

INTRAOPERATIVE AWARENESS

- A Three Year Prospective Study Using Bispectral Index Monitor (Bis) -

FAROUK M MESSAHEL* AND MARY JUNE GREGORIO**

Summary

Patients who experience awareness under surgery may suffer from the post-traumatic stress disorder (PTSD) with its long-lasting psychological damage. In addition, there are also media attention and legal consequences. In spite of understanding its causes, it is still occurring worldwide. This prospective study was conducted to determine the incidence of awareness using the bispectral index monitor (BIS) when its causes are eliminated. There were 2328 patients admitted to the study. Their ages ranged from 14-104 yr (mean 38.6 yr). All patients were interviewed in the postoperative period. There was no report of awareness during the course of surgery. Pre-and intraoperative anesthetic attention to patients presented for surgery, together with the use of modern anesthetic delivery units possessing facilities for monitoring BIS, and anesthetic gases, and the provision of good analgesia, are the most important combination in eliminating awareness during surgery.

Key words: anesthesia, general; audit; depth; surgery, awareness.

From Armed Forces Hospital Wadi Al Dawasir, Kingdom of Saudi Arabia.

* FRCA, Chief of Anesthesia, Intensive Care and Pain Medicine, Head of Medical Education Department.

** BSN, Operating Theater Staff Nurse.

Correspondence: Dr. Farouk M Messahel, P.O. Box: 228, Wadi Al-Dawasir 11991, Saudi Arabia.
Tel: +966 1 7842779, Fax: +966 1 7840468, Mobile: +966 53434653, E-mail: fmessahel@doctors.org.uk.

Introduction

Awareness ranks among patients' greatest fears regarding surgery^{1,2}. The experience of awareness is one of the most psychologically devastating sequel of surgery³. However, its incidence varies widely between individuals and surgical specialties, and it is as twice in patients who receive a muscle relaxant during surgery than those who do not receive it⁴. It may occur at any time of the surgical process: during induction of anesthesia (tracheal intubation); during maintenance; and during emergence.

Awareness is an old problem and efforts towards abolishing or minimizing its incidence are continuing. In spite of these attempts, recent reports show that the incidence of awareness is between 0.11% and 1.5% of individuals who receive GA^{1,4,5}. As many as 70% of patients with intraoperative awareness experienced unpleasant aftereffects, including sleep disturbances, dreams and nightmares, flashbacks, and anxiety during the day. A minority of them can develop the post-traumatic stress disorder (PTSD), which is associated with repetitive nightmares, anxiety, irritability, and preoccupation with death. These symptoms may persist for months, or even years^{6,7}, and require long-term medical and psychological support or treatment⁸. Added to the personal problems arising from the occurrence of awareness are media attention and litigation which appear to be on the rise⁸.

There are more than one cause of awareness:

1. Inappropriate planning of anesthetic techniques in accordance with the different variables between individuals and also with the surgical procedures.
2. Failure of the anesthetic apparatus to deliver the determined amount of the anesthetic.
3. Failure to adequately provide the paralyzed patient with the appropriate concentration to maintain anesthesia either by the inhalational or IV route, and,

4. The induction dose of the IV agent is unreliable to prevent awareness before the inspired anesthetic gas reaches its minimal anesthetic concentration (MAC; which is the concentration maintaining the patient anesthetized).

We conducted this study as part of an ongoing quality improvement programme established in our Hospital in 1997 and boosted recently by the introduction of the Total Quality Management in the Military Health Service of the Saudi Armed Forces.

Methods and Patients

Approval of the Hospital Research and Ethics Committee was obtained. The study lasted from 01/11/2003 to 31/10/2006. Patients above 14-years old, ASA I-III, presented for different surgical procedures under general anesthesia were admitted to the study.

Our anesthetic delivery units (Datex-Ohmeda AS/5, Finland) have facilities for monitoring BIS and the end-tidal anesthetic gas concentrations (ETAGC). They also have a built-in checking system including detection of gas leaks, which operates at the start of the surgical list. In addition, our operating rooms are provided with portable monitor for the detection of environmental pollution by the anesthetic gas nitrous oxide.

The anesthetic management of patients consisted of premedicating all elective cases with an anxiolytic (usually a benzodiazepine), except patients above 60 years old who were not premedicated, and patients for elective Cesarean section who received either an H₂-blocker or proton pump inhibitor.

Anesthesia was induced with fentanyl, 1-1.5 mcg/kg⁻¹ (given in Cesarean section after clamping of the umbilical cord), and by thiopental, 3-5 mg/kg⁻¹, and was maintained by nitrous oxide in oxygen to which added an inhalational anesthetic (isoflurane or sevoflurane). The dose of the inhalational anesthetic and the incremental doses of the narcotic

analgesic were titrated to keep the BIS between 50 and 55. Patients were also observed for intraoperative signs of awareness: sweating, tachycardia, hypertension, lacrimation and dilatation of pupils.

All in-patients were interviewed within 24 hour of surgery or anesthesia, while patients for day-case surgery were visited once they were fit for discharge. Special forms have been designed for this interview. If the patient does not voluntarily mention any recall of events happened during the procedure he/she is specifically asked about it. Questions asked about awareness in this structured interview are:⁹

1. What is the last thing you remember before you went to sleep for your operation?
2. What is the first thing you remember after your operation?
3. Can you remember anything in between these two periods?
4. Did you dream during your operation?
5. Are you satisfied with this part of the service?

Results

There was a total of 2328 cases (1089 males and 1239 females, male: female ratio of 0.88-1) during the period of the study. The median age was 38.6 years (range 14-104 years).

During the preoperative visit two patients complained of explicit awareness during previous surgical procedures. The first patient was a Saudi female who had a Cesarean section at another hospital. The second patient was a North American who remembered the anesthetist back home talking to her when he discovered that she was awake. Both patients received explanation from us and were assured of meticulous attention during the course of surgery.

None of the patients in this series voluntarily complained of awareness before or during the interview, therefore all patients were specifically asked about awareness and all of them categorically denied its occurrence.

Discussion

In spite of the fact that there is always an unfavorable strong public and media focus on the anesthetic service¹⁰⁻¹⁴, patient confidence in the anesthetist has been reported to be high¹⁵. Nevertheless, awareness is still one of the patients' fears of anesthesia¹⁶.

Since awareness during surgery was first brought to the attention of the medical profession¹⁷, ways of detection and prevention were unabated, and while unintentional awareness still exists^{9,18}, its incidence is decreasing. In general, anesthetists rely on vital signs as indicators of potential arousal.

Clinical observation remains the mainstay of the diagnosis of impending or actual awareness which usually heralded by an increase in autonomic (sympathetic) activity, reflected by the following signs: increase in heart rate (HR), rise in blood pressure (BP), dilatation of pupils, sweating, lacrimation, and increase in metabolic rate¹⁹. However, traditional vital signs monitoring may confirm lack of correlation between HR, BP, and consciousness^{6,20}. Numerous studies have documented awareness with stable HR and BP^{6,21-23}.

Bispectral index (BIS; Aspect Medical Systems, Newton, USA) was developed as a new electroencephalogram (EEG)-based method of monitoring anesthetic depth. The EEG signal is analyzed by bispectral analysis, which consists of Fourier transformation and phase coupling studies²⁵. The BIS and many other variables are calculated by the BIS-monitor, and it is possible to obtain numerical information about these variables during anesthesia with a very short delay. BIS has been found useful in monitoring anesthetic depth^{27,28}. The BIS-monitor can also guide the anesthetist to titrate anesthetic drug administration to obtain sufficient level of unconsciousness, and this allows a faster recovery from anesthesia^{29,30}.

Modern anesthetic delivery units have also facilities for monitoring ETAGC, so that the exact amount given to patients is known. In our study, attention was given to the adequacy of the anesthetic technique and

the ETAGC delivered to the patient in different types of surgical procedures.

Despite the general belief that the use of BIS prevents awareness, it is not even a claim by the manufacturer³¹. Whether such a monitor actually decreases the risk of awareness has yet to be proven^{4,32,33}. However, the vast majority of centers do not possess modern anesthetic or monitoring equipment³⁴. In addition these equipment, including the BIS, have limitations and patients may be explicitly aware at monitoring figures known to be adequately hypnotic³⁵⁻⁴⁰. That is why anesthetist's vigilance stands as the most important element in the prevention and detection of awareness during surgery²³.

Recommendations for avoidance of awareness during surgery include:

1. Prescription of a premedicant with an amnesic property,
2. Checking anesthetic delivery units for possible leaks,
3. Administer a muscle relaxant only when necessary,
4. Delivery of 1 MAC of volatile anesthetic agent,
5. Monitoring of end-tidal gases and vapours,
6. Provision of adequate intraoperative analgesia, and
7. The use of the BIS.
8. Monitoring of HR, BP, end-tidal carbon dioxide (ETCO₂), pupil size, sweating, lacrimation, temperature, and neuromuscular junction.

References

1. MYLES PS, WILLIAMS DL, HENDRATA M, ANDERSON H, WEEKS AM: Patient satisfaction after anesthesia and surgery: results of a prospective surgery of 10,811 patients. *Br J Anaesth*; 84:6-10, 2000.
2. RAMPIL IJ: Correspondence. *Anesthesiology*; 90:1798, 1999.
3. GHONEIM MM, BLOCK RI: Learning and consciousness during general anesthesia. *Anesthesiology*; 76:279-305, 1992.
4. SANDIN RH, ENLUND G, SAMUELSSON P, LENNMRKEN C: Awareness during anesthesia: a prospective case study. *Lancet*; 355:707-711, 2000.
5. GHONEIM MM: Awareness during anesthesia. *Anesthesiology*; 92:597-602, 2000.
6. MOERMAN N, BONKE B, OOSTING J: Awareness and recall during general anesthesia: facts and feelings. *Anesthesiology*; 79:454-464, 1993.
7. OSTERMAN J: PTSD in patients who have experienced awareness during anesthesia. *Gen Hosp Psychiatry*; 20:274-281, 1998.
8. American Psychiatric Association: *Diagnostic and Statistical Manual of Mental Disorders*. Washington DC: American Psychiatric Association, 247-251, 1987.
9. DOMINO KB, POSNER KL, CAPLAN RA, CHENEY FW: Awareness during anesthesia: a closed claims analysis. *Anesthesiology*; 90:1053-1061, 1999.
10. LIU WH, THORP TA, GRAHAM SG, AITKENHEAD AR: Incidence of awareness with recall during general anesthesia. *Anesthesia*; 46:435-437, 1991.
11. FORREST JB, CAHALAN MK, REHDER K, GOLDSMITH CH, LEVY W, STRUNIN L, ET AL: Multicenter study of general anesthesia. II. Results. *Anesthesiology*; 72:262-268, 1990.
12. COHEN MM, DUNCAN PG, DEBOER DP, TWEED WA: The postoperative interview: assessing risk factors for nausea and vomiting. *Anesth Analg*; 78:7-16, 1994.
13. MYLES PS, HUNT JO, MOLONEY JT: Postoperative 'minor' complications. Comparison between men and women. *Anesthesia*; 52:300-306, 1997.
14. WEBB RK, CURRIE M, MORGAN C, WILLIAMSON JA, COCKINGS J: The Australian incident monitoring study: an analysis of 2000 incident reports. *Anaesth Intensive Care*; 21:520-528, 1993.
15. WARDEN JC, BORTON CL, HORAN BF: Mortality associated with anesthesia in New South Wales, 1984-1990. *Med J Aust*; 161:585-593, 1994.
16. SHEVDE K, PANAGOPULOS G: A survey of 88 patients' knowledge, attitudes and concerns regarding anesthesia. *Anesth Analg*; 73:190-198, 1991.
17. KLAFTA JM, ROIZEN MF: Current understanding of patients' attitudes toward and preparation of anesthesia: A review. *Anesth Analg*; 83:1314-1321, 1996.
18. HUTCHINSON R: Awareness during surgery. *Br J Anesth*; 33:463-469, 1960.
19. SCOTT PV: Intraoperative Management. In: Pinnock C, Lin T, Smith T, eds. *Fundamentals of Anesthesia*. London: Greenwich Medical Media, 66, 1999.
20. RANTA SO-V, LAURILA R, SAARIO J, ALI-MELKKILÄ T, HYNYNEN M: Awareness with recall during anesthesia: incidence and risk factors. *Anesth Analg*; 86:1084-1089, 1998.
21. FLAISHON R, WINDSOR R, SIGL J, SEBEL PS: Recovery of consciousness after thiopental or propofol. *Anesthesiology*; 86:613-619, 1997.
22. MILLER DR, BLEW PG, MARTINEAU RJ, HULL KA: Midazolam and awareness with recall during total intravenous anesthesia. *Can J Anaesth*; 43:946-853, 1996.

23. SCHWIEGER IM, HALL RI, HUG CC JR: Assessing the adequacy of fentanyl anesthesia: plasma concentrations and lower esophageal contractility. *Acta Anaesthesiol Scand*; 35:227-234, 1991.
24. RANTA S, JUSSILA J, HYNENEN M: Recall of awareness during cardiac anesthesia: influence of feedback information to the anesthesiologist. *Acta Anaesthesiol Scand*; 40:554-560, 1996.
25. POMFRETT CJD: Monitoring depth of anesthesia. The Royal College of Anaesthetists, London, Bulletin (4), November 2000.
26. SIGL JC, CHAMOUN NG: An introduction to bispectral analysis for the electroencephalogram. *J Clin Monit*; 10:392-404, 1994.
27. KEARSE LA, ROSOW C, ZASLAVSKY A, CONNORS P, DERSHWITZ M, DENMAN W: Bispectral analysis of the electroencephalogram predicts conscious processing of information during propofol sedation and hypnosis. *Anesthesiology*; 88:25-34, 1998.
28. GLASS PS, BLOOM M, KEARSE L, ROSOW C, SEBEL P, MANBERG P: Bispectral analysis measures sedation and memory effects of propofol, midazolam, isoflurane, and alfentanil in healthy volunteers. *Anesthesiology*; 86:836-847, 1997.
29. SONG D, JOSHI GP, WHITE P: Titration of volatile anesthetics using bispectral index facilitates recovery after ambulatory anesthesia. *Anesthesiology*; 87:842-848, 1997.
30. GAN TJ, GLASS PS, WINDSOR A, PAYNE F, ROSOW C, SEBEL P, ET AL: Bispectral index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia. *Anesthesiology*; 87:808-815, 1997.
31. CHAMOUN NG: The position of Aspect. *Anesthesiology*; 92:897, 2000.
32. O'CONNOR MF, DAVES SM, TUNG A, COOK RI, THISTED R, APFELBAUM J: BIS monitoring to prevent awareness during general anesthesia. *Anesthesiology*; 94:520-522, 2001.
33. LESLIE K, MYLES PS: Awareness during anesthesia: is it worth worrying about? *Med J Aust*; 174:212-213, 2001.
34. MYLES PS, SYMONS JA, LESLIE K: Anaesthetists' attitudes towards awareness and depth-of-anesthesia monitoring. *Anesthesia*; 58:11-16, 2003.
35. BANNISTER CF, BROSIUS KK, SIGL JC: The effect of bispectral index monitoring on anesthetic use and recovery in children anesthetized with sevoflurane in nitrous oxide. *Anesth Analg*; 92:877-881, 2001.
36. MYCHASKIW G II, HOROWITZ M, SACHDEV V, HEATH BJ: Explicit intraoperative recall at a bispectral index of 47. *Anesth Analg*; 92:808-909, 2001.
37. GOTO T, NAKATA Y, SAITO H, ISHIGURO Y, NIIMI Y, SUWA K, ET AL: Bispectral analysis of the electroencephalogram does not predict responsiveness to verbal command in patients emerging from xenon anesthesia. *Br J Anaesth*; 85:359-363, 2000.
38. DETSCH O, SCHNEIDER G, KOCHS E, HAPFELMEIER G, WERNER C: Increasing isoflurane concentration may cause paradoxical increases in the EEG bispectral index in surgical patients. *Br J Anaesth*; 84:33-37, 2000.
39. BRUHN J, BOUILLON TW, SHAFER SL: Electromyographic activity falsely elevates the bispectral index. *Anesthesiology*; 92:1485-1487, 2000.
40. GUIGNARD B, CHAUVIN M: Bispectral index increases and decreases are not always signs of inadequate anesthesia [letter]. *Anesthesiology*; 92:903, 2000.