The use of activated charcoal filters for malignant hyperthermia-susceptible patients

Purging a "contaminated" anaesthetic machine is an essential part of management of patients at risk of malignant hyperthermia (MH) susceptibility[1].

Very few anaesthetic departments have a dedicated vapour-free anaesthetic machine for planned use in a known or suspected MH susceptible patient. The internal circuitry of current anaesthetic workstations is complex and inhalational agents are retained more readily than older models and flushing these machines takes longer to reach an appropriate concentration of anaesthetic[2,3]. This can be especially problematic in the setting of time critical requirements for general anaesthesia, for example, emergency general anaesthetic for caesarean section. The accepted safe level of inhalational agent is 5ppm[4]. This was determined using halothane (the most potent trigger of an MH reaction), therefore other inhalational agents are presumed safe with levels <5ppm. Purging a machine can be prolonged[2,3] although the time period can vary with different researchers. A period of flushing a machine for up to 70 minutes is inconvenient, time consuming and costly.

Activated charcoal filters (ACFs) for purging an anaesthetic machine were first suggested by Greene in 1986[5]. Later Gunter[6] found that a Quick Emergence Device™ reduced residual concentration of sevoflurane to <5ppm in 10 minutes using a Dräger Fabius anaesthesia machine. More recently Birgenheier[7] using an Apollo anaesthesia machine found that using Vapor-Clean ACFs on both inspired and expired limbs of a contaminated machine, volatile concentration with desflurane and sevoflurane fell to <2ppm in two minutes. The measurement, however, was only continued for 90 minutes. MHAUS[8] (Malignant Hyperthermia Association of United States) later recommended changing ACFs every hour.

Recent research[9] on the clinical use of ACFs conducted at the Royal Melbourne Hospital has been published in *Anaesthesia and Intensive Care*. The investigators sought to answer a range of questions about the configuration/number of ACFs required in the circuit, the safe duration for ACF usage and whether an anaesthetic machine needed to be flushed prior to inserting the ACF to achieve safe conditions for patients at risk of MH susceptibility. Experiments were performed on Datex-Ohmeda Aisys anaesthesia machines. The machines were contaminated for two hours ventilating a test lung and using isoflurane 1.5 per cent, desflurane 6 per cent and sevoflurane 2 per cent. Fresh gas flow was set at two litres/minute. Vapor-Clean™ activated charcoal filters (Dynasthetics LLC) containing 50 cc of activated charcoal in a polypropylene filter mesh were used.

MHANZ (Malignant Hyperthermia Australia & New Zealand) is the group of anaesthetists and scientists who test for MH susceptibility and advise ANZCA on MH-related policy. The following are our recommendations that follow from the results obtained by Melbourne investigators.

MHANZ recommendations for the use of activated charcoal filters in the preparation of anaesthetic machines for patients at risk for MH susceptibility:

1. Remove vaporisers from the anaesthetic machine.
2. Flush circuit for 90 seconds with oxygen or air at 10 litres/minute using the ventilator with a two litre test lung attached.
3. Change full breathing circuit and soda lime while maintaining flushing at 10 litres/minute (the ventilator is left unchanged).
4. Insert activated charcoal filters on both the inspiratory and expiratory ports of the breathing system. (NB: while Bilmen & Gillies[9] demonstrated the efficacy of using a single ACF on the inspiratory limb of a circle circuit, MHANZ recommendation is that two ACFs are used to remove the risk of incorrectly placing a single filter on the expiratory limb which is *ineffective*).
5. Maintain fresh gas flow of 10 litres/minute for 90 minutes from the commencement of the anaesthetic.
6. After 90 minutes it is safe to reduce FGF to three litres/minute.

7. ACFs can be used at three litres/minute until a total of 12 hours has elapsed from the commencement of the anaesthetic.
8. ACFs are single-use items.
9. In the event of an MH crisis, the addition of ACFs to the anaesthetic machine may be of benefit[7], but this has not been proven clinically. Clinical priorities in an MH crisis remain: dantrolene administration (2.5mg/kg), high fresh gas flows, treatment of arrhythmia/acidosis and active cooling.

Vapor-Clean ACFs are available in New Zealand through Jackson Allison Medical and Surgical Limited, but are awaiting TGA approval in Australia. The cost of a pair of ACFs is approximately $A130.

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