Prof. [redacted]

[redacted]

10 October 2021

Ms Nadia Persaud
Senior Coroner
Walthamstow Coroners Court
Queen's Road
Walthamstow
London
E17 8QP

Dear Ms Persaud,

Re HME/Filters

Further to last week's inquests and your request for comments in relation to HME/Filters, I have set out the following background, issues and potential solutions.

Background and current issues

1. When a patient is connected to a ventilator or anaesthesia machine, the tube that is in their trachea (orotracheal tube [via their mouth] or tracheostomy [through their neck]) bypasses their natural processes (in the nose and pharynx) for providing humidification to their upper airway and lungs. Furthermore, unlike room air, medical gases are completely free of water. Thus, some form of artificial humidification is required when a patient is receiving mechanical ventilation.
2. Such humidification can be provided in three main ways:
    a. Passive heat and moisture exchange (HME) devices placed at the patient end of the breathing system connected to tracheal tube.
    b. Active humidification through a device placed in the breathing system next to the ventilator.

c. Anaesthesia machines typically include a soda lime cannister to absorb carbon dioxide – this process also provides humidification, but this is insufficient for patients who require prolonged artificial ventilation.

3. Intensive care ventilators will typically have a disposable bacterial/viral filter placed where the expiratory limb of the patient breathing tubing attaches to the ventilator - this is to protect the ventilator from becoming contaminated by infection. Sometimes the same type of filter is attached between the ventilator and the inspiratory limb of the breathing tubing. Whether one or two of these filters are used, they should be attached directly to ventilator. These bacterial/viral filters do not provide any humidification.
4. Many HMEs also include a bacterial/viral filter and are known as HMEFs. These would also be placed in the patient end of the breathing system.
5. HMEs, HMEFs and bacterial/viral filters come in many shapes and sizes but are essentially indistinguishable. They will normally have writing on them to indicate what they are but this can be fairly subtle. They are usually coloured, and the manufacturers generally use one colour for each type, but there is no national or international standard for these colours, and they vary between manufacturers.
6. Several techniques are used to closely monitor a patient's breathing when they are receiving artificial ventilation. A standard of care is to measure continuously the carbon dioxide (CO_2) that a patient breathes out. This requires a CO_2 sampling tube to be attached to the breathing system close to the patient end of the breathing system.
7. Many HMEs and HMEFs include a port specifically designed to attach a CO_2 sampling line – this prevents the need for a separate connector in the breathing system specifically for the CO_2 sampling line.
8. Currently, most patients receiving artificial ventilation in the ICU will be receiving humidification from an active system. HMEs should not be used with active humidification because the HME will quickly become water-logged, which severely restricts or even prevents adequate ventilation of the patient. Where active humidification is used, attachment of one or two bacterial/viral filter filters to the ventilator will prevent it from being contaminated. These filters should not be placed at the patient end of the breathing system because they will reduce the amount of humidification reaching the patient and they can also become water-logged. When active humidification is used, the CO_2 sampling line will need a dedicated connector to enable sampling from the patient end of the breathing system.

9. Many manufacturers produce bacterial/viral filters that incorporate a port for CO_2 sampling (see Intersurgical, Drager and GE brochures). I can think of no reason for these to be used in anaesthesia or intensive care settings, although it is possible that they are aimed at resuscitation situations, particularly out-of-hospital, when short term ventilation is provided in an emergency (negating the need for humidification).
10. In my opinion, that the bacterial/viral filters included a sampling port contributed to the confusion recently experienced at the Nightingale Hospital London. This was compounded by non-standardised colours.

Potential solutions

11. Colour coding of filters should be standardised. For example:
    a. Bacterial/viral filter with HME function – yellow
    b. HMEF – green
    c. HME only – blue
    d. Another possibility is to have one colour for bacterial/viral filters, one for HMEs and then use both colours (in stripes?) for the HMEFs.
12. Unless there is an essential reason for including a sampling port on bacterial/viral filters, manufacture of such devices should cease. If they are considered essential (perhaps in a resuscitation situation), they should be cleared marked (packaging and the device itself) to indicate that they provide no humidification.
13. I think there is an opportunity to enhance the education about HMEs and filters. Given the incident at NHL, it may be appropriate to publish a National Patient Safety Alert on this topic (https://www.england.nhs.uk/patient-safety/patient-safety-alerts/)

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