Equipment failure of intravenous syringe pump detected by increase in Narcotrend stage

A case report

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Abstract
Rationale: Awareness is the recovery of consciousness during general anesthesia. It occurs when patients under general anesthesia receive inadequate anesthetic medications to maintain unconsciousness during surgery. Equipment failure is a common cause of intraoperative awareness.

Patient concerns: A 16-year-old boy, 85kg in weight, was admitted to our hospital for thyroglossal cystectomy under general anesthesia. Six minutes after the intubation, we noted that the Narcotrend index indicated a condition of light anesthesia and the patient was observed to be in tears.

Diagnosis: Improper positioning of the syringe fixing clamp on the CP700TCI infusion pump caused equipment failure and light anesthesia.

Interventions: Bolus of 50mg propofol and 2mg midazolam were administered manually by syringe, and inhalation of 2% sevoflurane was supplemented. Infusion pump was replaced.

Outcomes: The Narcotrend index of the patient returned to state of deep anesthesia following manual administration of the anesthetic medications. Following the surgery, the patient had an uneventful recovery, and did not present with evidence of awareness.

Lessons: Users of the CP700TCI syringe pump should pay attention to the position of the syringe fixing clamp. Anesthesiologists should check all the equipment according to a defined checklist prior to anesthesia. Narcotrend monitor could help to detect light anesthesia and prevent potential awareness.

Abbreviations: BIS = bispectral index, EEG = electroencephalogram.

Keywords: consciousness monitors, equipment failure, intraoperative awareness, prevention and control.

1. Introduction

Awareness is the unintended recovery of consciousness during general anesthesia. It can occur when there is insufficient anesthetic medication to keep patients unconscious during the operation. Awareness can cause significant distress, with some patients who experience awareness developing posttraumatic stress disorder.[1] Equipment failure is a common cause of intraoperative awareness.[2] Intravenous syringe pumps (CP700TCL, SLGO Medical Technology Co, Beijing, China) are widely used in China; to date, no equipment failure has been reported. Electroencephalographic (EEG) brain activity monitoring has the potential to decrease the risk of awareness. Bispectral index (BIS) monitor is the most widely used EEG monitoring system to measure the depth of anesthesia, and its application has been associated with a decrease in incidence of awareness. An increase in the BIS index could indicate a need for interventions to prevent possible awareness.[3–5] Narcotrend, another type of EEG monitor, is equally effective in measuring the depth of anesthesia,[6–8] but reports on the use of Narcotrend to prevent awareness are rare. Here, we report a case where improper positioning of a syringe fixing clamp of the infusion pump could have resulted in inadequate delivery of anesthetic medication and ultimately intraoperative awareness. Narcotrend index monitoring enabled real-time detection of the insufficient anesthetic condition due to equipment failure, and helped to prevent possible awareness.

2. Case presentation

A 16-year-old boy, 85kg in weight, was admitted to our hospital (The First Hospital of Jilin University) for thyroglossal cystectomy under general anesthesia. Preoperative laboratory results, chest X-ray, and electrocardiogram (ECG) were within the
normal ranges. The patient fasted for 12 hours prior to the operation.

In the operating room, noninvasive blood pressure, ECG, and oxyhemoglobin saturation (SpO2) were monitored by the IntelliVue MP50 monitor (Philips Medizin Systeme, Graseby Medical Limited, Watford, U.K.) and Narcotrend index by the Narcotrend Index Monitor (Technik, Bad Bramstedt, Germany). Rapid induction of anesthesia was performed with fentanyl (3 μg/kg), cisatracurium (0.2 mg/kg), and propofol (1.5 mg/kg). One minute after the induction, the Narcotrend index decreased from 99 to 27. After intubation, continuous infusion of 2% propofol (6 mg/kg/h and remifentanil 0.5 mg/h) was provided using an intravenous syringe pump (CP700TCI, SLGO Medical Technology Co China). Six minutes after the intubation, the Narcotrend index increased from 27 to 84 (Fig. 1). At the same time, the surgical staff observed that the patient was in tears. These observations indicated that the patient was under light anesthesia and might be at risk of developing awareness. The patient was twice provided with a bolus of propofol (10 mg/bolus) through the syringe pump. The infusion rate of propofol was increased to 8 mg/kg/h because we believed that the drug clearance rate in this patient was high. However, the Narcotrend index remained in the 73–85 range. The Narcotrend index did not change even after the patient was administered with additional bolus of propofol.

Further examination showed that the spring has been eroded by colloid and became viscid, and in consequence could not push up on the clamp. In effect, the syringe pump was found to be in working condition, but the issue with the syringe fixing clamp resulted in no infusion of propofol (demonstrated in Fig. 2A). This was confirmed by a lack of any change in volume of the propofol in the syringe in spite of multiple efforts at infusion. In light of this finding, the patient was manually administered with a bolus of 50 mg of propofol and 2 mg of midazolam using a syringe, and supplemented with inhalation of 2% sevoflurane by inhalation. We noted that the Narcotrend index had returned to 23 (a state of deep anesthesia) following the manual administration of anesthetic medications. The syringe pump was replaced, and the surgery was allowed to proceed and lasted for 105 minutes. During the surgery, the Narcotrend Index was maintained within the 22–64 range. The patient had an uneventful recovery, and showed no evidence of awareness immediately after the recovery period or in the 3-day follow-up.

3. Discussion

We report that improper positioning of the syringe fixing clamp component of the infusion pump resulted in insufficient delivery of anesthetic medication, and could have led to intraoperative awareness. We were able to detect the insufficient anesthesia on the basis of Narcotrend index monitoring, leading to the discovery of equipment failure, and more importantly were able to provide proper intervention to prevent potential intraoperative awareness. The intravenous syringe pump (CP700TCI, SLGO Medical Technology Co) is widely used in China, but we have identified 2 apparent defects that need to be addressed. First, the spring located at the end of syringe pump is liable to erosion, causing the syringe fixing clamp to become viscid and unable to bounce up to the correct position. This prevented delivery of the appropriate dose of medication unknowingly to the medical staff. Second, there was no alarm to notify users of issues with the specific syringe pump. We believe that attention should be given to the above-described components of the CP700TCI syringe pump to ensure correct administration of anesthetic medications.

We have now carefully evaluated the different syringe pumps available in our department, and these include the CP700TCI (SLGO Medical Technology Co), the CP3100 (SLGO Medical Technology Co), the JZB-1800C (Jianyuan Medical Technology Co), and the Graseby 3500 (Graseby Medical Limited, UK).
intentionally place the syringe fixing clamp at the wrong position by using adhesive tape or manually opening the clamp (shown in Fig. 2B–D) to mimic the condition described above. An alarm was triggered with the CP3100, JZB-188C, and Graseby 3500, but not with the CP700TCI. We concluded that alarm system in the CP700TCI was defective or not properly designed. We are in the process of removing the CP700TCI syringe pump from use in our hospital.

We strongly suggest that a systemic preoperative evaluation for anesthesia machine, vaporizer, leak detection of the respiratory circle, patient's IV line, and intravenous syringe pump be implemented. There is evidence to suggest that a checklist system to monitor equipment could improve the safety of anesthesia. We have made further improvements to our preoperative checklist, and emphasized the importance of this procedure to our entire department.

It has been reported that BIS index monitoring can help to prevent awareness during general anesthesia. Narcotrend (Monitor Technik, Bad Bramstedt, Germany) is another EEG device for the assessment of the depth of anesthesia, and has been commercially available in Europe since 2000 and recently received US Food and Drug Administration approval. However, reports on the use Narcotrend monitoring to help prevent awareness are limited. While the BIS index is more widely accepted by anesthesiologists, Narcotrend monitoring does have advantages. First, the cost of the sensors in the Narcotrend (£0.14 per sensor) is lower than those of the BIS system (£14.50 per sensor). Second, there is a good correlation between Narcotrend and BIS index. Lastly, in this report the Narcotrend index played a major role in identifying a risk of awareness due to an issue with the syringe pump.

In conclusion, we report a case of light anesthesia caused by failure of the CP700TCI infusion pump. Users of this specific syringe pump should pay attention to potential issues with the syringe fixing clamp and alarm system. Anesthesiologists should perform thorough evaluation of equipment using a well-defined checklist before anesthesia. Finally, we strongly advocate the application of Narcotrend monitor during anesthesia to detect signs of light anesthesia in order to prevent the occurrence of awareness.

Author contributions
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References
[1] Moerman N, Bonke B, Oosting J. Awareness and recall during general anesthesia. Facts and feelings. Anesthesiology 1993;79:454–64.
[2] Bergman IJ, Kluger MT, Short TG. Awareness during general anesthesia: a review of 81 cases from the Anaesthetic Incident Monitoring Study. Anaesthesia 2002;57:549–56.
[3] Ekman A, Lindholm ML, Lemmaren C, et al. Reduction in the incidence of awareness using BIS monitoring. Acta Anaesthesiol Scand 2004;48:20–6.
[4] Myles PS, Leslie K, McNeil J, et al. Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial. Lancet 2004;363:1757–63.
[5] Mathews DM, Rahman SS, Cirullo PM, et al. Increases in bispectral index lead to interventions that prevent possible intraoperative awareness. Br J Anaesthesia 2005;95:193–6.
[6] Kreuer S, Biedler A, Larsen R, et al. The Narcotrend (TM)—a new EEG monitor designed to measure the depth of anaesthesia—a comparison with bispectral index monitoring during propofol-remifentanil-anaesthesia. Anaesthesist 2001;50:921–5.
[7] Schmidt GN, Bischoff P, Standl T, et al. Narcotrend, bispectral index, and classical electroencephalogram variables during emergence from propofol/remifentanil anesthesia. Anesth Analg 2002;95:1324–30.
[8] Duan G, Guo S, Zhan H, et al. A new real-time method for detecting the effect of fentanyl using the preoperative pressure pain threshold and narcotrend index: a randomized study in female surgery patients. Medicine 2015;94:e316.
[9] Cassidy CJ, Smith A, Arnott-Smith J. Critical incident reports concerning anaesthetic equipment: analysis of the UK National Reporting and Learning System (NRLS) data from 2006-2008. Anaesthesia 2011;66: 879–88.
[10] Hartle A, Anderson E, Brysella V, et al. Checking anaesthetic equipment 2012: association of anaesthetists of Great Britain and Ireland. Anaesthesia 2012;67:660–8.
[11] Shepherd J, Jones J, Frampton GK, et al. Clinical effectiveness and cost-effectiveness of depth of anaesthesia monitoring (E-Entropy, Bispectral Index and Narcotrend): a systematic review and economic evaluation. Health Technol Assess 2013;17: 1–264.
[12] Kreuer S, Bruhn J, Larsen R, et al. Application of Bispectral Index and Narcotrend index to the measurement of the electroencephalographic effects of isoflurane with and without burst suppression. Anesthesiology 2004;101:847–54.