

MONITORING INTRAOPERATIVE DEPTH OF ANESTHESIA WITH THE BISPECTRAL INDEX™ (BIS™) MONITOR DURING TOTAL INTRAVENOUS ANESTHESIA

Total intravenous anesthesia (TIVA) can be challenging without technology that measures blood levels to determine if propofol is delivered as intended to achieve the desired depth of anesthesia.

Randomized controlled trials suggest compared to routine care, titrating anesthetic depth during TIVA using processed electroencephalography (pEEG) can reduce the amount of IV anesthesia used. This allows for quicker recovery with evidence of less cognitive impairment — without increasing the risk of intraoperative awareness.¹⁻⁴

BIS™ monitoring-guided TIVA reduces propofol use and recovery times

Bispectral Index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia

Gan TJ, Glass PS, Windsor A, et al.

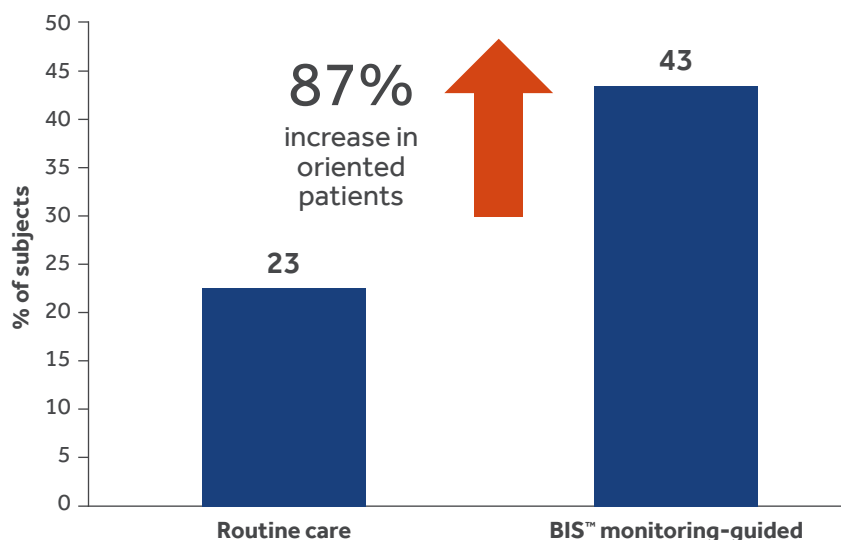


Figure: Percent of surgical patients oriented upon arrival in the postanesthesia care unit (PACU) ($P < 0.02$).

Compared to routine care, using BIS™ monitoring-guided TIVA was also shown to reduce:



Propofol use by 23 percent



Emergence times by 34–38 percent



PACU discharge time by 16 percent

Multicenter (4), randomized controlled trial examining the effect of titrating TIVA with the BIS™ monitor on drug use, emergence, and recovery.

- 302 patients with an expected surgery time of > 1 hour were randomized 1:1 to one of the following arms:
 - TIVA titrated using clinical signs
 - BIS™ monitoring-guided titration of TIVA to an index value of 45–60
- TIVA regimen included midazolam, alfentanil, and propofol for induction, and alfentanil, propofol, and nitrous oxide for maintenance — with neuromuscular blocking agents if necessary
- The BIS™ monitoring technology group:
 - Required lower normalized propofol infusion rates compared to the control group ($116 \mu\text{g/kg/min}$ vs. $134 \mu\text{g/kg/min}$; $P < 0.001$)
 - Was extubated sooner (7.25 min vs. 11.22 min; $P < 0.003$)
 - Had a higher percentage of patients oriented on PACU arrival (figure: 43 percent vs. 23 percent; $P < 0.02$)
 - Had better PACU nursing assessments scores ($P < 0.001$) and became eligible for discharge sooner (31.70 min vs. 37.77 min; $P < 0.04$)
- No significant difference was seen in the incidence of intraoperative responses to stimuli between the groups

Intraoperative awareness during surgery is reduced when BIS™ monitoring is used to guide TIVA

Bispectral Index monitoring prevents awareness during total intravenous anesthesia: a prospective, randomized, double-blinded, multi-center controlled trial

Zhang C, Xu L, Ma YQ, et al.

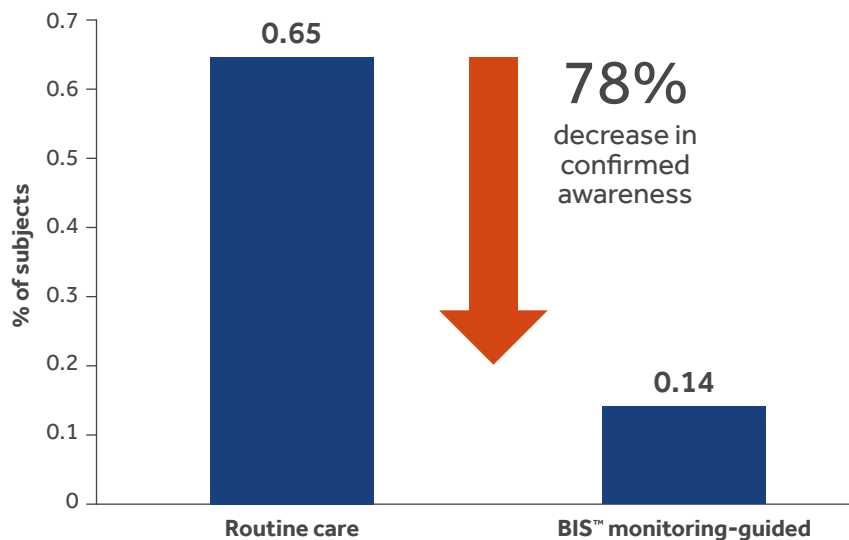


Figure: Percent of surgical patients experiencing confirmed intraoperative awareness (P = 0.002).

BIS™ monitoring-guided TIVA was associated with a **reduced risk of intraoperative awareness compared to routine care**



Multicenter (13), randomized controlled trial studying the risk of intraoperative awareness with BIS™ monitoring-guided TIVA

- 5,228 surgical patients were randomized 1:1 to one of the following arms:
 - TIVA titrated using clinical signs
 - BIS™ monitoring-guided titration of TIVA to an index value of 40–60
- Surgery types included: neurosurgery, craniofacial, cervical, cardiac, gynecological, obstetrics, chest, abdomen, urinary, spine, limb
- TIVA regimen included midazolam and propofol induction with propofol infusion for maintenance
- Analgesics and muscle relaxants were left to the discretion of the anesthesia provider
- There were fewer cases of awareness in the BIS™ monitoring-guided group vs. routine care:
 - Confirmed awareness (figure): 4 (0.14 percent) vs. 15 (0.65 percent) cases
 - Confirmed or possible awareness: 8 (0.27 percent) vs. 21 (0.91 percent) cases
- The incidence of possible awareness or dreaming was comparable between the two groups
- Intraoperative BIS™ monitoring data were available in six cases of confirmed awareness. In five cases, BIS™ index values > 60 occurred for 19–106 minutes. In one case, BIS™ monitoring values were less than 60.

BIS™ monitoring-guided TIVA may be associated with less anesthetic use, quicker cognitive recovery, and less postoperative delirium

Bispectral Index monitoring during anesthesia promotes early postoperative recovery of cognitive function and reduces acute delirium in elderly patients with colon carcinoma: a prospective controlled study using the attention network test

Zhou Y, Li Y, Wang K.

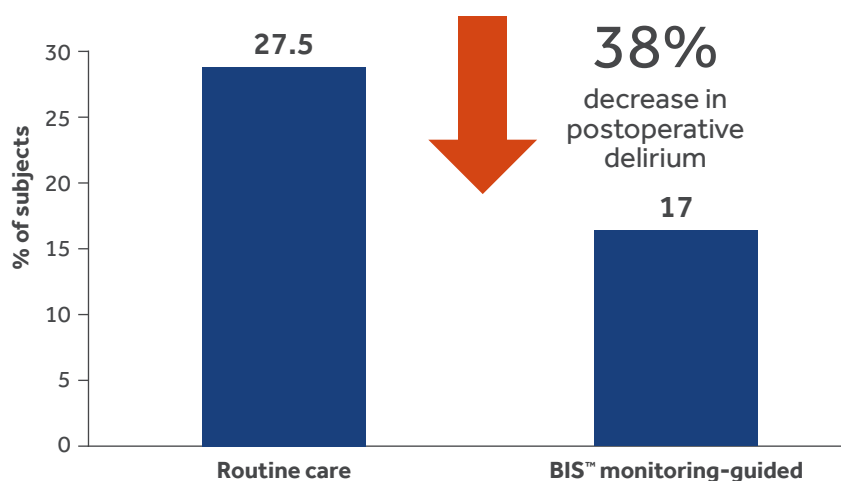


Figure: Percent of elderly colon carcinoma surgery patients diagnosed with postoperative delirium using the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) ($P < 0.001$).

Using BIS™ monitoring to titrate propofol-based TIVA was also associated with:



Less propofol and remifentanyl use



Recovery to preoperative levels of alerting and orienting functions by day five

Single-center randomized controlled trial examining the effect of BIS™ monitoring-guided TIVA on drug use and postoperative cognitive impairment

- 81 elderly colon carcinoma patients with an expected duration of surgery > 2 hours and hospital length of stay > 7 days were randomized 1:1 to one of the following arms:
 - TIVA titrated using clinical signs
 - BIS™ monitoring-guided titration of TIVA to an index value of 40–60
- TIVA regimen included sufentanil, propofol, and vecuronium for induction, and propofol, vecuronium, and remifentanyl for maintenance
- Compared to the control group, the BIS™ monitoring technology group:
 - Had higher BIS™ index values (51 vs. 41; $P < 0.001$)
 - Received less propofol and remifentanyl ($P < 0.001$)
 - Showed recovery in alerting and orienting functions to preoperative values by day 5 (which continued to be impaired in the control group)
 - Had fewer patients with postoperative delirium (figure; 17 percent vs. 27.5 percent, $P < 0.001$)

BIS™ monitoring plus train of four (ToF) monitoring reduces propofol use and cost, and decreases time to extubation

Cost-effectiveness of anesthesia maintained with sevoflurane or propofol with and without additional monitoring: A prospective, randomized controlled trial

Bocskai T, Loibl C, Vamos Z, et al.

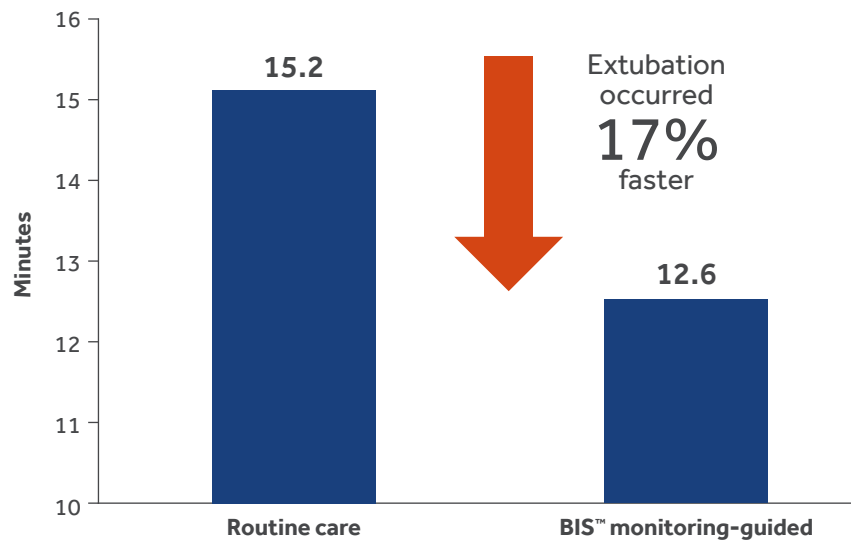


Figure: Time to extubation in ear, nose, and throat surgery patients receiving routine care-guided TIVA, compared to BIS™ monitoring system-guided TIVA plus train of four (ToF) monitoring ($P < 0.001$).

Compared to standard care, BIS™ monitoring-guided TIVA plus ToF was also associated with:



28 percent less propofol used



28.9 percent reduction in the cost of propofol for induction

Single-center, randomized controlled trial examining the cost effectiveness of BIS™ monitoring-guided anesthesia plus ToF monitoring

- 120 adult (aged 18–65) ASA I and II patients scheduled for ear, nose and throat surgery were randomized 1:1:1:1 to one of the following arms:
 - Propofol (TIVA): Standard of care (clinical signs) or BIS™ monitoring technology (titrated to BIS™ index value of 40–60) plus ToF
 - Sevoflurane: Standard of care (clinical signs), or BIS™ monitoring technology (titrated to BIS™ index value of 40–60) plus ToF
- In the propofol arms: TIVA regimen included fentanyl, propofol, and atracurium for induction, and propofol for maintenance
- Compared to the propofol control group, the propofol BIS™ monitoring technology / ToF group:
 - Received less propofol (2.1 mg/kg vs. 2.9 mg/kg; $P < 0.001$)
 - Demonstrated a lower cost of propofol as an induction agent (€ 0.81 vs. € 1.14, $P < 0.001$) equivalent to \$0.93 vs. \$1.30
 - Was extubated earlier (figure; 12.6 min vs. 15.2 min, $P < 0.001$)

1. Gan TJ, Glass PS, Windsor A, et al. Bispectral Index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia. BIS Utility Study Group. *Anesthesiology*. 1997;87(4):808–815.
2. Zhang C, Xu L, Ma YQ, et al. Bispectral Index monitoring prevent awareness during total intravenous anesthesia: a prospective, randomized, double-blinded, multi-center controlled trial. *Chin Med J*. 2011;124(22):3664–3669.
3. Zhou Y, Li Y, Wang K. Bispectral Index monitoring during anesthesia promotes early postoperative recovery of cognitive function and reduces acute delirium in elderly patients with colon carcinoma: a prospective controlled study using the Attention Network Test. *Med Sci Monit*. 2018;24:7785–7793.
4. Bocskai T, Loibl C, Vamos Z, et al. Cost-effectiveness of anesthesia maintained with sevoflurane or propofol with and without additional monitoring: a prospective, randomized controlled trial. *BMC Anesthesiol*. 2018;18(1):100.

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™ system alone for intraoperative anesthetic management is not recommended.

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