Airborne Precautions in Operating Rooms

A Working Group of subject matter experts including IPC physicians, infection control professionals, TB services, Surgical SCN, operating room managers and educators, Facilities Maintenance and Engineering, and Workplace Health and Safety updated these recommendations. If you have any questions or comments, contact IPC at ipcsurvstdadmin@ahs.ca.

Best practice recommendations

Purpose

1. Reduce the risk of patient and staff **airborne exposure** to communicable diseases in the **operating room (OR) theatre** during surgical procedures.
2. Describe best practice for managing patients who require surgery and have suspected or confirmed infection due to an airborne pathogen.
3. Determine OR accommodation based on site infrastructure and the patient's infectious risk, i.e., case-by-case assessment.
4. Surgery programs may use these recommendations to develop site and/or department-specific plans and processes prior to a patient event in consultation with site Infection Prevention and Control (IPC) teams.

Note: These recommendations are based on current scientific evidence and will be updated as further data becomes available.

Application

Alberta Health Services employees, members of the medical and midwifery staffs, students, volunteers and other persons acting on behalf of Alberta Health Services (including contracted service providers as necessary).

1. General principles

1.1 Routine practices are a standard of care always used for all patients to reduce the risk of infection.

1.2 Additional precautions (airborne, contact, droplet) are the use of extra measures for contact with a patient known or suspected to be infected or colonized with certain microorganisms and based on the potential for transmission of the microorganism. Routine practices continue when additional precautions are in use.

1.3 Airborne precautions are used for communicable disease pathogens transmitted through the air over extended time and distance by small particles and aerosols containing droplet nuclei (including but not limited to pulmonary tuberculosis or measles).

- Some infections, e.g., disseminated shingles/primary varicella need a combination of additional precautions since the causative organism can be transmitted by more than one route.
- OR and perioperative staff must have a current N95 fit test, i.e., within the last 2 years, and know their immune status for vaccine preventable airborne communicable diseases, e.g., measles, varicella.

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1.4 Airborne communicable diseases currently include, but are not limited to:

1.4.1 **Tuberculosis (TB)**

- Potential for transmission is more likely with respiratory disease:
  - pulmonary
  - laryngeal
  - miliary
- Airborne precautions are also required for extra-pulmonary TB if the procedure could aerosolize drainage.

1.4.2 **Rubeola (measles, red measles)**

- Includes exposed and susceptible individuals who are in the incubation period of the disease.

1.4.3 **Varicella-zoster virus**

- Primary varicella (chickenpox) - includes exposed and susceptible individuals who are in the incubation period of the disease
- Disseminated shingles
- Localized shingles in an immunocompromised patient

1.4.4 **Less common diseases**

- Smallpox

1.5 If surgery is required for a patient with a suspected or confirmed airborne communicable disease:

- Refer to the IPC Acute Care Resource Manual – Diseases and Conditions Table.
- Consult an IPC physician, Infectious Diseases (ID) physician and/or Medical Officer of Health (MOH).
- For TB cases consult IPC on-call or TB Services physician on-call or MOH.

2. Clearance time [also referred to as "settle time"]

2.1 Facilities Maintenance and Engineering (FME) must determine air change rates for each theatre. Refer to Figure 1.

2.2 After a patient on airborne precautions has been transferred to the patient care unit, ensure adequate **air clearance/settle time** of at least 99% of airborne particles before the next patient enters the theatre. Healthcare professionals (HCPs) may enter the theatre prior to the completion of the clearance/settle time if a **fit tested N95 respirator** or equivalent is worn. Refer to Figure 1.

Figure 1: Clearance/settle times based on the air change rates provided by FME

The Canadian Tuberculosis Standards - 8th Edition (Chapter 14)	
OR theatre air changes per hour	Minutes required for 99% air clearance
6	46
12	23
15	18
20	14
unknown	120

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3. Facility infrastructure

1.1. OR Theatre Requirements

- There are two over-arching principles to consider:
  - OR theatres are set to positive pressure airflow to minimize the risk of surgical site infection (SSI).
  - Use of OR theatres with negative airflow capability, a minimum of 15 air changes per hour and an **anteroom** minimize the risk of exposures and transmission due to a suspected/confirmed airborne infection; however, switching to negative airflow increases the SSI risk. See Appendix B.
- Ventilation measures are in place to remove contaminated air, which include:
  - Laminar flow diffusers over the patient;
  - Air changes;
  - Mixing of outdoor and recirculated air; and
  - High-efficiency particulate air (HEPA) filtration.
- Refer to Canadian Standards Association (CSA) Z317.2-19. Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in healthcare facilities and Technical Design Requirements for Alberta Infrastructure Facilities for further details.
- Consult with FME regarding infrastructure and Heating Ventilation and Air Conditioning (HVAC).

1.2. Monitoring of pressure differential, alarms, and testing

- FME monitors pressure differential either manually or electronically.
  - If central monitoring systems/building management systems are present, FME may take a trend report on OR request.
  - In some sites, OR theatres have room pressurization built-in sensors to alert staff to deviations from standard recommended range as per CSA standard (local alarm).
- FME sets up differential pressure measurement and air change per hour calculation as part of their annual preventative maintenance program.
  - Preventative maintenance on OR theatres capable of negative pressure are done quarterly and annually.
  - Preventative maintenance on OR theatres not capable of negative pressure is done on an annual basis.
  - FME documents and keeps records of test results.

4. Decision process [see Appendix A]

4.1 Determine whether the surgery is urgently required in consultation with the surgeon, anaesthesiologist and OR manager/designate. Consult with IPC, ID, MOH and/or TB Services as needed.

4.2 Delay elective surgical procedures until airborne precautions are discontinued, i.e., an airborne infection has been ruled out or until the patient is no longer infectious.

4.3 For urgent/emergent surgical procedures, determine if surgery can be performed on-site or if patient transfer is required.

4.4 Sites performing surgery

- An appropriate OR theatre is available as per unit/department process.

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- All staff members assigned to the case, including the anaesthesia team, are notified of the suspected or confirmed diagnosis.
- Scheduling is an operational decision.
  - Consider scheduling as last case of the day.
  - Ensure adequate clearance/settle times regardless of when case scheduled, see Section 4 and Figure 1.

5. Options for proceeding with surgery [see Appendix B]

Options	Actions/Alternatives
1	Do not proceed.
2	Use an OR theatre with an anteroom. Maintain positive pressure air flow.
3	Use an OR theatre with a sub-sterile room or equivalent. Maintain positive pressure air flow
4	Use the most appropriate OR theatre with no sub-sterile room. Maintain positive pressure air flow.
5	Switch OR theatre to negative air flow. [Sub-optimal]

Notes

- For all options: airborne precautions will be in place including use of a fit tested N95 respirator.
- Neutral pressure air flow is not an option. Check with site FM&E regarding the pressure differential and air flow.

6. Pre-operative management

6.1 Intubate the patient in a room that is used for airborne isolation.

6.2 A disposable bacterial/viral filter that provides filtration at > 99 % at 0.3 microns should be placed on the patient's anaesthesia breathing circuit at the endotracheal tube or expiratory side of the circuit.

6.3 Limit staff present to those essential to perform intubation, if possible, i.e., anaesthesiologist and assistant.

6.4 If intubation must occur in the OR theatre, the patient must wear a surgical mask during transport.

- Consider alternate strategies for neonates, infants, toddlers who cannot tolerate a mask, e.g., cuddle position facing towards care provider.
- Staff accompanying patient must wear a fit tested N95 respirator during transport.

6.5 Sites should have a clearly documented process for patient transport.

- Use pre-determined transport routes to minimize exposure for healthcare providers, other patients and visitors.
- A team member or Protective Services member clears the path from the patient care unit to the OR theatre.

6.6 Avoid performing aerosol-generating medical procedures (AGMP) enroute.

6.7 Transport the patient directly into the OR theatre and bypass the holding area.

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7. Peri-operative management

7.1 Post an **airborne precautions** sign on every door into the OR theatre.

7.2 All HCPs in the OR theatre follow airborne precautions. HCPs must wear fit tested N95 respirators.

7.3 The anesthesiologist intubates the patient (may use a videolaryngoscope) and places a bacterial/viral heat and moisture exchange (HME) filter between the endotracheal tube and the Y-piece, i.e., inspiratory limb.

- Use a disposable anaesthesia circuit with a bacterial/viral filter in the expiratory limb to minimize the risk of contaminating anaesthesia equipment.
- If a disposable circuit is not available, change the entire circuit after the surgery is complete and reprocess according to the manufacturer's instructions.

7.4 Strictly control traffic into and out of the OR theatre to ensure adequate air changes are maintained.

- Doors to the OR theatre are kept closed except when moving patients and supplies in or out.
- Carefully plan equipment and supply needs to minimize traffic and air flow disruptions.

8. Post-operative management

8.1 Staff not required for extubation, or post-operative recovery should leave the theatre before extubation and should not re-enter until after air settle/clearance times are completed.

8.2 The patient will be extubated and recovered either in the OR theatre or Post Anaesthesia Care Unit (PACU).

8.3 Extubation in the OR theatre preferred.

- As with intubation, minimal personnel should remain in the theatre.
- Extubate directly to face mask.
- Once airway stable, i.e., no coughing place procedure/surgical mask on patient followed by a simple oxygen mask.
  - Procedure mask, i.e., with ear loops, preferred for patient.
  - If using surgical mask (with ties), tie mask securely to ensure good fit, i.e., no gaps**.**
- A simple oxygen mask can be placed over or under the procedure/surgical mask or if using a nasal cannula, place it under procedure/surgical mask.
- Remove oxygen as soon as patient condition deems it is safe to do so, and place procedure/surgical mask on patient (most often occurs in PACU).

8.4 Recover the patient in the OR theatre unless there is an airborne isolation room in the PACU.

8.5 Patient wears a surgical mask during transport to an airborne isolation room on an inpatient unit.

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8.6 Sites should ensure that they have a clear process for patient transport.

- A team member or Protective Services member clears the path from the OR theatre to the patient care unit.
- Consider alternate strategies for neonates, infants, toddlers who cannot tolerate a mask e.g., cuddle position facing towards care provider.

8.7 After the patient leaves the OR

- Keep the OR theatre door closed to allow airborne particles to clear/settle.
- Follow air clearance/settle times outlined in Section 4, Figure 1.
- Any staff entering room including cleaning staff before air clearance/settle time is completed must wear a fit tested N95 respirator.
- Do not remove the airborne precautions sign until after cleaning done.
- If not the last case of the day; complete air clearance/settle time before the next patient enters the OR theatre.

8.8 Clean room according to OR Theatre Cleaning processes, either between the case, or end of day (as applicable). Environmental Services (ES) policies and practices are available on AHS Insite: Home > Teams > Nutrition Food Linen & Environmental Services > Policy & Practice Documents.

8.9 Send re-usable medical devices to the Medical Device Reprocessing Department as per usual process.

8.10 Use routine practice when handling laundry, garbage and biomedical waste.

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Definitions

Term	Definition
Aerosol-generating medical procedures (AGMP)	Medical procedures that can generate aerosols (solid or liquid particles ranging in size from 10 µm–100 µm suspended in the air) because of artificial manipulation of a person's airway.
Airborne exposure.	May occur if small particles, i.e., aerosols containing droplet nuclei with viable microorganisms are generated, propelled over short or long distances and inhaled.
Airborne isolation room	A room that is designed to maintain negative pressurization relative to adjacent areas; and is constructed and well ventilated to limit the spread of microorganisms from an infected occupant to the surrounding areas of the health care facility.
Air exchange	The ratio of the airflow in volume units per hour to the volume of the space under consideration in identical volume units, usually expressed in air changes per hour (ACH).
Air settle/clearance time	The time needed (in minutes), based on the number of air changes per hour to reduce airborne contaminants in the room by 99% or 99.9%.
Anteroom	A small room or space at the entrance to an airborne isolation room that is separated by doors from both the outside and the main space in the airborne isolation room; allows for storage and removal of PPE and provides an airlock between adjacent space and patient.
Bacterial/viral filter.	A filter that provides filtration at > 99 % at 0.3 microns. Use of the filter in the inspiratory limb between the endotracheal tube and ventilator circuit of the breathing circuit protects the patient from the anaesthesia machine, and a filter in the expiratory limb protects the anaesthesia machine from the patient.
Fit tested	The use of a qualitative or quantitative method to evaluate the fit of a specific make, model and size of respirator on an individual.
High-efficiency particulate air (HEPA) filtration	Achieved using a high-efficiency particulate air filter to remove ≥99.97% of particles 0.3 µm in size. The filter can be either portable or stationary.
Negative pressure	Special ventilation to create inward directional airflow to the room, relative to the adjacent area. Negative pressure keeps air from flowing out of the room and into adjacent rooms or areas.
N95 respirator	A disposable particulate respirator that is ≥95% efficient at removing 0.3 µm particles (the most penetrating particle size) and is not resistant to oil.
Operating Room (OR) theatre	A restricted room within a surgical suite designated and equipped for the purposes for performing a surgical operation.
Pressure differential	A measurable difference in air pressure that creates a directional airflow between adjacent compartmentalized spaces. (Refer to Appendix B) Positive and negative pressures refer to a pressure differential between two adjacent air spaces. Air flows away from areas or rooms with positive pressure (pressurized), while air flows into areas with negative pressure (depressurized).
Sub-sterile room	A room that may be shared between two or more operating rooms designed to permit entrance in to, and exit out of, the semi-restricted area to the operating room.

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Appendix A: Decision-making process for patients on airborne precautions who requires surgery

1. Is it an urgent/emergent procedure?

- **YES → go to #2**
- **NO →** deemed elective/non-urgent; delay until patient no longer requires airborne precautions, i.e., no longer communicable or airborne infection excluded:

2. Assemble Multidisciplinary Team (MDT)

- Surgery;
- Anaesthesia;
- Operating Room Manager/designate;
- Infection Prevention & Control (IPC);
- Infectious Diseases (ID);
- Zone Medical Officer of Health (MOH)/designate;
- Tuberculosis (TB) Services if patient is suspected or confirmed TB;
- Other clinical services as applicable, e.g., attending physician, Critical Care;
- Facilities Management & Engineering (FME);
- Unit/program/site leadership;
- Others as needed.

2.1 **Discuss**

a) Patient case specifics e.g., clinical presentation, exposure risk factors, type of surgery required, etc.
b) Is patient considered to be communicable?
c) Is patient stable enough for transfer?
d) Can surgery be performed safely at another acute care site?
e) What are current site's capabilities/infrastructure?

2.2 **Based on discussion in #3**

a) Decide whether the patient will be transferred to another site.
b) Determine how airborne precautions will be implemented at site of surgical procedure.

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Appendix B: Options for proceeding with surgery – background Information

Note: Options are listed below in order of preference, i.e., most preferred to least preferred.

Option 1: Delay procedure until patient is not considered communicable for an airborne infection.

Option 2: Use an OR theatre with an anteroom; OR theatre maintains positive air flow.

- Ideal pressure differentials and air flows, as per CSA Z317.2-19 Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in healthcare facilities:
  - OR theatre is positively pressured to the anteroom, i.e., air flows from OR into the anteroom.
  - Corridor is positively pressured to anteroom, i.e., air flows from corridor into anteroom.
  - Anteroom is negatively pressured to OR theatre and corridor with air being discharged to the outside, i.e., air flows into the anteroom and is exhausted outside.
- Anteroom is not to be used for donning and doffing of personal protective equipment (PPE) related to additional precautions because infectious organisms are drawn into the anteroom before being discharged outside.

Limitations

- Most sites (all but one) in the province do not have an OR with an anteroom.
- May not be clinically or practically feasible to transfer patient to a site with an OR theatre with an anteroom.
- Portable anterooms are not a viable option currently.

Option 3: Use an OR theatre with a sub-sterile room or equivalent; OR theatre maintains positive air Flow.

Limitations

- Sub-sterile room HVAC system may not provide adequate pressure differential and/or removal of airborne contaminants.
- Patient will require intubation in a room used for airborne isolation.
- OR theatre door requires seal to maintain setting conditions.
  - Adjacent/connected theatre must be shut down and blocked off.
- OR theatres are not intended to be negative air pressure. Room pressurization controller may need to be bypassed or shut down.
- To use a sub-sterile room as an anteroom, site surgical services, FME and IPC should create a plan about how to use the sub-sterile room/equivalent appropriately.
  - Consult with FME about pressure differential and number of **air exchanges** per hour.
  - This includes a discussion about pressure differentials between the OR theatre, sub-sterile room/equivalent and corridor.
  - Ideal pressure differentials and air flows as per CSA Z317.2-19 requirements (see Option 2).
  - In addition, sub-sterile room being used as anteroom cannot be used for donning and doffing of personal protective equipment (PPE) related to additional precautions (see Option 2).

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Option 4: Use the most appropriate OR theatre with no sub-sterile room.

- This includes a discussion about pressure differentials between the OR theatre and corridor.
- Ideal pressure differentials and air flows are as below.
  - OR theatre air flow remains positive.
  - Air is being discharged to the outside.
    - FME must confirm that air flow from the OR theatre is exhausted directly outside (i.e., not back into corridor).
- OR theatre is not to be used for donning and doffing of PPE related to additional precautions. Don and doff in designated area(s) in corridors.

Limitations

- Patient will require intubation in a room used for airborne isolation.
- OR theatre door requires seal to prevent airborne contaminants from flowing into hallway.
- Site surgical services, FME and IPC should create a plan about how to do this as safely as possible.

Option 5: Switch OR theatre to negative airflow.

Limitations

- OR theatres are not intended to be negative air pressure. Room pressurization controller may need to be bypassed or shut down.
- Negative pressure may compromise the surgical site and contribute to a greater risk of surgical site infection(s).

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