Bispectral Index Monitoring and Perioperative Outcomes: Does It Make a Difference?

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It is hypothesized that incorporating a brain monitor, like the Bispectral Index (BIS), into routine anesthetic practice can improve anesthetic management and patient outcomes by eschewing both too little and unnecessarily deep anesthesia. By avoiding light anesthesia, intraoperative awareness and its attendant complications, like posttraumatic stress disorder, can be prevented. Evidence from several large trials suggests that a BIS-based protocol decreases intraoperative awareness with postoperative recall when total IV anesthesia with pharmacological paralysis is administered.

However, when anesthesia is based on a potent volatile drug, a BIS-based protocol is not superior to a protocol based on exhaled anesthetic concentration in preventing awareness with recall (Figure 1).†-‡ Unnecessarily deep anesthesia is almost certainly associated with prolonged recovery and poorer quality of recovery. More controversially, deep anesthesia has been postulated to increase directly a variety of postoperative complications, including mortality, delirium, cognitive decline, dementia, myocardial infarction, stroke, renal failure and cancer.

Some trials have indicated that a BIS-based protocol may decrease anesthetic administration and improve early recovery (discharge from postanesthesia care unit, nausea, vomiting) compared with routine care or an alternative protocol, but other trials have not replicated these findings. An association has been noted between the cumulative duration of low BIS and intermediate-term mortality (1–4 years). This association was independent of anesthetic duration or volatile anesthetic concentration. Other studies have not found that cumulative duration of BIS<45 in isolation was connected with increased mortality. A concurrence of low BIS, low anesthetic concentration and low arterial blood pressure, the “triple low” phenomenon, has been linked to increased all-cause postoperative mortality. The clinical relevance of this finding is currently uncertain, and might simply reflect patient vulnerability. If the link between triple low and death is causal, the pathophysiologic mechanisms by which triple low could indiscriminately increase mortality, especially cancer deaths, are unclear. Thus, relations between intraoperative BIS values (or other surrogate measures of anesthetic depth) and adverse postoperative outcomes (e.g., death, myocardial infarction, stroke, renal failure, cognitive decline, dementia, cancer recurrence) require scrupulous investigation.

There is mounting evidence from several randomized, controlled trials that a BIS-based protocol can decrease postoperative delirium, possibly by decreasing anesthetic administration or by minimizing epochs of electroencephalographic burst suppression. The results of an unpublished meta-analysis [Whitlock et al.] of four randomized studies comparing BIS-guided anesthesia with a control group (routine care or an alternative protocol) suggest that BIS-guided anesthesia lessens postoperative delirium, with a summary odds ratio of 0.56 (95% confidence interval, 0.42 to 0.73) (Figure 2). Although the finding is compelling, the mechanism for decreased delirium is unclear because most large studies have not demonstrated that BIS guidance alters average anesthetic administration. Furthermore, logic would suggest that if a slight reduction in general anesthetic administration is associated with improved clinical outcomes, the use of no general anesthesia (e.g., medical management or regional anesthesia) should result in substantially better outcomes. On the contrary, meta-analyses of trials that have randomized patients to general or regional anesthesia for surgical procedures and large effectiveness trials that have randomized patients to major surgery with deep general anesthesia versus nonsurgical management (e.g., coronary artery bypass grafting versus percutaneous stenting) have failed to demonstrate an improvement in outcomes (e.g., mortality, cognitive decline, delirium, quality of life) up to five years later with regional anesthesia or nonsurgical, nonanesthetic management. Before we can conclude that a minor decrement in anesthetic concentration (or anesthetic depth) improves outcomes, we must demonstrate that general anesthesia at any concentration is injurious to patients.

Although skepticism is important and we should not reach overly hasty inferences, there is accumulating evidence that brain monitoring helps practitioners to administer anesthesia more appropriately for some individual patients, and is therefore likely to be associated with some improvements in patient outcomes. Hence brain monitoring during general anesthesia could enjoy more widespread adoption. In the United Kingdom, for example, guidelines from the National Institute for Health and Care Excellence (NICE) recommend the use of electroencephalography-based brain monitoring, especially in vulnerable patients. Implementation of these guidelines has been controversial due to the lack of definitive evidence for the benefit of such monitors and insufficient information on what constitutes “vulnerability.” Thus, most anesthesiologists in the United Kingdom currently do not follow the NICE guidelines, and either through choice or unavailability of the devices, do not use electroencephalography-based brain monitors. Nonetheless, brain monitoring is heuristically appealing as the brain is the target organ of general anesthesia. The BIS is only one of many available brain monitors; while it has been an important advance and has helped focus the attention of the anesthesiology

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community on the brain, BIS has important limitations that must be addressed in future devices.\textsuperscript{26,28–31} New brain monitoring approaches rooted in principles of neurobiology are being explored and could make the administration of general anesthesia less based on gestalt and median population parameters, and more driven by measured effects on its target organ.

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