Factitious reading by gas monitor

Sir,
In the era of low flow anesthesia, gas monitors have become an integral part of anesthesia work station. They provide critical information about inspired and expired concentrations of $O_2$, $N_2O$, and $CO_2$ and also provide a guard against the possibility of intraoperative awareness by giving accurate minimal alveolar concentration (MAC) value of various volatile anesthetic agents. However, as with any technology gas monitoring is also associated with inherent errors and fallacies, which if overlooked can potentially lead to patient morbidity. In a recent critical incidents analysis involving anesthesia equipment, 13.4% incidents were related to problems with gas monitoring. [1]

Here, we report a case of erroneous detection of enflurane despite of the agent not being used and explore a possible mechanism behind the error.

To anesthetize a 1-year-old child, we used Drager Primus ASAE-0129 workstation with a side stream gas analyzer. Anesthesia was induced using sevoflurane in $O_2$ and $N_2O$ mixture of 50:50 ratios at 5 L/min of fresh gas flow (FGF). When a MAC value of 3.0 was reached, intravenous cannula was secured, and sevoflurane vaporizer was turned off and airway was secured using laryngeal mask airway device. The isoflurane vaporizer was turned on and anesthesia was

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maintained using isoflurane in O₂ and N₂O mixture of 50:50, at 2 L/min of FGF. The gas analyzer detected the volatile anesthetic agents as sevoflurane and enflurane along with their inspired and expired concentrations and MAC value [Figure 1], although enflurane had never been used with this anesthesia machine. MAC value was not relied thereafter and FGF was not decreased below 2 L. The monitor showed MAC values for both iso- and en-flurane throughout the procedure.

Anesthetic gases are most commonly analyzed by infrared method (dispersive or nondispersive) to isolate the absorbance characteristics of the gas sample. Many gases absorb infrared energy at a wavelength specific to the gas being analyzed[2]. Infrared absorbance spectra for CO₂ and N₂O are located at the 4-5 μm range and for volatile anesthetic agents; it ranges between 8 and 13 μm. The refractive index of en-, iso- and sevo-flurane is overlapping (1.540.4, 1.563.3 and 1.538.3, respectively).[3] Thus, they require complex methods of discrimination along with advanced mathematical techniques to identify and measure them.

Wrong detection as halothane for patient’s expired breath methane[4] or isopropyl alcohol has been reported at lower wavelengths (3.0-3.3 μm). Misidentification can also occur if a wrong agent has been filled in the vaporizer. However, since the Drager Primus uses higher wavelengths for its volatile anesthetic agents analysis (8-13 μm) and has a fool proof filling method, both the above events can not be true in our case. We postulate that the use of both agents that is, sevoflurane during induction and isoflurane during maintenance of anesthesia may have led to the wrong detection of enflurane whose peak wavelength lies around the wavelengths of both these agents. Fault in expired gas sensor membrane may have contributed to this factitious enflurane identification.

The technical support team from Drager medicals were contacted for the cause and the fault was found to be in the sensor of gas monitor (ILCA2 infrared gas analyzer Drager Medical, Lubeck, Germany). After replacing the part with the new one, the sensor started to identify the agents correctly. This gas analyzer works by pulsed nondispersive infrared method and a multispectral detector. The measurement method is not susceptible to cross-sensitivities from water vapor, ethanol, and acetone.

These sensors need to be checked periodically as per the manufacture’s recommendations and moisture should be prevented from entering into the sampling line. This particular sensor needed to be replaced monthly according to the manufacturers recommendation, but the step had been overlooked which probably lead to the misidentification. Agents like enflurane, which are no longer in use, should not be encoded into the sensors. When such a problem is encountered, the FGF should not be decreased to <1 L, as the disparity between delivered and inspired concentration of anesthetic agents becomes more marked at low flows. Sensors which do not cross-react with the gases, which are exhaled by the patient such as alcohol, acetone, carbon monoxide, and methane, should be used.

Standards for basic intraoperative monitoring presently do not require volatile anesthetic agents measurement. However, erroneous readings may lead to over or under dosing of these agents leading to patient morbidity including delayed awakening, hemodynamic instability and intraoperative awareness. Wrong identification of volatile anesthetic agents by the gas monitor may lead to unnecessary hassle at the same time giving a hint that the ongoing gas monitoring may not be reliable to ensure adequate depth of an ongoing general anesthetic.

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2. Wilkes AR, Mapleson WW. Interference of volatile anaesthetics with infrared analysis of carbon dioxide and nitrous oxide
Intrathoracic bronchial intubation: A feasible option to manage life-threatening hypoxia in a neonate

Sir,

One day, 1600 g, preterm baby with type C tracheoesophageal fistula (TEF) was scheduled for emergency TEF repair. In the operating room, pulse oximetry, electrocardiography, noninvasive blood pressure and temperature monitoring was established. Anesthesia was induced using 100% oxygen and sevoflurane titrated to effect. Intravenous fluid consisted of balanced crystalloids (Isolyte P; 4 ml/kg/hr), injection Atracurium 0.8 mg, fentanyl 4 mcg was administered intravenously. Trachea was intubated with 3.0 mm ID uncuffed polyvinyl chloride endotracheal tube (ETT). Manual positive-pressure ventilation was commenced. Correct ETT placement confirmed by end-tidal CO$_2$ (EtCO$_2$) and bilaterally equal air entry without undue distention of the stomach on auscultation. ETT was fixed at 9.0 cm. Extra-length of ETT was cut to minimize dead space and prevent kinking. Posterio-lateral thoracotomy position was made and neonate put on pressure controlled ventilation (peak airway pressure 15-20 cmH$_2$O; respiratory rate, 25/min; inspiratory: Expiratory ratio [1:1.5]) using retropleural approach, surgeon identified and exposed a low lying fistula. Soon thereafter, sudden fall in airway pressures and EtCO$_2$ occurred. Manual ventilation did not improve respiratory parameters. Surgeon noticed accidental knick in main stem trachea near the right tracheo-bronchial junction. Tip of ETT was visible through the severed carina, but it could not be advanced as ETT was cut at the oral end and then fixed. Surgeon’s attempt to ventilate with the thumb over the rent failed. Neonate desaturated rapidly, SpO$_2$ 30%; the heart rate 40/min. At this moment, another 3.0 mm ETT was given to surgeon for intrathoracic endobronchial insertion via the rent and manual ventilation of the right lung was initiated through this ETT [Figure 1]. SpO$_2$ and heart rate improved. Three-fourths of the rent was repaired around intrathoracic ETT. Thereafter, oral ETT was replaced in the lateral position and advanced just above the carina. Surgeon removed intrathoracic ETT and directed oral ETT into the bronchial lumen to complete the repair. Subsequently, oral ETT was withdrawn back to carina and breathing circuit again connected at the oral end. In the postoperative period, mechanical ventilation and supportive therapy continued in Intensive Care Unit (ICU). Rest of ICU stay was uneventful.

Limited data are available on the iatrogenic tracheal injuries in neonates. Previously, trauma during delivery endotracheal intubation or foreign body removal has been reported, [1] Di Gaetano et al. [2] reported cautery induced carinal perforation in an adult. Managed using selective bilateral main stem bronchial intubation. There is a case report of left main stem bronchial tear with EtCO$_2$ upsurge during thoracoscopic TEF repair. [3] Dango et al. [4] reported subtotal posttraumatic rupture of distal tracheobronchial tree in a toddler. Patient required abridgment with a pericardial patch. In the present neonate, large accidental knick lead to complete loss of ventilation. Prompt intrathoracic endobronchial ETT placement restored hemodynamics and acted as a bridge for surgical repair. Therefore, it is suggested...