International Journal of Nursing Studies 63 (2016) 201–212

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/ijns

Review

Depth of anaesthesia monitoring during procedural sedation and analgesia: A systematic review and meta-analysis

Aaron Conway [a,b,*], Joanna Sutherland [c,d]

[a] Queensland University Technology (QUT), Institute of Health & Biomedical Innovation, Kelvin Grove Campus, Kelvin Grove, QLD 4059, Australia
[b] Cardiac Catheter Theatres, The Wesley Hospital, Auchenflower, QLD, Australia
[c] Coffs Harbour Health Campus, Australia
[d] Rural Clinical School University of New South Wales, Australia

ARTICLE INFO

Article history:
Received 25 January 2016
Received in revised form 3 May 2016
Accepted 4 May 2016

Keywords:
Procedural sedation and analgesia
Conscious sedation
Deep sedation
Bispectral index
Depth of anaesthesia monitor

ABSTRACT

Objectives: Processed electroencephalogram-based depth of anaesthesia monitoring devices provide an additional method to monitor level of consciousness during procedural sedation and analgesia. The objective of this systematic review was to determine whether using a depth of anaesthesia monitoring device improves the safety and efficacy of sedation.
Design: Systematic review and meta-analysis.
Data sources: Electronic databases (CENTRAL; Medline; CINAHL) were searched up to May 2015.
Review methods: Randomised controlled trials that compared use of a depth of anaesthesia monitoring device to a control group who received standard monitoring during procedural sedation and analgesia were included. Study selection, data extraction and risk of bias assessment (Cochrane risk of bias tool) were performed by two reviewers. Safety outcomes were hypoxaemia, hypotension and adverse events. Efficacy outcomes were amount of sedation used, duration of sedation recovery and rate of incomplete procedures.
Results: A total of 16 trials (2138 participants) were included. Evidence ratings were downgraded to either low or moderate quality due to study limitations and imprecision. Meta-analysis of 8 trials (766 participants) found no difference in hypoxaemia (RR 0.87; 95% CI = 0.67–1.12). No statistically significant difference in hypotension was observed in meta-analysis of 8 trials (RR 0.96; 95% CI = 0.54–1.7; 942 participants). Mean dose of propofol was 51 mg lower for participants randomised to depth of anaesthesia monitoring (95% CI = −88.7 to −13.3 mg) in meta-analysis of results from four trials conducted with 434 participants who underwent interventional endoscopy procedures with propofol infusions to maintain sedation. The difference in recovery time between depth of anaesthesia and standard monitoring groups was not clinically significant (standardised mean difference −0.41; 95% CI = −0.8 to −0.02; I^2 = 86%; 8 trials; 809 participants).
Conclusions: Depth of anaesthesia monitoring did impact sedation titration during interventional procedures with propofol infusions. For this reason, it seems reasonable for anaesthetists to utilise a depth of anaesthesia monitoring device for select populations of patients if it is decided that limiting the amount of sedation would be beneficial for the individual patient. However, there is no need to invest in purchasing extra equipment or training staff who are not familiar with this technology (e.g. nurses who do not routinely

* Corresponding author at: Queensland University Technology (QUT), Institute of Health & Biomedical Innovation, Kelvin Grove Campus, Kelvin Grove, QLD 4059, Australia. Tel.: +61 731386124.
E-mail addresses: aaron.conway@qut.edu.au (A. Conway), Joanna.Sutherland@ncahs.health.nsw.gov.au (J. Sutherland).

http://dx.doi.org/10.1016/j.ijnurstu.2016.05.004

use a depth of anaesthesia monitoring device during general anaesthesia) because there is no high quality evidence suggestive of clear clinical benefits for patient safety or sedation efficacy.

What is already known about the topic?

- Frequent monitoring of level of consciousness is required during procedural sedation and analgesia so that corrective interventions can be implemented if patients enter a level of sedation that is deeper than intended.
- Level of consciousness is usually monitored using clinical observation by judging a sedated patient's response to increasing levels of stimulation.

What this paper adds

- Using a depth of anaesthesia monitoring device for adults undergoing either diagnostic or interventional procedures did not improve patient safety by reducing adverse events caused by over-sedation.
- Using a depth of anaesthesia monitoring device to monitor level of consciousness for adults undergoing either diagnostic or interventional procedures did not reduce the duration of sedation recovery to a clinically significant degree and had no impact on procedure completion rates.
- Using a depth of anaesthesia monitoring device reduced the amount of propofol required to sedate adults undergoing interventional endoscopy procedures.

1. Background

Frequent monitoring of level of consciousness is recommended during procedural sedation and analgesia so that corrective interventions can be implemented if patients enter a level of sedation that is deeper or lighter than intended (ANZCA, 2014; Gross et al., 2002). An example of a corrective intervention would be to reduce or increase the infusion rate of sedation medications. Level of consciousness is usually monitored using clinical observation by judging a sedated patient's response to increasing levels of stimulation (Sheahan and Mathews, 2014). Standardised sedation assessment scales that assign numerical ranks to observable clinical behaviours known to be associated with changes in the level of consciousness are used to supplement clinical observation methods for assessing changes in level of consciousness during procedural sedation and analgesia. Electroencephalogram-based depth of anaesthesia monitoring devices can provide an additional method to monitor level of consciousness that can be used to supplement clinical observation.

Although interpretation of raw electroencephalograms can be used to monitor depth of anaesthesia, processed electroencephalogram-based depth of anaesthesia monitoring devices, such as the Bispectral Index™ (Covidien, Inc., Boulder, CO, USA), are more common in anaesthetic practice (Rampil, 1998). The Bispectral Index™ device calculates a numerical derivative from brain electrical activity. It is calculated from an electroencephalogram measured at the forehead. Bispectral Index™ values range between 0, which represents a state of 'no detectable brain electrical activity', and 100, which represents the 'awake' state (Johansen, 2006). Values below 60 correspond to 'deep' sedation (Glass et al., 1997). Other depth of anaesthesia monitors which use proprietary algorithms to process electroencephalogram information include the E-Entropy (GE Healthcare) and Narcotrend-Compact M monitors (MT Monitor Technik). Similar to the Bispectral Index™, both of these monitors produce numerical values to represent different states of the depth of anaesthesia.

Evaluation of the potential clinical benefits of using depth of anaesthesia monitoring during procedural sedation and analgesia, including syntheses of the available evidence, is required. One important potential clinical benefit of using depth of anaesthesia monitoring during procedural sedation and analgesia is that this technology could improve patient safety. Potentially, earlier identification of lapses into deeper than intended levels of sedation using depth of anaesthesia monitors can lead to more effective titration of sedative and analgesic medications, resulting in a reduction in the risk of sedation-related adverse events caused by over-sedation, such as inadequate oxygenation/ventilation or circulation. Another potential clinical benefit is that depth of anaesthesia monitoring could improve detection of situations where depth of sedation is insufficient, which could lead to increased procedural-related pain and stress. The objective of this review was to determine whether using depth of anaesthesia monitoring during procedural sedation and analgesia in the hospital setting improves patient safety and sedation efficacy.

2. Methods

A systematic review and meta-analyses adhering to our published protocol was conducted (Conway and Sutherland, 2015).

2.1. Eligibility criteria and literature search

Studies meeting the following criteria were included: *Design* – Parallel and cross-over randomised controlled trials; *Population* – patients (adults or children) who received procedural sedation and analgesia (with or without local anaesthesia) in any inpatient or outpatient setting where procedural sedation and analgesia was used in a hospital (studies that included patients who received general or regional anaesthesia were excluded from the review); *Intervention* – Depth of anaesthesia monitoring,