OHTAC Recommendation

Air Cleaning Technologies

November 16, 2005

OHTAC Ontario Health Technology Advisory Committee

Ontario

Air Cleaning Technologies

On November 16, 2005, The Ontario Health Technology Advisory Committee (OHTAC) met to review the findings of the Health Technology Policy Assessment (HTPA) completed by the Medical Advisory Secretariat (MAS) evaluating the use of air cleaning technologies in the control of infectious diseases in Ontario Health Care facilities.

This HTPA was completed upon request of three separate applicants: The Ontario Expert Panel on SARS and Infectious Disease Control, the Emergency Management Unit of the Ministry of Health and Long-term Care (MOHLTC) and Mount Sinai Hospital.

Background

Infection control is achieved by a combination of administrative, engineering, and personal protection control measures. Administrative controls try to reduce the risk of exposure to infectious diseases through institutional policy development and surveillance practices, engineering controls by reducing the concentration of infectious particles (germs) in the air and personal respiratory protection controls by the use of mask, gown and gloving techniques. These control measures are not mutually exclusive but rather each is an essential and necessary component of a comprehensive infection control program in any health care facility. Air cleaning is a type of engineering infection control measure.

Certain infectious diseases such as tuberculosis, measles, chickenpox, and disseminated herpes zoster are transmitted from person to person by very small particles called droplet nuclei that can remain in the air for long periods of time, travel with air currents over large distances and can be inhaled into the lungs. This is called *airborne transmission*. However, diseases such as influenza and severe acute respiratory syndrome (SARS) are transmitted from person to person primarily by large particles called droplets that fall out of the air to surfaces very quickly. Because of this, these infectious diseases are transmitted primarily by direct contact with an infected person or indirect contact with contaminated surfaces. Direct contact means being approximately 3 feet from the infectious person to incur an exposure risk. Air cleaning is an engineering infection control method used to prevent the spread of airborne diseases whereas surface

disinfection such as handwashing will help prevent the spread of non-airborne diseases.

In some cases, as with new emerging infectious disease the route of transmission initially may not be known. Such was the case with severe acute respiratory syndrome (SARS). In these situations, it is prudent to suspect there is airborne transmission until otherwise proven.

Airborne transmission of infectious diseases depends in part on the concentration of breathable infectious particles in room air and risk of illness may increase as the concentration of infectious particles increases. Engineering infection control measures are used to reduce the concentration and prevent the spread of these particles throughout a building in order to decrease exposure to and risk of illness from infectious pathogens.

General ventilation is the main engineering infection control measure, which is carried out by the heating ventilation and air conditioning (HVAC) system of a building. Ventilation is the process of bringing clean air into a room and removing or exhausting contaminated air out. Bringing clean air into a room will dilute and reduce the concentration of infectious particles in room air. This is called dilution ventilation. Exhausting the contaminated air to the outside of the building will remove the infectious particles from the room. This is called exhaust ventilation. By exhausting more contaminated air out of a room than enters, a negative pressure room can be created which will prevent contaminated air from leaking out of the room.

There are national and international guidelines for adequate HVAC ventilation rates in health care facilities and which vary depending on the specific area of the facility (eg. morgue, ICU, bronchoscopy room). However, if the HVAC system is unable to provide adequate ventilation rates as set out in these guidelines and/or if after an infection control risk assessment more negative pressure rooms are needed in a hospital, then the HVAC system must undergo costly renovations to meet these demands. As an alternative to renovating the HVAC system an in-room

air cleaner may be used to improve room ventilation rates or to convert a standard (non-pressurized) hospital room into a negative pressure room.

In-room air cleaners are supplied as portable or fixed devices and come in various shapes and sizes. Unlike the HVAC system, which brings clean air into and removes contaminated air from a room, an in-room air cleaner is a re-circulating air cleaning system, which works by filtering contaminated room air through a High Efficiency Particulate Air (HEPA) filter and then re-circulates the cleaned (filtered) air back into the room. Some in-room air cleaners also use Ultraviolet Germicidal Irradiation (UVGI) lights as well as HEPA filters and some use only HEPA filters to clean contaminated air.

The size of the room will determine the size of the in-room air cleaner required. In general, larger in room air cleaners can clean and exhaust more room air and therefore will be better for large rooms.

The effectiveness of in-room air cleaners to reduce the number of infectious particles in room air varies widely. Variability is due to several factors including where the in-room cleaner is placed in the room, the volume of air that flows through the device (air flow rate), the air mixing patterns in the room and the type of filter used in the cleaner. Because of this, guidance documents from the U. S. Centers for Disease Control (CDC) while recognizing that in-room air cleaners may be used as supplemental air cleaning methods, also recognize they are inferior to the HVAC system and if required are best used in a fixed room position instead of as a portable device so as to maximize effectiveness. Likewise, to maximize effectiveness it is imperative that consultation with the building's ventilation engineer and infection control practitioner be undertaken before they are used to determine the optimal room placement. Finally, for optimal performance of any air cleaning system regular maintenance and monitoring of the system is mandatory.

As mentioned, some in-room air cleaners use HEPA filters and some use a combination of UVGI lights and HEPA filters. After completing a systematic review of the published literature, the benefits of using an in-

room air cleaner with combined UVGI lights and HEPA filtration instead of that which uses HEPA filtration only was uncertain.

In situations where the route of transmission of an infectious disease is unknown but suspected to be airborne, and surge capacity (more negative pressure rooms, increased room ventilation rates) is needed it may be prudent to use an in-room air cleaner as a portable device and as a temporary solution to reduce the risk of exposure.

Currently, there are approximately 310 in room air cleaners in health care facilities around Ontario, which are used in a variety of service areas including clinic and emergency waiting rooms and intensive care units to increase room ventilation rates as well as to create negative pressure rooms.

The cost of an in-room air cleaner varies between manufacturer and or distributor, the size of the device and the type of air cleaning technology in the device. On average, units that can clean large room volumes and those with combined UVGI lights and HEPA filtration will be more expensive than smaller devices and those with HEPA filtration only. Devices that can service a room up to 2000 cubic feet and that have combined UVGI lights and HEPA filtration may cost between $3,000 and $8500 (CDN). Similarly, for the same room size devices, devices that use only HEPA filtration can cost approximately $3,600.

Additional expenses will include replacement costs for filters and UVGI lights if applicable, maintenance costs for the device (if not undertaken by the facility), disposal costs for used filters and energy usage costs for operating the device. In-room air cleaners that use a combined UVGI and HEPA technology will use more energy than those with HEPA filtration only.

Upon reviewing this evidence the committee concluded that:

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When the HVAC system cannot support or provide adequate ventilation rates for a building as set out in national and international guidance documents and or when an infection control risk assessment determines more negative pressure rooms are required consideration should first be given to renovating the HVAC system. If this is deemed too costly, supplemental ventilation may be obtained from in-room air cleaners used in a fixed and permanent placement. In acute situations where surge capacity is needed because of a suspected airborne infectious disease, in room air cleaners may be used as portable devices and as temporary solutions only for supplemental ventilation and creation of negative pressure rooms.

In all situations, consultation with the building's ventilation engineer and infection control practitioner must be done before in-room air cleaners are used.

For all air cleaning systems, HVAC or in-room air cleaners, regular maintenance and monitoring are required for optimal effectiveness.

OHTAC Recommendations:

In room air cleaners may be used to decrease the concentration of airborne infectious pathogens in a room.

In room air cleaners are unlikely to be of any benefit in the containment of non-airborne transmitted infections diseases such as influenza and SARS as these diseases are primarily transmitted by direct and indirect contact.

In room air cleaners are optimally deployed as fixed and permanent devices and used when the HVAC system cannot meet building ventilation rate requirements as set out in international and national guidance documents or when after an infection control risk assessment an increase in the number of negative pressure rooms is required in the health care facility and these cannot be created by renovating the HVAC system.

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In room air cleaners may be used as portable devices and as a temporary solution for supplemental ventilation and or creation of negative pressure rooms in acute situations where surge capacity is needed to manage the spread of a known or suspected airborne infectious disease. This would include situations in which the mode of spread of the pathogen is not yet determined and airborne transmission cannot be ruled out.

In all situations of use, in-room air cleaners should be deployed only after consultation with a ventilation engineer and an infection control practitioner.

All air cleaning systems in health care facilities should have written protocols for maintenance and monitoring of these systems. Monitoring of air cleaning systems should include assessment of room air flow patterns, air flow rates provided by the HVAC system or through an in-room air cleaner and the pressure differential between the inside and outside of a room designated to be under negative pressure.

There is insufficient evidence at this time regarding any additional benefit of using an in-room air cleaner with combined UVGI lights and HEPA filter air cleaning technology instead of those with HEPA filter technology only.

It is recommended that The University Health Network Human Factors Laboratory undertake the evaluation of the use of in-room air cleaners in hospitals.

These recommendations are made to Ontario hospitals and community services with the relevant expertise. They will be communicated to the hospitals and rehabilitation service providers through their posting on OHTAC's website and the distribution of OHTAC's E-bulletin.