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Perioperative Brain Monitoring (Part 1 of a 3-Part Series) **Optimizing Care in Total Intravenous Anesthesia Procedures With BIS Monitoring**

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Introduction

Brain monitoring may enhance outcomes for surgeries that necessitate total intravenous anesthesia (TIVA).^{1,2} Of note, the Bispectral Index™ (BIS™) Monitoring System enables clinicians to noninvasively gain insights into the patient-specific effects of anesthesia, allowing personalization of dosing to help mitigate the risk for adverse effects and enhance postoperative recovery.³⁻⁵

Overview of TIVA

Anesthesia requirements vary due to interindividual differences in pharmacodynamics and pharmacokinetics.⁶⁻⁸ Although many anesthesiologists rely on clinical signs (eg, heart rates, blood pressures, change in breathing patterns and patient movements) or end-tidal anesthetic gas to titrate anesthetic dosing, these parameters may not reliably predict the level of consciousness and can lead to potential over- or underdosing, causing intraoperative and postoperative complications.⁹⁻¹²

Intraoperative awareness is a distressing event caused by an inadequate depth of anesthesia.^{3,9,10} The risk for awareness during TIVA could be 5 to 10 times higher than that for inhaled anesthesia.^{3,9,13,14} This may be partially attributed to the short-acting nature and variable dosing of certain IV anesthetics and lack of end-tidal measurement to monitor anesthesia depth.^{9,10} Awareness during

surgery may lead to serious psychological disturbance and postoperative delirium.^{3,9,11} In addition, the use of too much anesthetics may prolong postoperative recovery and increase complications.¹⁵

Despite the increased risk for awareness, propofol may be preferred to inhalational anesthesia. Because intravenous agents cause less depression of evoked responses, it is the preferred anesthetic for spine surgeries, as it facilitates somatosensory-evoked and motor-evoked potential monitoring.^{16,17} Due to its smooth, coherent emergence with less risk for vomiting, propofol is commonly used during awake craniotomy.¹⁷ Additionally, propofol may be used to mitigate the baseline risk for postoperative nausea and vomiting and postoperative cognitive dysfunction.¹⁸⁻²³

Reliable monitoring techniques allow providers to take advantage of the benefits of TIVA while maximizing patient safety. Of note, processed electroencephalogram (EEG) monitoring is strongly recommended within enhanced recovery after surgery protocols and by several medical societies, including the American Society for Enhanced Recovery, to reduce intraoperative awareness with TIVA.^{1,15,24}

BIS-Guided TIVA

The BIS™ Brain Monitoring system collects real-time EEG data, applies a validated algorithm, and presents a BIS value that correlates well with the hypnotic state and anesthetic drug concentration, especially during high hypnotic–low opioid anesthesia.^{14,25} The BIS value ranges from 0 (deep anesthesia) to 100 (awake), with a range of 40 to 60 recommended during maintenance of anesthesia.^{15,25,26} By quantifying the level of consciousness, BIS monitoring provides a more objective measure of awareness compared with traditional assessments.²⁷

A 2019 Cochrane review found that BIS-guided TIVA with propofol reduced intraoperative awareness risk by 76% compared with monitoring clinical signs.²⁸ Individual controlled studies report even greater reductions in awareness ranging from 79% to 82%.^{3,9} Despite these impressive findings, BIS monitoring alone will not



prevent intraoperative awareness; however, it can complement clinical observations, becoming a vital preventive tool.²⁶

BIS-guided TIVA also has other advantages compared with standard practice.^{11,12,28-31} A 2019 Cochrane review found a shortened time to eye opening and post-anesthesia care unit (PACU) discharge by approximately 2 and 7 minutes, respectively, with BIS monitoring-guided anesthesia care.²⁸ In a multicenter, prospective, randomized study using propofol-alfentanil-nitrous oxide anesthesia, BIS monitoring led to faster extubation (7.25 vs 11.22 minutes), higher orientation rates on PACU arrival (43% vs 23%), quicker eligibility for discharge (31.70 vs 37.77 minutes), and improved nursing assessments compared with standard practice.²⁹ In a prospective, randomized controlled trial of 120 patients undergoing ear, nose, and throat surgery with sevoflurane or propofol, BIS-guided TIVA with propofol accelerated extubation (12.6 vs 15.4 minutes; $P<0.001$) and resulted in a 28.9% reduction in the cost of propofol induction (\$0.93 vs \$1.30; $P<0.001$).³⁰ In terms of anesthetic

dosage, a 2014 Cochrane review found that BIS-guided TIVA reduced the mean propofol infusion rate by 1.32 mg/kg per hour, whereas individual studies have found propofol dose reductions ranging from 5% to 50%.^{11,12,31} A 2018 randomized controlled trial found that BIS-guided TIVA led to a lower incidence of postoperative delirium when compared with standard practice (17% vs 27.5%; $P<0.001$).³²

Conclusion

Maintaining proper levels of sedation is vital for patient safety during surgery.¹⁻³ Incorporating BIS monitoring can enhance personalization of anesthetic dosing and safety throughout TIVA-administered surgeries and yields improved perioperative outcomes.^{11,12,28-31}

The BIS™ monitoring system should not be used as the sole basis for diagnosis or therapy and is intended only as an adjunct in patient assessment. Reliance on the BIS™ monitoring system alone for intraoperative anesthetic management is not recommended.

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