DEPTH OF ANAESTHESIA MONITORING

Professor Paul Myles

Director of Anaesthesia & Perioperative Medicine,
The Alfred Hospital, Melbourne, Australia

Although the introduction of general anaesthesia remains one of the great achievements in medicine, awareness continues to worry anaesthetists and their patients. In addition, despite monitoring numerous variables during anaesthesia, we have not been able to directly monitor the effects of anaesthetic drugs. The relatively recent introduction of depth of anaesthesia monitoring provides solutions to these dilemmas.

The incidence of awareness is about 1 to 2 per 1,000 in an unselected surgical population undergoing relaxant general anaesthesia (2-5), but is high in at-risk groups such as patients with cardiovascular or end-stage lung disease (5,6), and those undergoing cardiac surgery (7), caesarean section under general anaesthesia (8), and major trauma surgery (9).

The detection of awareness is not straightforward. Fluctuating memories, confusion with timing of the event being recalled, and biases in detection and classification make accurate figures and comparison between studies problematic. About two-thirds of awareness cases will be missed if the anaesthetist is reliant upon notification from the patient or surgeon (10). Some memories of intraoperative events are not recollected by the patient until days or weeks after surgery, and some are recalled immediately but not at later times (6,11). Also, some reports of awareness are not true awareness, in that the recollection relates to postoperative events on emergence, in the recovery room, or intensive care unit (6). Intraoperative or postoperative dreaming may be misinterpreted as awareness during surgery (6,12). Thus, spurious reports of awareness do occur. These outnumber true incidents of awareness, and it cannot be expected that such events will be reduced with depth of anaesthesia monitoring. It is strongly recommended that a structured questionnaire (5,6,11,13,14) and adjudication committee be used to verify awareness reports (5,6). This should be a gold standard for future studies.

Can depth of anaesthesia monitor prevent awareness? A recent publication has challenged this belief (14). Proof-of-concept studies have demonstrated a relationship between depth of anaesthesia monitor and hypnotic drug concentration, and/or with increasing sedation. Many of these studies have found that some particular EEG parameter, or proprietary device, is superior to others in some respects. Results vary and are sometimes contradictory. Nevertheless, it is common for there to be a moderate correlation between anaesthetic drug concentration and any particular depth of anaesthesia monitor, with a correlation coefficient of about 0.7 (15,16).

Reduced drug usage and faster recovery times have been demonstrated for BIS (18,19), entropy monitoring (20), evoked potential monitoring (21), and Narcotrend (22). However, other studies have found no reduction in recovery times. (23,24)

The B-Aware Trial (6) included 2643 adult patients at high risk of awareness, and randomly allocated them to routine monitoring or monitoring that included BIS. Awareness was identified by blinded structured interviews done at about 4 hours, 24 hours, and 30 days after surgery. A blinded adjudication committee assessed all reports of awareness. There were two confirmed reports of awareness in the BIS-guided group and 11 reports in the routine monitoring group: a risk reduction of 82% (95% CI: 17 to 98%), P=0.022.

There has also been a large nonrandomized study in 4,945 patients (25), which used a before-and-after design and found a significant (P=0.038) similar 5-fold reduction in the incidence of awareness with BIS monitoring. More recently, a prospective observational study found 25 awareness cases from 19,575 patients in 7 US centres: an incidence of 0.13% (5). Although BIS monitoring was used in about 40% of cases, it was not associated with a reduction in the risk of awareness. But, as the authors point out, this was not the purpose of this study (which is more validly tested with a randomized design), and it is likely that patients at a high risk of awareness were more likely to receive BIS monitoring.

Several professional organizations have adopted guidelines for use of depth of anaesthesia monitoring to prevent awareness (26-28). Although differences exist, the general recommendation is that depth of anaesthesia monitoring should be available and the anaesthetist should consider such use in at-risk patients.

As stated above, a recent study failed to replicate the findings of the B-Aware Trial (14). This study was established as a non-inferiority trial (see www.clinicalttrials.org) yet was reported differently. In any case it was underpowered to detect a clinically important benefit of BIS monitoring, because they could only identify 4 confirmed awareness events. An updated meta-analysis still demonstrates statistically significant effectiveness (29): revised risk reduction 69% (95% CI: 9 to 89%), P=0.03.

In conclusion, BIS monitoring can lead to a marked reduction in the risk of awareness and this monitoring should be used in patients with any risk factor for awareness. Depth of anaesthesia monitor will not however prevent all cases of awareness.

References

1. Akavipat P, Sookplung P, Premsamran P, Toomtong P, Kusumaphanyo C, Muansaiyart P. The Thai Anesthesia Incident Monitoring study (Thai AIMS): an analysis of 21 awareness events. J Med Assoc Thai 2009;92:335-41.
2. Liu WHD, Thorp TAS, Graham SG, et al. Incidence of awareness with recall during general anaesthesia. Anaesthesia 1991; 46:435-7.
3. Myles PS, Williams DL, Hendrata M, et al. Patient satisfaction after anaesthesia and surgery: results of a prospective survey of 10,811 patients. Br J Anaesth 2000; 84:6-10.
4. Moerman N, Bonke B, Oosting J. Awareness and recall during general anesthesia. Facts and feelings. Anesthesiology 1993; 79: 454-64.
5. Sebel P, Bowdle T, Ghoneim M et al. The incidence of awareness during anesthesia: a multicenter United States study. Anesth Analg 2004; 99: 833-9.
6. Myles PS, Leslie K, Forbes A, McNeil J, Chan M, for the B-Aware Trial Group. Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial. Lancet 2004; 363:1757-63.
7. Dowd NP, Cheng DCH, Karski JM, et al. Intraoperative awareness in fast-track cardiac anesthesia. Anesthesiology 1998; 89: 1068-73.
8. Lyons G, Macdonald R. Awareness during Caesarean Section. Anaesthesia 1991; 46: 62-4.
9. Lubke GH, Kerssens C, Phaf RH, Sebel PS. Dependence of explicit and implicit memory on hypnotic state in trauma patients. Anesthesiology 1999; 90:670-80.
10. Macleod AD, Maycock E. Awareness during anaesthesia and post-traumatic stress disorder. Anaesth Intensive Care 1992; 20: 378-82.
11. Sandin RH, Enlund G, Samuelsson P, et al. Awareness during anaesthesia: a prospective study. Lancet 2000; 355:707-11.
12. Leslie K, Skrzypek H, Paech MJ, Kurowski I, Wybrow T. Dreaming during anesthesia and anesthetic depth in elective surgery patients: a prospective cohort study. Anesthesiology 2006 (in press).
13. Brice DD, Hetherington RR, Utting JE. A simple study of awareness and dreaming during anaesthesia. Br J Anaesth 1970; 42:535-41.
14. Avidan MS, Zhang L, Burnside BA, et al. Anesthesia awareness and the bispectral index. N Engl J Med 2008;358:1097-108.
15. Lennmarken C, Bildfors K, Enlund G, Samuelsson P, Sandin R. Victims of awareness. Acta Anaesthesiol Scand 2002; 46:229-31.
16. Leslie K, Sessler DI, Schroeder M, Walters K. Propofol blood concentration and the Bispectral Index predict suppression of learning during propofol/epidural anesthesia in volunteers. Anesth Analg 1995; 81:1269-74.
17. Doi M, Gajraj RJ, Mantzaridis H, Kenny GN. Relationship between calculated blood concentration of propofol and electrophysiological variables during emergence from anaesthesia: comparison of bispectral index, spectral edge frequency, median frequency and auditory evoked potential index. Br J Anaesth 1997; 78:180-4.
18. Gan TJ, Glass PS, Windsor A, et al. Bispectral Index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia. Anesthesiology 1997; 87: 808-15.
19. Song D, Joshi GP, White PF. Titration of volatile anesthetics using bispectral index facilitates recovery after ambulatory anesthesia. Anesthesiology 1997; 87:842-8.
20. Vakkuri A, Yli-Hankala A, Sandin R, et al. Spectral entropy monitoring is associated with reduced propofol use and faster emergence in propofol-nitrous oxide-alfentanil anesthesia. Anesthesiology 2005; 103:274-9.

21. Weber F, Seidl M, Bein T. Impact of the AEP-Monitor/2-derived composite auditory-evoked potential index on propofol consumption and emergence times during total intravenous anaesthesia with propofol and remifentanil in children. Acta Anaesthesiol Scand 2005; 49:277-83.
22. Kreuer S, Biedler A, Larsen R, et al. Narcotrend monitoring allows faster emergence and a reduction of drug consumption in propofol-remifentanil anesthesia. Anesthesiology 2003; 99:34-41.
23. Bruhn J, Kreuer S, Bischoff P, et al. Bispectral index and A-line AAI index as guidance for desflurane-remifentanil anaesthesia compared with a standard practice group: a multicentre study. Br J Anaesth 2005; 94:63-9.
24. Pavlin JD, Souter KJ, Hong JY, et al. Effects of bispectral index monitoring on recovery from surgical anesthesia in 1,580 inpatients from an academic medical center. Anesthesiology 2005; 102:566-73.
25. Ekman A, Lindholm ML, Lennmarken C, Sandin R. Reduction in the incidence of awareness using BIS monitoring. Acta Anaesthesiol Scand 2004; 48:20-6.
26. Australian and New Zealand College of Anaesthetists. PS18 (2006) Recommendations on Monitoring During Anaesthesia. www.anzca.edu.au/publications/profdocs/view.htm#ps
27. American Society of Anesthesiologists. Practice Advisory for Intraoperative Awareness and Brain Function Monitoring. www2.asahq.org/publications/pc-109-4-practice-advisory-for-intraoperative-awareness-and-brain-function-monitoring.aspx
28. Osborne GA, Bacon AK, Runciman WB, Helps SC. Crisis management during anaesthesia: awareness and anaesthesia. Qual Saf Health Care 2005; 14:16-22.
29. Myles PS, Leslie K, Forbes A. Anesthesia awareness and the bispectral index. N Engl J Med 2008; 359:428-429.