Title: Portable Negative Pressure Isolation Devices

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Context and policy issues:

Negative pressure isolation rooms are used to isolate patients with airborne infections such as tuberculosis \( ^1 \) and are not likely to affect the spread of non-airborne infections such as severe acute respiratory syndrome (SARS) and influenza. \(^2\) A negative pressure isolation room is created by exhausting more air out of a room than enters the room. This prevents contaminated air from spreading into surrounding areas. \(^2\) The heating ventilation and air conditioning (HVAC) system is often used to create a negative pressure isolation room, however; the HVAC system may not be able to provide adequate ventilation rates. Renovating the HVAC system to provide negative pressure rooms can be expensive, and therefore in-room air cleaners may be used to transform a standard room into a negative pressure isolation room. \(^2\) In-room air cleaners can convert a room into a negative pressure isolation room only if the air is exhausted to the outside. Otherwise, these devices only serve to increase room ventilation rates. \(^1\)

Since the replacement of existing older negative pressure isolation rooms with portable units is possible, it is important to determine the ability of portable devices to provide effective isolation.

Research questions:

What is the clinical effectiveness of portable negative pressure isolation devices for providing effective isolation? What are the guidelines for portable negative pressure isolation devices?

Methods:

A limited literature search was conducted on key health technology assessment resources, including PubMed, OVID Embase, CINAHL, The Cochrane Library (Issue 1, 2007), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international HTA agencies, and a focused Internet search. Results include articles published between 2002 and the present, and are limited to English language publications only.
Summary of findings:

Clinical effectiveness of negative pressure isolation rooms

Recommendations from the Ontario Health Technology Advisory Committee (OHTAC) discuss the factors that influence the effectiveness of in-room air cleaners.\(^2\) The location of the in-room air cleaner in the room, the air flow rate, the air mixing patterns in the room and the type of filter can all affect the success of in-room air cleaners to reduce the number of infectious particles in the air.\(^2\)

There were no studies reporting on the clinical effectiveness of negative pressure isolation rooms. A systematic review by the Ontario Ministry of Health and Long-Term Care was conducted in 2005 and investigated the use of air cleaning technology and was not specific for negative pressure isolation rooms.\(^1\) No health technology assessments or high quality evidence was identified, and only one study was included. This study investigated the use of an in-room air cleaner with ultraviolet germicidal irradiation (UVGI) lights and HEPA filtration and examined the effectiveness of the UVGI light. This information is therefore not relevant for the present report.\(^1\)

The New Hampshire Department of Health and Human Services (NH DHHS) conducted a survey of all hospitals regarding isolation rooms and produced a fact sheet.\(^3\) This fact sheet states that portable units are useful because they can be moved to different rooms to provide isolation. In addition, these units can be transferred to other hospitals if necessary. This report also states that portable units are as effective as fixed units for creating an isolation room.\(^3\)

Guidelines for negative pressure isolation rooms

The systematic review conducted by the Ontario Ministry of Health and Long-Term Care discussed the recommendations for use of in-room air cleaners.\(^1\) A pressure differential of at least 0.01 inches of water gauge between the inside and outside of a room is recommended to achieve negative pressure. Monitoring with smoke tubes, manometers or flutter strips is necessary to ensure the air flows in the proper direction. The pressure differential should be monitored daily if the room is occupied for negative pressure.

The US Department of Health and Human Services Centers for Disease Control and Prevention (CDC) has recommendations for infection control.\(^4\) Patients infected with organisms that spread by droplet nuclei require airborne infection isolation (AII) in a negative pressure isolation room. These rooms must have at least 12 air changes per hour (ACH) for a room constructed after 2001, or more than 6 ACH if constructed before 2001. The pressure differential must be 0.01 inches of water gauge (> -2.5 Pascal). Manometers or smoke tubes and flutter strips should be used to monitor direction of air flow, and the air should be exhausted to the outside.\(^4\)

Guidelines for design and testing of isolation rooms for Nordic hospitals was published in 2004.\(^5\) Specific ventilation parameters are discussed, such as the pressure differential between rooms, ventilation supply air volume, ventilation exhaust-supply differential volume, air exchange rate (ACH), planned leakage, unplanned envelop leakage and thermal comfort. Monitoring of the performance of the isolation room is necessary with both permanent monitors and transient testing methods. Permanent monitors include monitors for the maintenance of negative pressure, monitoring for HEPA filter pressure drop (pressure drops across the filter as particles clog the filter over time), and monitoring of ventilation supply and exhaust air volumes. Transient testing methods includes the smoke tube method to determine direction of airflow.
between rooms and airflow pattern within the patient room. The air exchange rate should also be monitored, either by dividing the exhaust rate by the room volume or by measuring tracer release. Air volumes, leakage rate, containment and thermal comfort can also be measure by transient testing methods.\(^5\)

**Limitations**

There was a lack of high quality evidence on portable negative pressure isolation devices. Because only health technology assessments, systematic reviews, meta-analyses as well as guidelines were searched for this report, evidence found in clinical studies would not be included in this report. In addition, due to the nature of the topic, randomized controlled studies are not feasible and therefore none were found that addressed this question. Therefore, there may be evidence contained in other types of studies regarding clinical effectiveness of portable negative pressure isolation rooms. Furthermore, some of the guidelines discussed above are not specific for portable devices. The literature search included only the past five years, and additional studies regarding effectiveness may have been published previous to this date.

**Conclusions and implications for decision or policy making:**

There was limited evidence available on the clinical effectiveness of portable negative pressure isolation devices. The one systematic review that was found on the topic did not have any evidence on effectiveness of these devices. One report from New Hampshire did state that portable negative pressure isolation devices are as useful as fixed negative pressure isolation units for providing isolation.\(^3\)

There is a need for high quality evidence regarding effectiveness of portable negative pressure isolation devices. It remains possible that evidence exists on this topic, but is of a lower quality than what was included for the purposes of this report. It remains unclear whether portable negative pressure isolation devices are useful, and whether they should replace negative pressure isolation rooms.

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