Best Practice & Research Clinical Anaesthesiology
Vol. 20, No. 1, pp. 221–228, 2006
doi:10.1016/j.bpa.2005.10.004
available online at http://www.sciencedirect.com

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Processed EEG and patient outcome

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The era of research evaluating clinical outcomes associated with processed electroencephalogram (EEG) monitoring began with the first randomized trial of bispectral index monitoring (BIS) performed as part of the clearance process for approving routine clinical use of the BIS monitor by the United States Food and Drug Administration. Subsequent to this initial investigation, numerous other clinical investigations have demonstrated that the use of processed EEG monitors as an additional method of patient assessment and an aid to anaesthetic dosing can decrease anaesthetic usage and hasten recovery times. Because of the presumed association between anaesthetic effect and EEG changes, it is not surprising that the additional research has focused on the impact of processed EEG monitoring on postoperative outcomes and perioperative safety especially the prevention of intraoperative awareness.

Key words: processed electroencephalogram; outcome; perioperative outcome; perioperative safety; long-term outcome; intraoperative awareness.

INTRODUCTION

Processed electroencephalogram (EEG) monitoring technology has progressed significantly during the past 15 years. Initial laboratory investigations establishing the key features of EEG changes in response to different doses of anaesthetic agents and clinical state responses were followed by trials showing the clinical feasibility of such monitoring technology. The era of research evaluating clinical outcomes associated with processed EEG monitoring began with the first randomized trial of bispectral index monitoring (BIS) performed as part of the clearance process for approving routine clinical use of the BIS monitor by the United States Food and Drug Administration.[1] In this key pivotal trial involving more than 300 patients, BIS monitoring was used to guide propofol dosing. Subsequent to this initial investigation, numerous other clinical investigations have demonstrated a variety of patient outcomes

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influenced by the use of processed EEG monitors as an additional method of patient assessment and aid to anaesthetic dosing. Many of these studies evaluating perioperative outcomes, perioperative safety and long-term outcome will be discussed in this chapter.

RESEARCH EVALUATING PERIOPERATIVE OUTCOMES

Because of the presumed association between anaesthetic effect and electroencephalographic (EEG) changes, it is not surprising that the largest amount of clinical evidence has measured the impact of processed EEG monitoring on specific perioperative outcomes associated with anaesthesia care. The number of prospective, randomized trials measuring these outcomes now number over 40 clinical investigations. Recently, a meta-analysis was performed to examine the effects of BIS monitoring on patient outcomes.[2] In this publication, Liu evaluated 11 randomized clinical trials (RCTs) 'to examine the effects of BIS monitoring on anaesthetic use, incidence of nausea and vomiting, duration of PACU stay and time to patient discharge in ambulatory anaesthesia.' He determined that 'the use of BIS monitoring modestly reduced anaesthetic consumption, risk of nausea and vomiting, and recovery room time' but did not result in cost savings because the cost of the BIS electrodes exceeded the savings associated with the improved outcomes.

Studies evaluating anaesthetic use and recovery times

Several studies have evaluated the ability of processed EEG monitoring to decrease primary anaesthetic use. In these studies, the general approach is that processed-EEG monitoring provides another piece of clinical response data that the anaesthesia provider can use to adjust the administered dose of anaesthesia agent. In most of the studies (across processed-EEG monitoring technologies) a defined 'target zone' is used to direct care in the 'brain monitor' group such as BIS = 45–60 versus 'standard clinical practice' in the control group (care based upon vital sign monitoring and end-tidal gas monitoring for volatile anaesthesia). In the first pivotal study of BIS monitored anaesthesia care, Gan et al[1] randomized over 300 patients receiving a propofol-alfentanil-nitrous oxide anaesthetic to 'standard clinical practice' or an anaesthetic directed at maintaining the BIS between 45 and 60. This study demonstrated that BIS-guided anaesthesia care was associated with significant reductions in anaesthetic drug dosing as well as improved recovery milestones including emergence time and better orientation scores on arrival to the post anaesthesia care unit (PACU). Luginbühl et al[3] randomly assigned 160 patients scheduled for elective gynaecological surgery to either desflurane or propofol anaesthesia with and without BIS monitoring. In one group, anaesthesia was 'standard clinical practice' while in the other group, anaesthetic agents were administered to maintain the BIS level between 45 and 55. These authors found that BIS monitoring reduced the total amount of propofol administered and hastened recovery in the propofol groups but did not effect the amount of desflurane administered or speed anaesthetic recovery when desflurane was the primary anaesthetic agent. In a third study, BIS monitoring resulted in a 13% reduction in sevoflurane anaesthetic administration in outpatients.[4] Interestingly, this decrease in anaesthetic usage resulted in a shortened recovery time in men but not women.