Heat and moisture exchanger filter in a paediatric patient: A dilemma for anaesthesiologists - to use or not to use?

Sir,

Endotracheal intubation bypasses the upper airway leading to loss of heat, humidity and increased chances of infection. Hence, Heat and Moisture Exchanger (HME) is incorporated in the anaesthesia circuit to conserve a part of the patient’s exhaled heat and moisture.\(^1\) Adding a filter to the breathing system reduces the transmission of microbes and other particulate matter (together HMEF).\(^2\)

A six-year-old, 20 kg, American Society of Anesthesiologists (ASA) class 1 male child was scheduled for medulloblastoma excision. The standard ASA monitors were attached. Anaesthesia was induced with intravenous fentanyl 40 μg, propofol 50 mg, and vecuronium 2 mg. Tracheal intubation was done with a cuffed endotracheal tube of 5.5 mm internal diameter. After confirming bilateral equal breath sounds on auscultation and normal capnography, surgery was started. The patient was ventilated with a tidal volume (TV) of 140 ml, respiratory rate (RR) 14/min, FiO\(_2\) 0.5, and inspiratory-expiratory (I:E) ratio of 1:2 using Drager Primus Infinity Kappa anaesthesia workstation. Anaesthesia was maintained with sevoflurane 2-3% in oxygen, and air. After about 30 minutes of surgery, the end-tidal carbon dioxide (EtCO\(_2\)) started rising. We ruled out one-lung ventilation, bronchospasm, and kinking of the endotracheal tube. Despite adjusting the ventilator settings (respiratory rate to 20, and tidal volume upto 10 ml/kg) and subsequent suctioning of the endotracheal tube, EtCO\(_2\) increased to 70 mm Hg. Interventions like changing the sampling line, soda-lime (Dragersorb 800 Plus) and the workstation did not help.

The arterial blood gas (ABG) analysis showed a pH of 7.1 and pCO\(_2\) 80. Icepacks were applied as there was a rise of 2-degree Celsius in the patient’s body temperature. We decided to remove the paediatric HMEF (Medisafe) connected to the Y-piece of the circuit. Subsequently, the EtCO\(_2\) decreased to its normal value in half an hour. The temperature and ABG also became normal. Further intraoperative course was uneventful.

Endotracheal tube, Y piece, tube adaptor, and HMEF device add to the apparatus dead space during mechanical ventilation. This increases rebreathing, resistance, and the work of breathing.\(^3\) In children, a vast apparatus dead space volume could be most of the tidal volume, resulting in inadequate ventilation and the development of respiratory acidosis. So, even though the patient might benefit from the addition of the HMEF, some harm might also occur. Kwon MA studied the effect of paediatric HME in healthy patients. They found that HME significantly increased PaCO\(_2\). The removal of the HME decreased PaCO\(_2\) from 46.1 ± 6.9 mmHg to 37.9 ± 4.3 mmHg (P < 0.001) and increased the pH from 7.32 to 7.37 (P < 0.001). This change was inversely proportional to weight and age.\(^4\)

In healthy adult patients, HME has a low resistance and a relatively small volume (about 75 ml), that does not impair ventilation.\(^5\) However, most paediatric patients are applied with the standard size of HME which has a volume of 20-25 ml.\(^6\) This amounts to about 1/10 of the tidal volume of a 20 kg patient or 1/5 for a 10 kg patient. In our case, HMEF lead to relatively more dead space resulting in ineffective ventilation and accumulation of CO\(_2\). There was the buildup of heat and a rise in temperature as well.

In short surgeries, HMEF can be avoided. However, not using an HMEF in prolonged surgeries can lead to hypothermia and metabolic acidosis. Sometimes, the filter may become damp and increase the resistance leading to respiratory acidosis. Hence, further investigations on optimum paediatric HME devices with smaller dead spaces are strongly desirable. Also, various sizes of paediatric filters are now available with reduced dead space: HMEF Paediatric for weight >10 kg and HMEF Neonatal for children <10 kg. Age and weight appropriate filters should be used, with a low threshold for replacing the filter if the EtCO\(_2\)/pCO\(_2\) is persistently high.

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.
Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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Submitted: 04-May-2020
Revised: 21-Jun-2020
Accepted: 11-Oct-2020
Published: 01-Nov-2020

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Access this article online

Quick response code
Website: www.ijaweb.org
DOI: 10.4103/ija.IJA_516_20

How to cite this article: Shagufta N, Chandni S, Ajeet K, Adil A. Heat and moisture exchanger filter in a paediatric patient: A dilemma for anaesthesiologists- to use or not to use? Indian J Anaesth 2020;64:992-3.

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