consciousness. The mean BIS score was 62.8 ± 9.6 for the study. The lowest BIS score mean for all of the patients was 29.7 ± 13.7, indicating that a level of general anesthesia was necessary to induce the desired stated of consciousness that would permit the practitioner to perform the procedure. The data for the patients are tabulated in Table 2.

The mean cumulative dose of propofol received by intermittent bolus was 166 ± 47 μg/kg/min. All patients were nonresponsive without movement during needle insertion, indicative of an Aldrete score of 0 for level of consciousness and impaired movement. The mean Aldrete score for level of consciousness was 0.9 ± 0.4, indicating a depressed level of consciousness. The mean activity level was 1.0 ± 0.4, indicating impaired movement.

DISCUSSION

Recent technologic advances enable physicians and personnel who are administering sedation to monitor subcortical brain waves to determine the level of consciousness. Sedative and anesthetic drugs produce changes in the pattern of the electroencephalogram (EEG), a decrease in frequency and amplitude. The BIS index monitor was developed to measure the electrophysical state of the brain during anesthesia. This device uses advanced computer programs to analyze various aspects of the EEG to evaluate the effect of sedative and hypnotic agents.[3,4] Numerous studies have demonstrated the effectiveness of the BIS monitors in both adults and children as an effective monitor of the depth of anesthesia.[3,5–7] McDermott and others[8–13] recently validated the utility of the BIS monitor in children who undergo sedation. A BIS value of 100 represents a fully awake patient, values ranging from 70 to 90 are associated with diminished recall, and patients with values <70 are unconscious. A value of 0 represents an isoelectric EEG.[3,4]

Frequently, the term "conscious sedation" or "moderate sedation" is used as the descriptive term to describe the level of sedation used in children. This implies that the child requires only a relatively small amount of sedative to achieve cooperation for the procedure and that airway reflexes are intact and respiratory and cardiovascular compromise does not occur. Hence, there is minimal risk to the patient undergoing the sedative procedure. Recently, Hoffman et al[14] noted that 22% of children who are scheduled for conscious sedation using less potent sedatives (chloral hydrate, midazolam, fentanyl) actually achieve deep sedation. The complication rate (hypoxia, airway obstruction, aspiration, hypotension, bradycardia) was 3.8% in patients who remained conscious and 5.6% in patients who were deeply sedated.

Our results illustrate that levels of deep sedation and/or general anesthesia are necessary to prevent movement during bone marrow aspiration and intrathecal chemotherapy administration. Our study differs from other studies in that propofol was the sole agent used and trained anesthesia personnel monitored the patient. In our study, the lowest BIS mean was 29.7 ± 13.7, indicating that a level of

TABLE 2. Summary of Data

Gender	Age (Months)	Weight (kg)	Propofol (μg/kg/min)	Time (Minutes)	Lowest BIS	Mean BIS	Loss of Consciousness	Activity Range
F	23	23	123	23	12	45	0.4	0.4
F	112	37	155	35	27	49	0.9	1.1
M	109	50	80	30	21	59	1.1	1.3
M	52	20	167	30	30	66	1.3	0.5
M	53	20	167	30	25	71	0.4	0.4
M	61	21	163	35	28	64	0.9	1.0
M	86	20	216	30	14	55	0.7	0.4
F	52	17	196	30	36	65	1.1	1.1
M	14	12	140	40	40	60	0.4	0.7
M	14	13	247	35	38	59	0.9	1.0
M	14	13	230	20	38	81	1.4	1.4
F	70	18	222	35	29	67	1.4	1.5
F	77	26	175	35	21	68	1.1	1.1
M	130	33	164	30	16	56	1	1.3
M	156	35	107	32	62	73	0.7	0.8
M	94	22	192	33	33	57	0.8	0.8
F	114	34	141	27	9	52	0.5	0.6
F	79	18	185	30	30	70	1.1	1.1
M	190	92	81	27	55	79	1.4	1.6
Mean	79	28	166	31	29.7	62.8	0.9	1.0
SD	48	18	47	46	13.7	9.6	0.4	0.4

general anesthesia was necessary to optimize the condition of the child for the procedure. The mean BIS number in our study was 62.8 ± 9.6, correlating with a level of deep sedation. The average dose of propofol used in the procedure was 166 ± 47 μg/kg/min, further supporting the concept that deep sedation and/or general anesthesia was used for these procedures. The terms "conscious" and "moderate sedation" should not be used when propofol is administered to children who undergo invasive procedures.

Furthermore, the addition of an opioid such as fentanyl, which is frequently used in sedation, could have resulted in a lower dose of propofol being required as a result of the synergistic effect of the 2 classes of drugs. Whether this drug combination would have resulted in a higher BIS index because of less propofol use or a lower BIS index because of the synergistic effect requires additional study.

Children who have leukemia frequently exhibit negative behavioral responses when they have undergone repeated parental separation and painful diagnostic or therapeutic procedures. Increased awareness of both the negative physical and psychological effects of painful procedures combined with pharmacologic advances in hypnotic agents have led to providing sedation for both diagnostic and therapeutic procedures in children. Procedures that are performed in the hospital setting are subject to the regulations by the JCAHO.[2] Because of the continuum of sedation and anesthesia, JCAHO regulations are specific in terms of assessment, monitoring, resuscitation equipment, qualifications of personnel administering the sedative, and discharge of the patient. In an effort to reduce cost, procedures such as intrathecal chemotherapy and bone marrow aspiration occur in the office or an off-site location rather than the operating room. Regulatory bodies have little influence on the care that patients receive outside the hospital or ambulatory care setting. After an evaluation of the Food and Drug Administration adverse drug event reporting system, Cote et al[15] reported that permanent neurologic injury or death occurred more frequently in a non–hospital-based facility (92.8% vs 37.2%). This study and others have clearly demonstrated that conscious sedation may rapidly progress to deep sedation and even general anesthesia. Physicians who provide care for the child should be acutely aware of the increased risks associated with deep sedation and become knowledgeable in the diagnosis and treatment of such complications.

The BIS monitor has significant advantages over observational scoring systems for monitoring the level of sedation. It is easy to use, quantitative, and valid. Equally important is that it does not require interaction with the child that may cause disruption of the procedure for which the sedation is given.[9] Additional evaluation is necessary to determine that patient safety is improved by using the BIS monitor in children who undergo sedation.

CONCLUSIONS

On the basis of our study, we propose that the terms "deep sedation" and "general anesthesia" be used when children receive propofol for invasive procedures. The presence of personnel who are skilled in the administration of anesthesia and pediatric airway management should be mandatory. Patient safety measures that include continuous cardiopulmonary and hemodynamic monitoring, age-appropriate resuscitative equipment, and risk-reduction measures including adherence to American Academy of Pediatrics and American Society of Anesthesiology guidelines should be implemented.[1,16]

These safety measures are even more critical when deep sedation is planned and the patient unintentionally slips into general anesthesia. The practitioner administering the sedation must be capable of rescuing the child. The presence of trained anesthesia personnel during sedation may explain why no complications occurred during our study. Because these patients have blunted airway reflexes and the possibility of ventilatory and hemodynamic compromise, the potential for adverse events is always a concern.

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OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

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Pediatrics 2004;114;e74
DOI: 10.1542/peds.114.1.e74