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Increased airway resistance in the prone position associated with heat and moisture exchangers with integral bacterial/viral filters

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To the editor: A heat and moisture exchanger with integral bacterial/viral filters (HMEF) is usually used to preserve heat and humidity and to prevent contamination in a patient's airway. However, this device sometimes causes ventilatory disturbance when in contact with liquid [1,2] or a foreign body [3]. We recently observed increasing airway resistance caused by an HMEF during neurosurgery in a patient in the prone position. The patient was a 9-year-old female (body weight, 32 kg). An HMEF (DAR Hygrobaby-M; Mallinckrodt Medical, Mirandola, Italy) was attached between a 5.5-mm endotracheal tube (ETT) and the anesthesia circuit just after tracheal intubation. Five hours after starting the operation, we noticed an increase in both the airway resistance (approximately 20 to 30 cmH_2O) and the end-tidal CO_2 (29 to 45 mmHg). The respiratory sounds indicated neither laterality nor stenosis, while the expiration phase was prolonged. We checked the anesthesia circuit and noticed that the weight of the HMEF was increased. The HMEF was replaced and the airway resistance and end-tidal CO_2 immediately decreased to the previous levels. The weight of the HMEF was approximately 10 g, 1 g heavier than the new one (dry weight, 9 g). Neither sputum nor any foreign substance was observed in the HMEF.

We examined whether as little as 1 ml in volume of water would significantly increase the resistance of an HMEF (DAR Hygrobaby-M; Mallinckrodt Medical; capacity, 8 ml) and a heat and moisture exchanger (HME) without bacterial/viral filters (Humid vent; Gibeck, Upplands Väsby, Sweden, capacity, 7 ml). The HMEF or the HME was attached between an anesthesia circuit and a test lung (volume, 500 ml; flow resistance, 5 cmH2O·l·min^{-1}). The anesthesia circuit pressure (ACP) was measured with a Datex AS/3 anesthesia monitor (Helsinki, Finland). The ventilator setting was: tidal volume, 300 ml; frequency, 15 cycles·min^{-1}; inspiratory-expiratory (I:E) ratio, 1:1.5. After the ACP was measured with or without these devices, 0.5 ml distilled water was dripped into each device. After infiltration was complete, change in the ACP was evaluated. An additional 0.5 ml distilled water was then infiltrated and the ACP was measured. The results are shown in Fig. 1. The ACP increased in the HMEF but did not increase in the HME. In the operating manual, the resistance of the dry HMEF to gas flow was reported to be 1.9 cmH_2O at 10 l·min^{-1}, supporting our observation. These observations indicate that the bacterial/viral filter that absorbed water induced high airway resistance. The constituents of the HMEF electrostatic filter, made of a non-woven fabric consisting of polypropylene fibers, and those of the HME, made of a

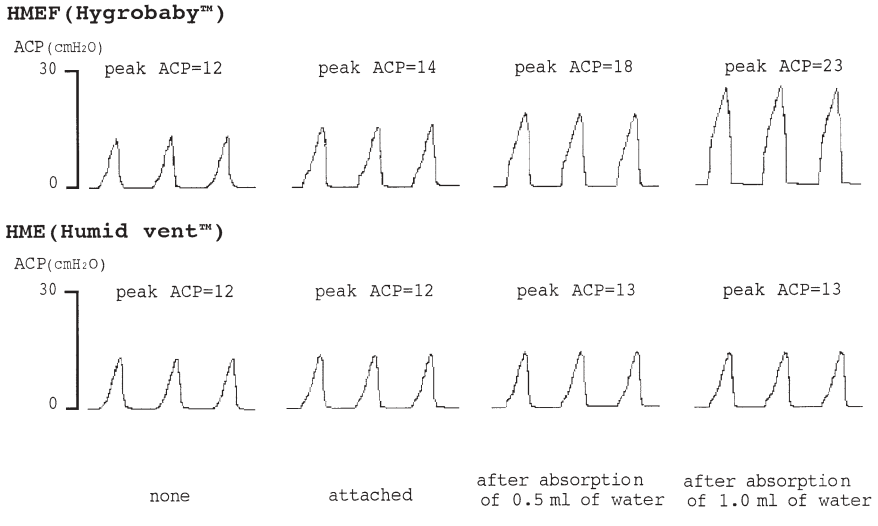

Fig. 1. Change in the anesthesia circuit pressure (*ACP*) during the water infiltrating test. *HME*, heat and moisture exchanger; *HMEF*, heat and moisture exchanger with integral bacterial/viral filters

hydrophilic cellulose membrane, may be related to this phenomenon.

The DAR Hygrobaby-M (Mallinckrodt Medical) is designed for use in infants weighing between 3 and 8 kg. Because our patient weighed 32 kg, the HMEF was small for her, and the increase of airway resistance caused by the HMEF was small. However, our finding suggests that expiratory moisture in the ETT condensed to become a water droplet and infiltrated into the HMEF during surgery with the patient in the prone position. The filter absorbed water and induced ventilatory resistance. In conclusion, while using the HMEF in a patient in the prone position, ventilatory disturbance can occur and must be monitored for.

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