Mechanical Ventilation of SARS Patients

Safety Issues Involving Breathing-Circuit Filters

Summary. Patients suffering from severe acute respiratory syndrome (SARS) sometimes require mechanical ventilation. This raises safety concerns about the SARS virus being carried by droplets that exit from the exhalation limb of the ventilator. ECRI recommends that breathing-circuit filters be incorporated in the exhalation limb of any ventilator used on a patient with SARS. In this article, we review the issues behind our recommendations and describe steps hospitals can take to prevent any adverse effects on ventilation.

For guidance on protective measures to take during maintenance of medical devices that have been exposed to the SARS virus, refer to the Guidance Article ”Protecting against SARS during Equipment Maintenance” on page 213 of this issue.

SARS Patients on Mechanical Ventilation

Patients with severe acute respiratory syndrome (SARS) who have difficulty breathing or maintaining adequate blood oxygen levels may need to be placed on mechanical ventilation. Ventilating a SARS patient raises infection control concerns, however, since the SARS virus may exit the ventilator in droplet or aerosol form along with the patient’s exhaled air. Although this has not been demonstrated as a known mechanism for spreading SARS, we believe that taking steps to minimize such a risk would be prudent.

Hospitals should prepare now for the possibility of ventilating SARS patients by reviewing their infection control policies and practices related to ventilator use and ensuring that appropriate practices are consistently followed. In particular, some new practices may be required related to the use of breathing-circuit filters.

The U.S. Centers for Disease Control and Prevention (CDC) has issued several statements about using filters on the exhalation limb of ventilator circuits. For example, it states that “Some hospitals caring for SARS patients have used bacterial/viral filters on exhalation valves of mechanical ventilators to prevent contaminated aerosols from entering the environment. Although the effectiveness of this measure in reducing the risk of SARS transmission is unknown, the use of such filters may be prudent during HFOV [high-frequency oscillatory ventilation] of patients.

* Hospitals should also review their policies for protecting healthcare workers during potential aerosol-generating procedures. The U.S. Centers for Disease Control and Prevention (CDC) recommends such a review because of the possibility that procedures capable of stimulating coughs and prompting the generation of aerosols could increase the risk of SARS transmission. Aerosol-generating procedures include administration of aerosolized medication treatment; diagnostic sputum induction; bronchoscopy; airway suctioning; endotracheal intubation; positive-pressure ventilation via facemask (e.g., BiPAP, CPAP), during which air may be forced out around the facemask; and high-frequency oscillatory ventilation (HFOV). See CDC 2003 May 20.
with SARS” (CDC 2003 May 20). And in its guidelines on ventilator use during air and ground transport of SARS patients, CDC calls for “HEPA [high-efficiency particulate-air] or equivalent filtration of airflow exhaust” (CDC 2003 May 8 and 2003 Apr 29).

ECRI recommends the use of breathing-circuit filters on the exhalation limb whenever SARS patients are mechanically ventilated. This is a prudent measure that might help reduce the risk of spreading the disease. Using filters also eliminates the need for cleaning and sterilizing or disinfecting any reusable components downstream of the filter.

Many hospitals already routinely use filters in the breathing-circuit exhalation limb for all ventilator patients. These hospitals will need to verify that the filters they are using provide adequate protection against the spread of SARS. Some ventilators require the use of a specific filter; if this filter does not offer enough protection, then an additional one will have to be installed upstream of the existing filter and the exhalation valve.

Hospitals not already using filters will need to decide if this is to be done for all patients or only for patients who have, or might have, SARS (or other diseases caused by airborne infectious agents, such as tuberculosis). These hospitals will also need to ensure that an effective filter is selected and that it is used in a way that provides protection and does not interfere with patient ventilation. They should consult with the ventilator equipment manufacturer as needed.

**Filter Selection and Placement**

Breathing-circuit filters are available from a number of suppliers. CDC calls for the use of a HEPA filter in some of its recommendations. As an alternative, breathing-circuit filters having bacterial and viral filtration efficiencies of 99.97% or greater will offer protection equal to or better than HEPA filters. Before a final selection is made, the fit of the filter into the circuit should be checked to verify that the filter does not increase the risk of a breathing-circuit disconnection, misconnection, or obstruction.

When possible, the filter should be placed upstream of any reusable components. For an intensive care ventilator, the filter should usually be attached between the end of the exhalation limb tubing and the ventilator so that it will prevent contamination of the exhalation valve and other reusable components located at or within the ventilator.

**Preventing Adverse Effects on Ventilation**

Any new component in a ventilator breathing circuit can introduce new risks. With filters, the greatest risk is that moisture accumulating in the filter could cause increased exhalation resistance or an obstruction, possibly resulting in decreased ventilation effectiveness or pneumothorax. Misconnection or disconnection of breathing-circuit components may also be possible.

Be sure that policies on using breathing-circuit filters are available and that appropriate training is provided for respiratory therapy, nursing, and any other personnel responsible for setting up and using the ventilator. Policies and training should include the following instructions:

- Follow the manufacturer’s instructions on the maximum filter replacement interval (often 24 hours). Consider tagging the filter with the date and time that it is installed in the breathing circuit; be sure to make clear that this is the installed date, not the replace-by date.

**CDC Web Resources**

The following CDC Web pages are referenced in this article:


Make sure that the filter is correctly and securely installed so that it does not contribute to any risk of disconnection of any portion of the breathing circuit or misconnection of components.

Install the filter before performing manual pre-use checks and automatic ventilator breathing-circuit compliance tests.

Follow manufacturer recommendations and hospital policies for emptying water traps so as to minimize infection risks while ensuring that the trap does not overfill into the filter.

Use care in handling and disposing of the contaminated filter.

During ventilation, watch for signs of obstruction or increased exhalation resistance. One way to do this is to monitor the peak expiratory flow and the duration and slope of the exhaled breath on the waveform display. Alternatively, if no waveform display is available, exhalation pressure can be checked during an expiratory hold maneuver.

Consider the use of a heated-wire circuit or a heat/moisture exchanger (HME), if appropriate, to minimize the moisture in the breathing circuit and therefore the moisture load on the filter.

Update the ventilator worksheet as needed. Alternatively, at least record filter replacements and the checks that have been made for high resistance.

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**Protect That Pressure Sensor**

Many ventilators have a sensor located inside the ventilator, with a tube or pathway allowing the pressure in the breathing circuit to be sampled. Since the sensor cannot be accessed for cleaning and disinfection, it must be protected against contamination. In many cases, a breathing-circuit filter positioned at the connection between the exhalation tubing and the ventilator will prevent sensor contamination. However, if a breathing-circuit pressure-sensor line is connected to the patient wye, make sure that a high-efficiency particulate-air (HEPA) filter (or better) is used in the sensor-line tubing between the wye and the ventilator. Verify that moisture will not create back pressure or occlusion that will interfere with pressure sensing.

It is important to decide on policies now, obtain appropriate filters, and be sure that staff are familiar with their correct use. Waiting until there is actually a SARS patient who requires ventilation may not leave you enough time to implement the required measures. This could unnecessarily increase personnel exposure to the virus or place the patient at risk from incorrect filter application and maintenance.