Vancouver Coastal Health Guidelines for the use of Respiratory Equipment for Patients on Airborne Precautions in Acute Care Facilities

Goals

1. To meet respiratory care needs in patients who are on airborne precautions.
2. To provide respiratory care clinicians with equipment options to minimize exposure to potentially infectious airborne or droplet particles.
3. To recommend equipment and techniques to provide maximal exhalate filtration of airborne particles.

Important Notes

1. Use of this respiratory equipment **DOES NOT** preclude the use of Personal Protective Equipment (PPE). See **VCH Regional Infection Control Manual** for appropriate use of PPE and donning/doffing procedures.
2. Recommendations for the use of specific respiratory equipment are meant to be ***guidelines*** and should be discussed by the health care team as to the appropriateness of use in each patient.
3. As with any emerging disease, information and guidelines pertaining to patients with severe respiratory illnesses with unknown diagnosis are in evolution. Information presented here is based on evidence and equipment available at the time of publishing and is subject to change. Images are for illustration purposes only—Vancouver Coastal Health does not endorse specific manufacturers or products.
4. Equipment and language used in this document is indicated for use by Respiratory Therapists and clinicians who have experience in using the equipment described. All clinicians using these guidelines must individually confirm their equipment for applicability and patient safety and monitor carefully. Consult your Respiratory Therapy Department for specific questions on the use of recommended equipment.
5. These guidelines are not intended to provide guidance for the clinical management of patients.
6. This document frequently refers to use of an 'appropriately rated expiratory filter'. In all cases, this refers to any filter that can demonstrate meeting HEPA filtration criteria (>99.97% filtration of MPPS using NaCl test).
7. For more information and recommendations, please refer to the following resources:

VCH Regional Infection Control Manual

Guidelines for the Acute Management of the Patient with SARS in the Hospital Setting

Pandemic Planning - Clinical Management and Health Care Facilities

VCH Worksafe and Wellness Respiratory Protection Program

How to Use PPE Safely and Effectively

Public Health Agency of Canada: Interim Guidance: Infection Prevention and Control Measures

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Definitions

Aerosol-generating Medical Procedures (AGMPs): any procedure carried out on a patient that can induce the production of aerosols of various sizes, including droplet nuclei. Examples include: non-invasive positive pressure ventilation (BIPAP, CPAP); endotracheal intubation; respiratory/airway suctioning; high-frequency oscillatory ventilation; tracheostomy care; chest physiotherapy; aerosolized or nebulized medication administration; diagnostic sputum induction; bronchoscopy procedure; autopsy of lung tissue.

Section A. **Oxygen Therapy Systems and Humidification**

For patients with low oxygen requirements ($FiO_2 \leq 0.40$), a simple oxygen face mask, Oxymask™ or nasal prongs will be adequate to meet oxygen demands. When patients are outside the room, a surgical mask can be worn by the patient overtop their nasal prongs to protect staff from expired droplets (e.g. cough or sneeze). Generally, low flow oxygen systems do not need to be humidified. Bubble-through humidifiers are largely ineffective in delivering humidity and should be avoided as they may increase the risk of infectious airborne particles. Large volume nebulizers also generate aerosols and should be avoided if at all possible on patients who have low oxygen requirements.

For patients with high oxygen requirements ($FiO_2 > 0.40$), a FLO_2Max® mask (**see figure 1**) with a good seal around the face is ideal for oxygen delivery. It does not require nebulized gas, protects staff from expired droplets (e.g. cough or sneeze), and filters most of the exhalate if the mask fits well. Blended gas can be used for patients with specific FiO_2 requirements. However, this may not be ideal for long-term use as many of these patients require humidification. This mask may also be used for patient transport outside room (i.e. a patient would not require an additional surgical mask overtop).

Figure 1 **FLO_2Max Isolation Oxygen Therapy Mask**

The Oxymask™ (**see figure 2**) can also be considered for use with high oxygen requirements as it does not use nebulization. However, this mask has large ports and does not provide a baffle for expired droplets (e.g. cough or sneeze) or filter patient exhalate. It is therefore not recommended for use in transport for these patients. It does utilize atmospheric air entrainment, therefore may provide some ambient humidity for patients.

Figure 2 Oxymask™

Non-ventilated patients with tracheostomy or endotracheal tubes frequently require humidified oxygen or air. Generally, this is delivered with a large-volume nebulizer system, which could increase the risk of creating infectious airborne particles. Tracheostomy masks or T-pieces with large volume nebulizers for humidity should be avoided. Instead, use a heat moisture exchanger with appropriately rated incorporated filter (HMEF) to filter the expired air (**see figure 3**). By using an HMEF, much of the patient's expired moisture is retained, and the need for humidified gas is reduced, therefore a dry nebulizer can be used to provide oxygen (see figure 3). HMEF's must be changed frequently and these patients need to be watched closely to ensure that the filters do not become plugged with secretions.

Figure 3 **Dry Nebulizer with T-piece, HMEF, flextube and inline suction catheter**

High flow humidified oxygen should not be delivered via large-volume nebulizer and open aerosol face mask, as the nebulized gas can carry bacteria and viruses in expired aerosolized particles. A better alternative would be to deliver humidity and oxygen with a heated humidifier system (e.g. Fisher-Paykel Optiflow System, **see figure 4**). The heated humidifier systems provide humidity with vapour, which do not easily carry bacteria and viruses. The circuit used would ideally be a disposable single limb with internal heater wire, to prevent condensate from forming in the circuit (which could lead to infectious droplets). It is important to ensure humidifier settings and room temperature settings are set optimally so as not to lead to condensate within the circuit. Consultation with the clinical product specialist for these systems may be helpful. Patient interfaces used with these systems include: nasal prongs, nasal pillows, tracheostomy interfaces and face masks. Patients could wear a surgical mask if they are using nasal interfaces to protect staff against expired droplets (e.g. cough or sneeze). **NOTE**:

The heated humidifier systems have high gas flows, and therefore could lead to propelling of expired gases with high velocity into the room.

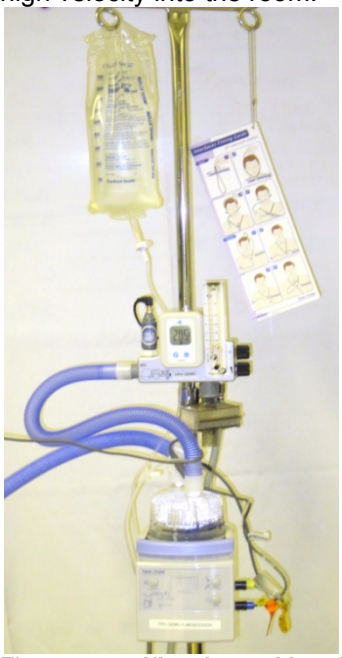

Figure 4 **Optiflow heated humidity blended gas system**

Summary: Oxygen Therapy Delivery Systems and Humidification

	Recommended	Not Recommended
Spontaneously breathing patient, no artificial airway, FiO_2 requirements <0.40	A. Simple oxygen face mask B. Oxymask™ C. Nasal prongs, no bubble humidifier	Large volume nebulizer with sterile water
Spontaneously breathing patient, no artificial airway, FiO_2 requirements >0.40	A. FLO_2Max® mask B. Optiflow humidification system with blender or entrainment device C. Oxymask™	Large volume nebulizer with sterile water
Spontaneously breathing patient, tracheostomy or endotracheal tube, FiO_2 requirements 0.21-1.00	A. HMEF with inline suction catheter, T-piece and **dry/empty** large volume nebulizer B. Optiflow heated humidification system with blender or entrainment device	Large volume nebulizer with sterile water

Section B. **Respiratory Medication Delivery Systems**

Avoid the use of small-volume nebulizers for medication administration whenever possible to avoid generating aerosolized particles. If bronchodilators are required, metered dose inhalers (MDI) (see **figure 5**, **figure 6**) are preferable.

Examples of Metered Dose Inhaler Delivery Systems

Figure 5 **MDI with spacer and mouthpiece**

Figure 6 **MDI with spacer and mask**

If this mode of delivery is not feasible for the patient and nebulization must be used (e.g. decreased level of consciousness or if the patient has difficulty coordinating the optimal breathing pattern), then a breath-actuated nebulizer (**see figure 8**) with minimal emissions or a closed aerosol delivery system with a reservoir and appropriate filter (**see figure 7**, **figure 9**) should be used. Non-vented masks are preferable.

Examples of Closed Aerosol or Breath Actuated Delivery Systems

Figure 7 **Circulaire® with VixOne™ nebulizer and expiratory filter**

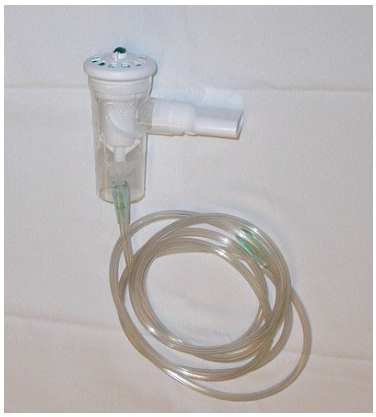

Figure 8 **AeroEclipse® II breath-actuated nebulizer**

Figure 9 **Circulaire® with VixOne™ nebulizer and expiratory filter for use with tracheostomy patients**

Summary: Respiratory Medication Delivery Systems

	Recommended	Not Recommended
Respiratory medication required	A. MDI with spacer and mouthpiece or mask B. Closed, filtered aerosol delivery system C. Breath-actuated nebulizer	A. Small volume nebulizer

Section C. **Noninvasive Ventilation**

On single limb noninvasive ventilation circuits using typical machines, all exhaled gases and corresponding droplet nuclei are vented out a small orifice either on the breathing circuit or on the mask itself. Caution must be taken due to the risk of propelling infectious airborne particles at high velocities. Options for filtration are available, such as the Philips Respironics™ circuit with expiratory port filter (**see figure 10**), which would need to be used with a closed (non-ported) face mask.

Figure 10 **Philips Respironics™ circuit with expiratory port filter**
*photo used with permission

An alternative would be to use a closed (non-ported) face mask and a mechanical ventilator (**see figure 11**) with an appropriate expiratory filter capable of delivering a non-invasive mode of ventilation with adequate leak compensation settings. A disposable dual-limb circuit would be used so that all expiratory gases can be filtered through the expiratory limb and filter of the ventilator.

In both options, there is always risk of exposure from leaks around the sides of the face mask; therefore these options do not preclude the use of personal protective equipment.

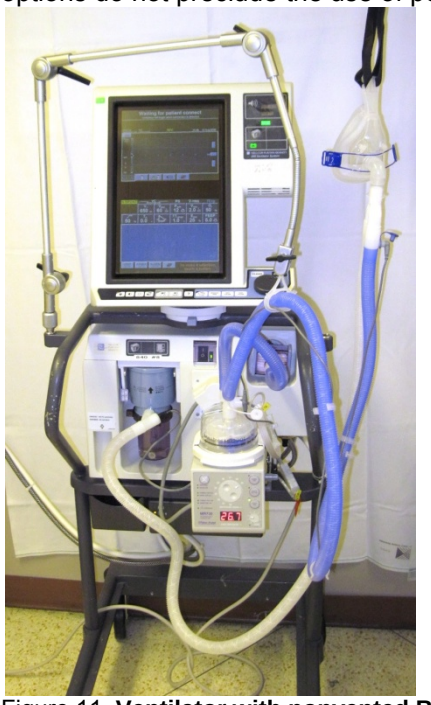

Figure 11 **Ventilator with nonvented Bipap mask and heated humidified circuit on NIV mode**

Summary: Noninvasive Ventilation

	Recommended	Not Recommended
Noninvasive Ventilation required	A. Mechanical ventilator in noninvasive mode with non-ported mask, disposable circuit and heated expiratory filter B. Philips Respironics™ noninvasive patient circuit with expiratory port filter B. Early intubation as applicable	A. Bipap or CPAP without filtration

Section D. **Invasive Ventilation**

Patients who are invasively ventilated (i.e. with tracheostomy or endotracheal tube) should ideally have a disposable dual-limb circuit with heated humidifier, heater wires within both the inspiratory/expiratory lines to prevent condensate, and an appropriately rated heated expiratory filter. Mechanical ventilation creates high gas flows, therefore use of a cuffed tracheostomy or endotracheal tube is optimal to prevent expired gases from being propelled into the room. Uncuffed tubes or Laryngeal Mask Airways are less optimal for this reason. Tracheal cuff pressures should be checked frequently and kept inflated at pressures of 25-30 cmH_20 to create a good seal against the tracheal wall. Mechanical ventilators that have an internal, appropriately rated heated expiratory filter are ideal (see **figure 13**). Others can have an external heated appropriately rated expiratory filter added to the circuit (e.g. VADI®, see **figure 12**).

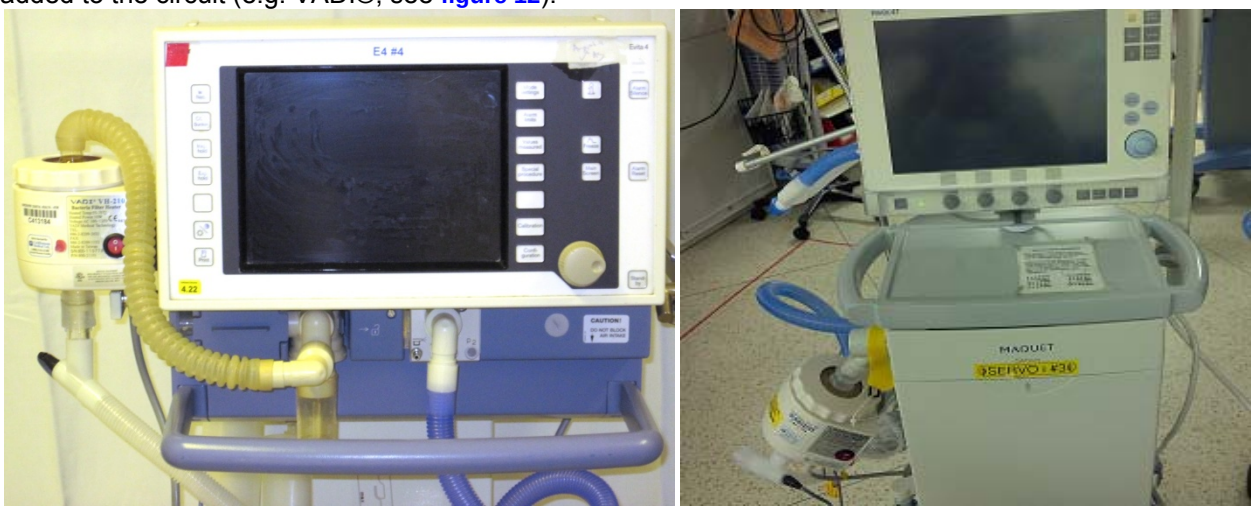

Figure 12 **Ventilators with VADI® external heated expiratory filter**

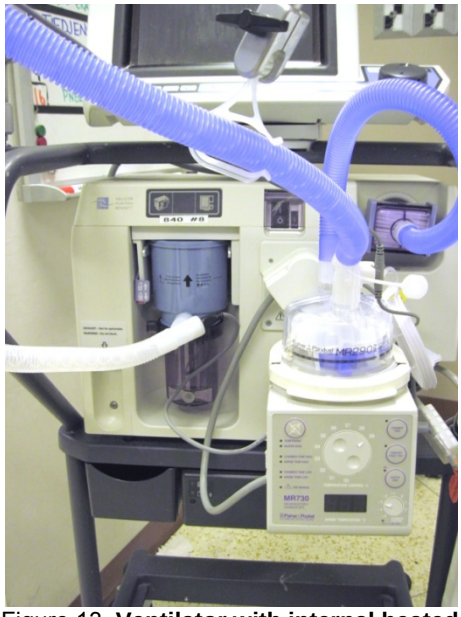

Figure 13 **Ventilator with internal heated expiratory filter**

Another option to provide expiratory filtration and humidification is to use a Heat Moisture Exchanger with Filter (HMEF, see **figure 14**). Care should be taken to ensure the product you are using has the filter included (some products are HME only). However, these filters need to be changed frequently as they become saturated with moisture or secretions and create resistance to flow. It is important for staff to note that each HMEF change results in a patient circuit disconnection and a short period of time when expired airborne particles are not filtered.

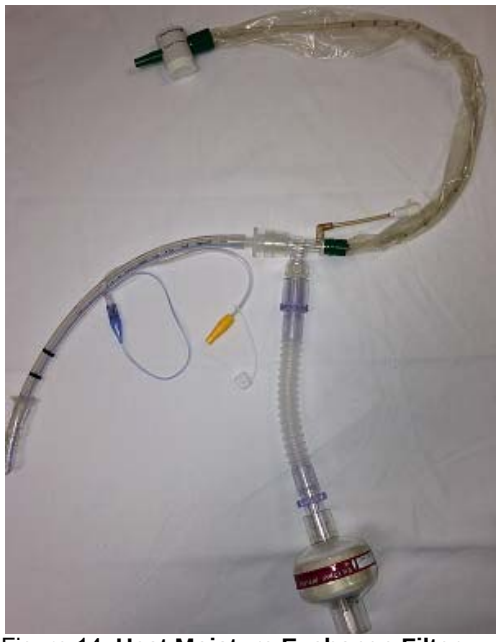

Figure 14 **Heat Moisture Exchange Filter**

Disposable ventilator circuits should be used whenever possible. Circuit changes should be avoided and changed only when clinically indicated; most manufacturers recommend changing the circuits once every 7 days, and some circuits are safe to use for a longer period of time.

Summary: Invasive Ventilation

Item	Recommended (best option)	Acceptable	Not Recommended
Artificial airway	A. Cuffed tracheostomy tube or endotracheal tube with subglottic suction port B. Cuff pressures maintained 25-30 cmH20	A. Cuffed tracheostomy or endotracheal tube without subglottic suction port B. Cuff pressures inflated to minimal occluding volume	A. Cuffless tracheostomy or endotracheal tubes B. Laryngeal mask
Ventilator circuit	A. Disposable, dual-limb circuit with heated humidifier and insp/exp limb heater wires B. Circuit changes > 7 days	A. Circuit changes at 7 days	A. Nondisposable circuits, nonheated expiratory limb B. Circuit changes < 7 days
Filtration	A. Heated internal expiratory filter	A. Externally applied heated expiratory filter (e.g. VADI®)	A. No filtration

		B. Heat moisture exchange filter (HMEF)	

Section E. **High Frequency Oscillatory Ventilation**

High frequency oscillators should be used with extreme caution due to the risk of propelling infectious airborne particles at high velocity, caused by the rapidly moving piston. Newer circuits for the Sensormedics 3100B oscillator include expiratory filters; however, these are not heated and would need to be changed frequently, necessitating frequent circuit disconnection (resulting in an increased risk of Ventilator Associated Pneumonia), would result in lung de-recruitment (lung recruitment maneuvers must be performed after each disconnect), and increase the number of staff exposures to airborne gases.

Modifications to the oscillator circuit are possible to incorporate the use of an added external heated expiratory (VADI®) filter (see **figure 15**). A heated filter results in less water saturation and therefore does not need to be changed periodically. This circuit modification requires some further manipulations to support the use of this filter (regarding bracket support, tube kinking, etc) and these specific instructions are included as an addendum to this document.

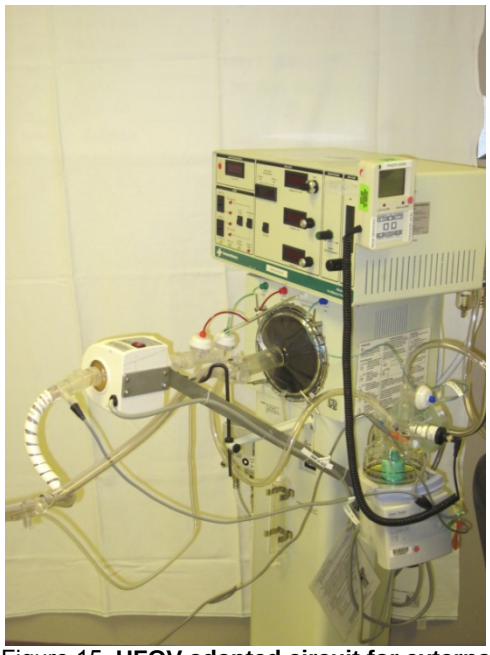

Figure 15 **HFOV adapted circuit for external heated expiratory filter**

NOTE: Contact VGH Respiratory Services for recommendations on circuit modifications for use of a high frequency oscillator with external heated expiratory filter.

Summary: High Frequency Oscillatory Ventilation

	Recommended (best option)	Acceptable	Not Recommended
HFO circuit	A. Heated external expiratory filter with circuit modifications (e.g. VADI®)	A. Nonheated expiratory filters	A. Standard circuit without filtration

Section F. **Manual Ventilation Units**

Manual Ventilation Units (MVUs) should ideally be disposable and have an appropriately rated HMEF attached (see **figure 16**). An added feature of the MVU shown is the multi-directional exhaust port, which may be adjusted to direct exhaust away from the care provider.

Figure 16 **MVU with HMEF**

Summary: Manual Ventilation Units

	Recommended	**Not Recommended**
MVU	A. MVU with HMEF	A. MVU without HMEF

Section G. **Tracheal Suctioning**

Inline (closed) tracheal suction systems (see **figure 17**) should be used whenever possible to avoid disconnecting the ventilator circuit during the suctioning procedure. They should be changed only when clinically indicated to avoid repeated disconnection of the ventilator circuit. These systems can also be used with non-ventilated patients (i.e. endotracheal tubes or tracheostomy tubes), but should be changed Q24 hours if they are used in an open circuit to prevent colonization (see **figure 3**).

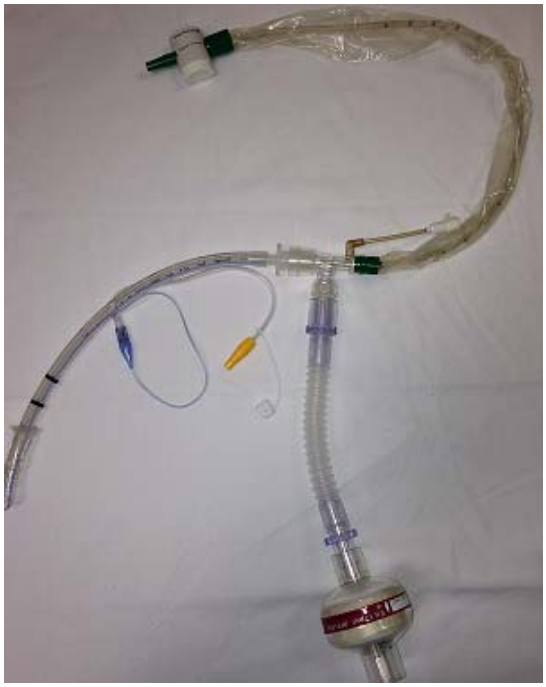

Figure 17 **Closed inline suction catheter**

Summary: Tracheal Suctioning

	Recommended	**Not Recommended**
Tracheal Suction Catheters	A. Closed (inline) suction catheters	A. Circuit disconnection and manual tracheal suction procedure with disposable suction catheters

Section H. **Patient Transport**

Transporting patients on airborne precautions presents an added risk to staff, visitors and patients. The FLO_2Max® mask (see **figure 1**) can be used for spontaneously breathing patients requiring oxygen. Humidity is not generally necessary for short transports, and these masks can be disposed of after use. Patients with tracheostomy or endotracheal tubes can be attached to an MVU with HMEF(see **figure 16**), even if they require no ventilatory support. Transport ventilators should also be used with an HMEF. Infants should be transported in closed incubator systems.

Summary: Patient Transport

	Recommended	**Not Recommended**
Patient transport	A. Manual ventilation unit or transport ventilator with Heat Moisture Exchange Filter B. FLO_2Max® mask	A. Open oxygen systems without filtration or large volume nebulizers

Section I. **Therapy and Diagnostic Procedures**

Percussive therapy and assist cough procedures should be avoided unless patient is ventilated with closed filtered circuit. Patients without artificial airways should wear a surgical mask to protect staff from high velocity expired droplets during procedure. **NOTE:** Accidental ventilator circuit disconnections are common during chest physiotherapy procedures. All clinicians involved should be wearing appropriate PPE and N95 masks.

Sputum induction procedures involving aerosolized saline should be avoided as a means of obtaining respiratory samples for culture and sensitivity. Nasopharyngeal swabs for influenza should be performed with the patient wearing a mask over their mouth during the procedure, and paired with a tracheal aspirate if patient has one insitu. Specimen containers should be wiped down with a virucidal agent prior to placement in a biohazard bag or container for transport.

Bronchoscopy should be performed in a negative pressure room using appropriate PPE. If bronchoscopy is performed away from the bedside (e.g. procedure room), adequate time for air recirculation must occur prior to the start of the next case (9 air exchanges/hr – wait 30 minutes; 12-15 air exchanges/hour – wait 20 minutes) per Health Canada Guidelines.

Complete pulmonary function testing should not be performed. However, routine spirometry may be performed using an appropriate viral filter. For patients who need peak expiratory flowrates only, a disposable peak flowmeter (see **figure 17**) should be used.

Figure 18 **Disposable peak flowmeter**

Summary: Therapy and Diagnostic Procedures

	Recommended	**Not Recommended**
Chest physiotherapy (i.e. Assist Cough using manual technique or assistive devices, percussive techniques or devices)	A. Therapy utilized with closed filtered ventilator circuit or patient wearing a N95 mask if no artificial airway	A. No filtration during procedure
Sputum Collection	A. For influenza: nasopharyngeal swab performed with patient surgical mask overtop, paired with a tracheal aspirate through an artificial airway	A. Sputum induction with use of aerosolized saline nebulizer
Bronchoscopy	A. Use with caution in negative pressure room	
Pulmonary Function testing	A. Routine spirometry with appropriate filter B. Disposable peak flowmeter	A. Complete pulmonary function testing or use of equipment without adequate filtration