

## Improving Anesthetic Depth Assessment During Electroconvulsive Therapy With Bispectral Index Monitoring: A Pilot Quality Improvement Project

J. Frank Titch, DNP, CRNA  
Tracey Holsinger, MD  
Charles Vacchiano, PhD, CRNA  
Jane Blood-Siegfried, DNSc, CPNP

### Affiliation:

*From the Department of Psychiatry, Durham VA Medical Center, Durham, NC and the Duke University School of Nursing, Durham, NC.*

### Abstract

#### Background:

Achieving adequate anesthetic depth during an ECT procedure without suppressing the therapeutic seizure is challenging and increases the risk of patient awareness during the procedure.

#### Aim:

To assess provider satisfaction with, and identify potential barriers to the use of BIS monitoring during ECT as a means to determine the feasibility of adopting BIS monitoring in the clinical ECT setting.

#### Setting:

The pilot project was conducted in a 274-bed general medical and tertiary care facility located on the mid-Atlantic coast that provides services to more than 200,000 patients and administers over 200 ECT treatments annually.

#### Participants:

Psychiatry staff and nurse anesthetists caring for patients undergoing ECT.

#### Methods:

A convenience sample of 11 patients scheduled for 25 ECT treatments received BIS monitoring. Provider (n= 12) satisfaction was anonymously assessed using an 8-question survey.

#### Results:

While 7 of the 12 providers rated their overall satisfaction with using the BIS monitor during ECT as Very good only 2 providers affirmatively answered the BIS monitor added value to their decision-making process.

Two anesthetized patients, who responded purposefully to verbal commands despite BIS values in the deep hypnotic range indicating sufficient anesthetic depth, were considered at risk for awareness under anesthesia.

#### Conclusions:

Provider acceptance of the introduction of BIS monitoring to assess anesthetic depth during ECT was lukewarm at best. While the concept appears sound, one must question if the technology and tools are sufficiently developed to warrant its routine use in the described setting. Given the response of the two patients with BIS values indicating sufficient anesthetic depth, these observations merit further studies to replicate our findings in the psychiatric population and further explore the potential value of BIS monitoring during ECT.

#### Key Words:

Electroconvulsive therapy; ECT; Consciousness Monitors; Bispectral Index Monitor; Intraoperative Awareness; Anesthesia Awareness; Awareness During Anesthesia

#### Author Correspondence:

J. Frank Titch, DNP, CRNA, Duke University School of Nursing, DUMC 3322, 307 Trent Dr., Durham, NC 27710 ([frank.titch@duke.edu](mailto:frank.titch@duke.edu)); 919.684.5772

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## INTRODUCTION

### Background Knowledge

Electroconvulsive therapy (ECT), a recognized treatment for certain neuropsychiatric disorders, is performed after the administration of a short-acting intravenous hypnotic followed by the administration of a short-acting muscle paralytic that attenuates motor seizure activity.<sup>1</sup> The intravenous anesthetic depresses therapeutic seizure activity in a dose-dependent manner.<sup>2</sup> Given the challenge of achieving adequate anesthetic depth without suppressing the therapeutic seizure, the patient is at increased risk for awareness while paralyzed before the electrical stimulus.<sup>3</sup> A search of the literature identified 3 case reports of awareness and recall during ECT therapy.<sup>4-6</sup>

### Problem

Multiple sources cite light anesthesia, or an imbalance between anesthesia delivery and need, as the most common cause of awareness under anesthesia.<sup>7-9</sup> Reported long-term psychological sequelae after awareness under anesthesia include anxiety, depression, nightmares, post-traumatic stress disorder (PTSD), and flashbacks.<sup>10,11</sup> Previous studies have shown the bispectral index (BIS) monitor to be a reliable anesthesia depth monitor that lowers the incidence of awareness.<sup>12</sup> The device is an electroencephalogram-derived monitor that provides real-time, continuous measurement of hypnosis, optimizing anesthetic drug delivery and avoiding extremes of drug dosages.<sup>13,14</sup> However, use of BIS monitoring to prevent awareness under anesthesia during ECT, the actual incidence of awareness during ECT, and the process of implementing BIS monitoring in the clinical setting during ECT are not well reported in the psychiatric literature.

### Intended Improvement

Current practice standards do not require BIS monitoring during ECT; therefore, we designed this pilot project to assess the feasibility of using the BIS during ECT in an active day-to-day clinical setting and evaluate its impact on provider satisfaction. Specifically, we report on the practical feasibility of developing full-scale implementation, pilot findings related to provider satisfaction, and potential barriers that may influence its use. Prospective barriers to the implementation of standardized BIS monitoring for ECT may be associated with many factors, such as the integrity of BIS values, provider satisfaction, increased treatment times, and cost of supplies. Consequently, the purpose of this pilot project was to implement a practice change using the BIS monitor to assess anesthetic depth during ECT to improve quality and safety and evaluate its effectiveness. The goal of BIS is to minimize the risk of awareness with recall that may lead to PTSD in this psychologically vulnerable population. In particular, we wanted to determine whether it was feasible to use the BIS during ECT and whether anesthesia providers would find it useful in day-to-day practice. To most accurately replicate implementation of such a change into an active practice, we chose a pilot project, selected a convenience sample, and did not standardize the anesthetic protocol. We report the complexities associated with implementing such a protocol during the administration of ECT.

## METHODS

### Ethical Concerns

The facility's institutional review board approved both the pilot project's implementation and subsequent survey analysis. Both the chair of the psychiatry department and the attending psychiatrist provided organizational consent. We reported only de-identified data.

### Setting

The project was conducted in a 274-bed general medical and tertiary care facility on the mid-Atlantic coast that provides services to more than 200,000 patients living in a 26-county area. The facility treats more than 46,000 patients who make more than 339,000 outpatient visits annually. Psychiatric care is provided in both inpatient and outpatient settings and, at the time of the project, the psychiatry service administered slightly more than 200 ECT treatments yearly.

### Intervention

We undertook a pilot project to assess the feasibility of using BIS monitoring during ECT. A convenience sample of 11 patients scheduled for 25 ECT treatments as a routine healthcare service event received BIS monitoring over 53 calendar days. Patients were not randomly assigned to a study arm, and all patients received bilateral temporal index or maintenance ECT treatments using the spECTrum 5000Q<sup>®</sup> (Mecta Corp., Lake Oswego, OR). Standard procedural monitors, including a noninvasive blood pressure cuff, 5-lead electrocardiogram, pulse oximetry, and capnography, were employed during the ECT procedure. Per the manufacturer's protocol, the BIS monitor was applied to the patient's forehead when the patient entered the treatment area, and the device recorded values throughout the procedure.

The BIS electroencephalogram signal was acquired using a 4-electrode disposable sensor (BIS<sup>™</sup> Quatro Sensor; Covidien, Boulder, CO) applied to the patient's forehead as recommended by the manufacturer. The signal was then analyzed and recorded using the BIS VISTA<sup>™</sup> monitoring system (software revision 1.13.2.5; Covidien) with the latency period set at 15 seconds. On connecting the sensor to the monitoring system, the manufacturer's proprietary Sensory Integrity Check software tests the impedance of each electrode and does not begin normal processing of the BIS value until the impedance test is successfully completed.

We did not standardize anesthetic techniques for this pilot project. During the preoxygenation period, patients may or may not have received intravenous caffeine, labetalol, or opioid medications. General anesthesia was induced intravenously with either methohexital or etomidate after the administration of 100% oxygen by mask. On loss of responsiveness to verbal commands and eyelash reflex, we inflated a blood pressure cuff on the right lower leg, isolating circulation to the foot before succinylcholine administration. After the induction of hypnosis and paralysis, patients were asked to move the toes of their right foot. If there was no response, BIS values were noted and an electrical stimulus was delivered via bitemporal electrodes. We determined response to verbal command and

motor seizure duration using the unparalyzed isolated right foot, while the duration of the induced seizure was recorded using single bifrontal electroencephalogram leads monitored through the spECTrum 5000Q. We provided controlled ventilation throughout the procedure with 100% oxygen until the resumption of spontaneous breathing. We removed all monitors, and patients were transported to the postanesthesia care unit for additional monitoring.

### Evaluation

Following the sampled 25 ECT treatments, we anonymously assessed provider satisfaction with use of the BIS monitor during ECT using an 8-question, check-box paper survey. Participating psychiatry and nurse anesthesia providers (n=12) received the survey in an opaque envelope with instructions for completion. We developed the survey instrument using questions from previous surveys provided by the BIS manufacturer, and the survey's content validity was peer-reviewed by 5 nurse anesthetists and 1 research nurse not linked with the project. In addition, we tracked procedure times for each treatment.

### Analysis

We performed statistical analyses using the SPSS Statistics software for Windows (version 19; IBM Inc., Somers, NY) and descriptive statistics to synthesize and describe the survey analysis. We analyzed survey responses by question type and evaluated the provider's comfort level using the BIS monitor, satisfaction using it for ECT, and the added value of using BIS monitoring in the ECT setting. To assess provider comfort and satisfaction, we used a 5-point Likert scale with the response alternatives of Poor, Below Average, Average, Very Good, or Excellent. Responses of Very Good or Excellent were considered affirmative answers, and a response of Average was considered neutral. We assessed the added value of BIS monitoring during ECT using a 5-point Likert scale of Never, Rarely, Occasionally, Frequently, and Always, with Frequently and Always considered affirmative answers and Occasionally considered a neutral answer.

## RESULTS

### Outcomes

After 25 ECT treatments for 11 patients, all providers (n=12) directly involved with patient care during the pilot project completed the survey. All respondents denied having previously used the BIS monitor during ECT. However, 10 respondents reported routinely using the BIS to monitor depth of anesthesia during general anesthesia. Eleven providers reported personally using BIS technology for more than 3 years in the surgical setting; 9 of those respondents reported more than 5 years of experience. Three rated their level of comfort with using the BIS as Very Good, while 6 rated their comfort level as Excellent. Eleven providers rated their overall satisfaction with using the BIS monitor during ECT as Average (4) or Very good (7). No one rated his or her satisfaction as Excellent. Ten providers responded that the BIS monitor added value to their decision-making process either Occasionally (8) or Frequently (2) during ECT. No respondents said they felt the BIS monitor Always added value during ECT.

### Procedure Time

Of the 25 procedures tracked, the mean procedure time was 26±6 minutes, ranging from 15 minutes to 39 minutes. Numerous factors such as difficult intravenous access, individual provider, or total number of supporting psychiatry nurses confounded accounting for any additional procedure time resulting from inclusion of the BIS monitor during ECT.

## DISCUSSION

### Summary

Although most providers were comfortable using BIS technology, the survey results from this pilot project demonstrate that the overall reaction to assessing anesthetic depth with the BIS monitor during ECT was lukewarm at best. While 7 of the 12 providers rated their overall satisfaction with using the BIS monitor during ECT as Very good, only 2 providers reported that the BIS monitor added value to their decision-making process.

Much to our surprise, we also discovered that the BIS monitor alone did not allow consistent and accurate assessment of the patient's anesthetic depth before delivery of the electrical stimulus. Two anesthetized patients who responded purposefully to verbal commands despite BIS values in the deep hypnotic range (40-60), indicating sufficient anesthetic depth, were considered at risk for awareness under anesthesia and received additional intravenous anesthetic (Table 1). However, no patients reported postseizure recall of events regardless of the prestimulus BIS score.

Table 1 – Pre-Stimulus Purposeful Responses to Verbal Commands

Treatment	Pre-Stimulus BIS	EMG	SQI
4	42	48	90
10	40	29	98

Note. EMG=electromyography; SQI=signal quality index

### Interpretations

Initially, we were unsure how to integrate the BIS into everyday practice and did not wish to spend excessive time incorporating the device, which affected our ability to acquire a good signal quality in all cases. We were attempting to replicate true clinical practice and determine if the device would be useful. Due to limited available forehead space in patients receiving bilateral temporal ECT, the sensor was difficult to properly place. The monitor would not begin normal processing of the BIS value until it successfully completed its impedance test; therefore, it failed to record any data during 2 treatments. In addition, we were unable to record baseline BIS values, considered critical before the administration of anesthesia, for 6 of the 25 treatments. The device, in our view, required too much effort to troubleshoot, and we did not wish to excessively prolong the procedure. However, we began prewarming the BIS sensor array and applied a very small amount of ECT electrode gel to each 4-electrode disposable BIS sensor before patient application. Following initiation of this change at treatment 11, we consistently gathered BIS data for the duration of the project.

## Limitations

While the results of our pilot project are important, they must be viewed through the lens of their limitations. The financial implications must be considered and include extended procedure times and the equipment expense. Unfortunately, too many additional variables confounded our ability to accurately assess any extension of procedure times. For the purposes of this project, BIS monitoring devices were readily available in the facility, but this may not always be the case and may represent an additional

expense. Each BIS™ Quatro Sensor cost our institution \$25.20, resulting in an additional \$630 for the 18 (72%) treatments supplying usable data. In addition, Spiegel and colleagues (2006) have proposed that the BIS could prove useful in the early diagnosis of certain neurological diseases such as Alzheimer's.<sup>15</sup> Such findings suggest that BIS values are altered in patients with certain psychiatric conditions and the threshold indicating hypnosis in patients requiring ECT may differ from that of the rest of the population.

## Conclusions

The ECT setting would appear to offer an ideal application for the introduction of BIS monitoring. Yet, except for reports of using BIS monitoring for targeted anesthetic dosage administration, reports of its use in the psychiatric literature during ECT are limited.<sup>13,16,17</sup> Achieving adequate anesthetic depth during the ECT procedure without suppressing the therapeutic seizure is challenging and increases the risk of patient awareness.<sup>3</sup> Indeed, case reports describing instances of patient awareness during ECT exist in the literature.<sup>4-6</sup> Past studies have also shown that using the BIS monitor reduces the incidence of awareness under anesthesia in at-risk patients.<sup>18,19</sup> While the concept appears sound in its foundation, one must question if the technology and tools are sufficiently developed to warrant its routine use in the ECT setting. Based on our experiences, we would not recommend implementation. Could exclusive reliance on the device mask an insufficiently anesthetized patient? Given the intra-anesthetic purposeful response of two patients despite BIS values in the deep hypnotic range (40-60), indicating sufficient anesthetic depth, further studies are needed to replicate our findings in the psychiatric population and explore the potential value of BIS monitoring during ECT.

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