An unusual cause of intraoperative hypercarbia: Who’s the boss:- Machine or The Man behind the machine?

Sir,

Modern integrated anaesthesia workstations provide comprehensive facilities for patient ventilation, gas delivery and agent vapourisation, and allow seamless integration of patient monitoring and recording with anaesthesia information systems. American Society of Anaesthesiologists (ASA) 2008 recommendations for pre-anaesthesia checkout advocate pre-use testing of anaesthesia machine before the conduct of anaesthesia. [1] Modern anaesthesia workstations including Dräger Perseus® A500 (Dräger, Germany) have integrated automatic self-testing to circumvent human errors and ensure administration of safe anaesthesia. [2]

A 5 year-old boy with left hydrocele was posted for elective open herniotomy. Dräger Perseus® A500 anaesthesia workstation (Dräger, Germany) which had already passed an automated self-test was used to administer general anaesthesia with controlled ventilation using i-gel® supraglottic airway device (Intersurgical Limited, Wokingham) in-situ with ultrasound-guided left ilioinguinal and iliohypogastric nerve block. After obtaining valid informed parental consent, the child was pre-medicated with oral midazolam 0.5 mg/kg and wheeled into the operating room (OR). Standard ASA monitors were attached and incremental induction with sevoflurane (2-8%) was done. On achieving jaw relaxation and loss of purposeful movement, size 2 i-gel® was inserted and controlled ventilation using volume control auto-flow mode initiated. Anaesthesia was maintained using air-oxygen (50:50) and sevoflurane titrated to maintain age-adjusted minimum alveolar concentration (MAC) 1, with fresh gas flows (FGF) of 0.5 L/min. Following this, ultrasound-guided left-sided ilioinguinal and iliohypogastric nerve block using 0.15 ml/kg of 0.25% bupivacaine was given.

A few minutes later, end-tidal carbon dioxide (ETCO₂) and fraction of inspired carbon dioxide (FiCO₂) values were observed to have risen from baseline values of 34 to 62 and 0 to 16 respectively. Switching over to the manual controlled mode of ventilation showed no increase in airway resistance (peak airway pressure <15 cm H₂O) with bilaterally equal breath sounds. However, ETCO₂ values continued to rise. At this point, we switched over to Jackson Rees (JR) circuit, to rule out the possibility of a faulty closed circuit. Simultaneously, a quick survey of the machine revealed an empty absorbent canister. The same was immediately refilled, following which ETCO₂ values gradually normalised.

Increased ETCO₂ under anaesthesia is either due to decreased excretion or increased production [Table 1]. [3,4] In accordance with our OR standard operating procedure (SOP), the canisters are refilled as required, which is usually on completion of the last case of the day. Visual inspection for exhausted carbon dioxide absorbent is a standard practice in the ASA checklist. We failed to identify the empty canister on visual inspection prior to...
Letters to Editor

Table 1: Causes of increased end-tidal carbon dioxide

| Category                        | Causes                                                                 |
|---------------------------------|------------------------------------------------------------------------|
| I. Due to decreased excretion of carbon dioxide: | (a) increased inspired carbon dioxide  
(b) decreased minute ventilation  
(c) increased dead space |
| II. Due to increased carbon dioxide production | (a) Disease related  
(i) Muscular dystrophies  
(ii) Sepsis  
(iii) Rhabdomyolysis  
(iv) Pheochromocytoma  
(v) Malignant hyperthermia |
| (b) External Causes | (i) Equipment malfunction- faulty expiration valve  
(ii) Kinked/blocked endotracheal tube  
(iii) Tourniquet release  
(iv) Sodium bicarbonate administration for treatment of acidosis  
(v) Carbon dioxide insufflation |

beginning the case, which was a gross error irrespective of the high-end anaesthesia workstation. However, the machine passed the automated self-test and did not alert us regarding the same. Dräger Perseus® A500 workstation (Dräger, Germany) has two functional tools to support the safe conduct of low flow anaesthesia viz. the Low Flow Wizard and the Econometer.\[5\] Low Flow Wizard enables real-time analysis of data like patient uptake, breathing system leakage and the volume of carbon dioxide absorbed by the absorbent and compares the sum of these values with the actual FGF.\[5\] Econometer displays the FGF in a colour-coded bar graph based on filling of the manual breathing bag with each delivered breath, thus enabling a judicious and economical FGF set-up.\[5\] However, none of these tools are designed to identify the presence of an empty absorbent canister per se or indicate the time to complete exhaustion.

We recommend that automated self-tests should include testing for presence of the absorbent to ensure patient safety. This assumes greater importance particularly in the context of increasing practice of paediatric low flow anaesthesia. Furthermore, an in-built alarm indicating the absorbent’s functional capacity should be incorporated into the anaesthesia workstation to avert human errors and avoid hypercarbia.

The advancements of the century may be leading us to an era of robotic anaesthesia and hi-tech workstations; nonetheless, “it is not the machine, but the man behind it that matters.”

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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