Government of **Western Australia**
Department of **Health**
Public and Aboriginal Health Division

Communicable Disease Control Directorate
Guideline

Microbiological Air Sampling of the Perioperative Environment in Western Australian Healthcare Facilities

Guideline 0003 / December 2024

These guidelines have been released by the Communicable Disease Control Directorate, Public and Aboriginal Health Division, Western Australian Department of Health, to provide consistent and evidence informed advice to agencies involved in the prevention of infections and management of communicable diseases in Western Australia.

ACKNOWLEDGEMENT OF COUNTRY AND PEOPLE

The Communicable Disease Control Directorate at the Department of Health acknowledge the Aboriginal people of the many traditional lands and language groups of Western Australia. We acknowledge the wisdom of Aboriginal Elders both past and present and pay respect to Aboriginal communities of today.

Contents

1. Definitions / Acronyms

Term	Definition
Active Air Sampling	Is conducted using an air sampler device that draws air through the device, directly onto the surface of the testing medium[17].
Air Sampler	A device that draws air through and directly over testing medium to determine air quality. Air Samplers must be clean, maintained, calibrated and used by those trained in doing so[18].
Dust	The suspension of particles of solid materials in air. Can include microorganisms, spores and fungi.
Healthcare Facility	Any facility that delivers healthcare services. Can include inpatient, outpatient and community settings. For example: hospitals, haemodialysis centres, dentistry practices[16].
Healthcare Worker	Any person delivering healthcare services. Can include permanent, contract, students and volunteers[16].
HEPA Filter	A high efficiency particulate air (HEPA) filter is a disposable, extended media, dry type filter in a rigid frame, having a minimum filtration efficiency of 99.97% and designed to remove particles greater than 0.3 microns.[1]
HVAC	Heating, ventilation and air conditioning systems[18].
Laminar airflow	Laminar airflow refers to the delivery of air in a manner that provides uniform, directional, non-turbulent airflow at consistent velocity across the operating zone that does not readily mix or become entrained with other room air until lower velocities are achieved after passing through the operating zone.[2-5]
Minor refurbishment	Type A and B construction activity types as defined by the Australasian Health Care Facility Guidelines (refer Appendix 2).[6]
Major refurbishment	Type C and D construction activity types as defined by the Australasian Health Care Facility Guidelines (refer Appendix 2).[6]
Operating room (OR)	The room in which a surgical procedure is performed, with or without administration of an anaesthetic and there is use of microbiologically controlled air supply.

Operating room - conventional ventilation	Refers to an OR with general turbulent airflow (non-laminar). Air supply is to be delivered via a terminal HEPA filter. Supply airflow is not necessarily restricted to the operating zone but is distributed throughout the operating room. [2-5]
Operating room - ultra clean ventilation	Refers to an OR where a terminal HEPA filter delivers air via organised (laminar) flow, and it is delivered uniformly over the operating zone with minimal entrainment of room air. Proprietary ultra clean ventilation canopies can be provided to deliver this function. [2-5]
Surgical Site Infection (SSI)	An infection that develops as a result of an operative procedure[16].
WA health system entity	• All Health Service Providers as established by an order made under section 32(1)(b) of the *Health Services Act 2016* • Department of Health as an administrative division of the State of Western Australia pursuant to section 35 of the *Public Sector Management Act 1994*. Note: Contracted health entities are not considered WA health system entities.

2. Purpose

The purpose of this Guideline is to describe the procedural requirements for microbiological air sampling in the perioperative environment. This Guideline has relevancy to all healthcare facilities (HCFs) in Western Australian (WA) that have operating rooms (ORs). This guideline can also be applied to hybrid operating theatres and interventional procedure rooms that are HEPA filtered e.g. interventional radiology and cardiac catheterisation/angiography procedure rooms.

3. Introduction / Background

Surgical site infection (SSI) is a major complication following surgery and is associated with increased morbidity and mortality, as well as increased costs[7]. The function of OR ventilation is to prevent airborne microbial contaminants from entering surgical wounds. Under normal circumstances, the main source of airborne microbial contamination is microscopic skin fragments, contaminated with bacteria, shed by healthcare workers (HCWs) in the OR. Another potential source of airborne microorganisms are air supplies that are not properly filtered.[8] Contaminated dust particles dispersed during construction works and renovations can pose an infection risk to patients and staff. Careful planning of construction and renovation works is required to reduce this risk.

There is no national or international consensus on the methods, frequency, types of sampling or acceptable levels of microbial contamination in a functioning OR. However, there is evidence to support microbiological air sampling of ORs as part of the commissioning process of a new facility or following major refurbishment, as an adjunct to

other heating, ventilation and air conditioning (HVAC) quality assurance controls. The purpose of microbiological air sampling is to gauge the efficacy of the HVAC systems, including high-efficiency particulate air (HEPA) filters following installation or after major structural refurbishment.[8-14]

4. Requirements

Each HCF should have a nominated health professional, who is responsible for the coordination and delivery of microbiological air sampling. Air sampling must be performed in collaboration with the infection prevention and control service, the surgical service, and the pathology service. Air sampling should be used in conjunction with other testing processes such as HVAC checking by a qualified engineer, air pressure and air changes per hour checked and verified, and air flow in the OR checked and verified.

Microbiological air sampling, in accordance with the procedural requirements described in Appendix 1 Procedure for Microbiological Air Sampling will be undertaken:

- In conjunction with other testing processes and prior to commissioning or reopening of an OR.
- As part of the commissioning process of new ORs and includes sterile stock storage rooms, designated sterile set-up rooms and central sterile stock rooms that are located within the peri-operative suite.
- Air testing is required following any major structural refurbishment i.e. Type C and D construction activity of an existing OR. Air testing is not required for HEPA filter changes. A risk assessment should be undertaken for minor refurbishment i.e. Type A and B construction activity projects to assess if dust mitigation can be controlled, as microbiological air sampling may still be required [6].
- As part of an investigation into increased SSIs, if during investigation the evidence supports a link to the OR.
- The OR should not be utilised until acceptable results of the air sampling have been confirmed. HCFs need to ensure they have adequate turnaround time and plan accordingly as air sampling results can take between 3-7 days to be finalised.
- There is no evidence to support additional microbiological sampling e.g. passive sampling such as the use of settle plates or collection of environmental surface samples, and therefore this is not recommended.

5. Relevant Legislation

- Nil applicable

6. Guideline Contact

Enquiries relating to this Guideline may be directed to:

Infection Prevention Policy and Surveillance Unit

Directorate: Communicable Disease Control Directorate

Email: ippsu@health.wa.gov.au

7. Document Control

Guideline number	Version	Published	Review Date	Amendments
0003	V.1.	26/11/2021	26/11/2023	Original version
0003	V.2.	13/12/2024	13/12/2027	Updated definitions Updated minor wording Updated Results and Interpretations definitions Updated bibliography

8. Approval

Approved by	Dr Paul Armstrong, Director Communicable Disease Control Directorate, Department of Health
Approval date	13 December 2024

9. Bibliography

1. Australian Standard AS 4260-1997. High efficiency particulate air (HEPA) filters-classification, construction and performance. Standards Australia.

2. NHS Estates. Health Building Note (HBN) 26: Facilities for surgical procedures volume 1. 2004. Department of Health Estates and Facilities.

3. NHS Estates. Health Technical Memorandum (HTM) 03-01: Specialised ventilation for healthcare premises. Part A: design and validation. May 2021. Department of Health Estates and Facilities.

4. NHS Estates. Health Building Note 00-09: Infection control in the built environment. March 2013. Department of Health Estates and Facilities.

5. Western Australian Health Facility Guidelines for Engineering Services 2021. Department of Health Western Australia.

6. Australasian Health Care Facility Guidelines. Part D- Infection Prevention and Control, D-900-Construction and Renovation. Accessed 01/11/2024 from https://healthfacilityguidelines.com.au/part/part-d-infection-prevention-and-control-0

7. Bull A, McGechie D, Richards M, Russo P, Worth L. *Surgical site infection*. In: Cruickshank M, Ferguson J, Australian Commission on Safety and Quality in Health Care, editors. Reducing Harm to Patients from Health Care Associated Infection: The Role of Surveillance. Sydney: Australian Commission on Safety and Quality in Health Care; 2008.

8. Dharan S and Pittet D. *Environmental controls in operating theatres.* Journal of Hospital Infection (2002) 5, 79-84.

9. Hoffman PN, Williams J, Stacey A, Bennett AM, Ridgway GL et al. *Microbiological commissioning and monitoring of operating theatre suites.* Journal of Hospital Infection (2002) 52:1-28.

10. Landrin A, Bissery A, Kac G. *Monitoring air sampling in operating theatres: can particle counting replace microbiological sampling?* Journal of Hospital Infection (2005) 61, 27-29.

11. Pasquarella C, Vitali P, Saccani E, Manotti P, Boccuni C, et al. *Microbial air monitoring in operating theatres: experience at the University Hospital of Parma.* Journal of Hospital Infection (2012) 81, 50-57.

12. Napoli C, Marcotrigiano V, Montagna MT. 2012. *Air sampling procedures to evaluate microbial contamination: a comparison between active and passive methods in operating theatres.* BMC Public Health 12: 594-600.

13. Infection Prevention and Control Team. *Microbiological Air Sampling in Conventional Operating Theatres Standard Operating procedure v1.0.* July 2019.NHS Lothian

14. Sadrizadeh, S., Aganovic, A., Bogdan, A., Wang, C., Afshari, A., Hartmann, A., Croitoru, C., Khan, A., Kriegel, M., Lind, M., Liu, Z., Melikov, A.K., Mo, J., Rotheudt, H., Yao, R., Zhang, Y., Abouali, O., Langvatn, H., Sköldenberg, O., & Cao, G. (2021). A systematic review of operating room ventilation. Journal of building engineering, 40, 102693.

15. Environmental Monitoring for Clean Areas (2020), PathWest, Department of Health Western Australia. Accessed 01/11/2024 from https://pathwesttd.health.wa.gov.au/testdirectory/testdetail.aspx?TestID=2254

16. Australian Commission on Safety and Quality in Health Care. Australian guidelines for the Prevention and Control of Infection in Healthcare (2019). Canberra: National Health and Medical research Council.

17. Infection Control Principles for the Management of Construction, Renovation, Repairs and Maintenance within Health Care Facilities (2nd Ed). Department of Health Victoria.

18. Centers for Disease Control and Prevention. Guidelines for Environmental Infection Control in Health-Care Facilities. 2019. Accessed 01/11/2024 https://www.cdc.gov/infection-control/media/pdfs/Guideline-Environmental-H.pdf

10. Appendices

Appendix 1 Procedure for Microbiological Air Sampling

The parameters used in this Guideline are based on current available evidence. It should be noted that there are no internationally agreed standards for microbiological air quality monitoring.

1. **Planning**

- HCFs need to identify a National Association of Testing Authority (NATA) accredited laboratory for environmental testing and establish timelines for sample collection, processing and provision of results with that laboratory.

- HCFs must ensure adequate time is allowed for processing of results and the possible need for re-cleaning and re-testing prior to utilisation of the OR if results are outside acceptable parameters.

- Staff performing microbiological air sampling are to be trained in the use of the specific air sampler being used and the procedure for air sampling and transport of samples to the laboratory.

- The air sampler shall be checked to ensure it has been calibrated and serviced according to manufacturer's instructions. The outside of the air sampler must be cleaned prior to entering the OR.

- The OR shall be empty of all non-fixed items, including supplies, sterile stock and any mobile equipment.

- Dust mitigation/control strategies must be used during construction and renovation works to reduce dust contamination and migration. For example, use of drop sheets, hoarding/barriers, sticky/wet mats, frequently cleaning or vacuuming (with a vacuum fitted with a HEPA filter), wet moping as necessary, covering building materials and wastes to remove them from the OR area and from the site.

- Air sampling can be affected by movement in the area and adjacent rooms. No entry to the OR or adjacent rooms is permitted during the sampling.

- No microbiological air sampling is to be conducted until:
    - all building and construction works have been completed and all materials and waste removed from the OR and adjacent areas
    - all HVAC commissioning procedures have been completed for new builds. Following a renovation, the HVAC has been checked and verified as working correctly by a HVAC qualified engineer
    - all the ducting and air diffuser plates have been cleaned
    - the OR being sampled has been thoroughly cleaned by staff trained and deemed competent to do so, including ceiling spaces, service cavities,

ventilation grills, all horizontal and vertical surfaces including ceilings and walls, and any fixed equipment in the OR.
    - Note: a second clean of all horizontal and vertical surfaces within the OR is recommended to ensure any contamination is removed
    - the HVAC system has been running continuously on normal flow rates, for 24 hours following completion of all building and construction. Cleaning can be performed during this period.

2. Sampling Specifications

- Active air sampling is the required method for microbiological air sampling for commissioning of ORs or following construction and renovation works.
- The sampling site will depend on the type of OR.
- For conventional ventilated ORs, the air sampler is to be placed in the middle of the OR, or secured on a trolley where the OR table is usually located. Two samples are required.
- For ultra clean ventilated ORs (laminar airflow), sample points include;[18]
    - one at each corner of the unidirectional airflow zone perimeter
    - halfway along each side of the perimeter
    - one at each corner of the inner zone
    - one in the centre.
- The size of the sample must be 1,000 litres (1m3) collected from each air sampler location.
- The type of sampler used should be capable of sampling the volume of air without causing excessive drying of the recipient agar surface.
- Agar plates should be at room temperature prior to sampling.

3. Procedure

- The air sampler shall be cleaned prior to use and run briefly prior to loading the agar strips/plates to blow any contamination out of the sampler.

- The OR being sampled, and any area that is adjacent to or feeds air into the OR e.g. preparation room, sterile stock store), shall be left vacant with closed doors for a minimum of 15 minutes, but preferably one hour, before sampling proceeds, to avoid false-positive results due to any recent OR activity e.g. cleaning.

- Staff performing the air sampling shall wear theatre attire, a hair cover, surgical mask and don sterile gloves after performing hand hygiene. Note: clothing is to be supplied by the HCF when external contractors are used.

- Using aseptic technique, proceed with setting up and placing the agar strips or plate into the sampler as per manufacturer's instructions.

- For conventional ventilated ORs, place the air sampler in the middle of the OR table or secured on a trolley where the OR table is usually located.

- When sampling ORs with laminar flow the air sampler should be operated by remote control or a delayed start timer, from outside the uni-directional flow canopy to avoid compromising air quality.

- The OR doors must be kept closed and the OR empty of personnel until sampling is complete.

- Once air sampling is complete, aseptically remove the agar strip or plate, package to avoid contamination and label specific details including hospital name, OR number, volume of air sampled, date and time and transport to laboratory in a timely manner.

4. Results and Interpretation

- Preliminary results are generally not available until at least 48 hours after air sampling is completed. Results obtained at 24 hours may be misleading as many organisms will not grow visible colonies within this time frame.

- The acceptable level of colony forming units (CFUs) for the purpose of this operational directive is the same for all types of ORs.

- Aerobic cultures on non-selective media should not exceed 10 bacterial and 1 fungal CFUs per cubic metre (m^3) of air sampled. (Acceptable results: ≤10 cfu/m^3 bacteria and ≤1 cfu/m^3 fungal spores, including *Aspergillus* spp.).

- If results received are outside of these limits, the OR should not be used. The results need to be discussed with a clinical microbiologist, infection prevention and control and surgical services personnel to initiate an appropriate course of action. The cleaning of the environment (check for dust, fibres, fans, ventilation ducts/grills, ceiling voids and adjacent areas), sampling process, engineering systems such as filters and air change rates should be reviewed.

- Prior to retesting, repeat terminal cleaning must be performed.

- If repeat testing produces results above acceptable levels the HVAC systems should be reviewed by the appropriate personnel.

Appendix 2 Definitions of the Construction Activity Types [6]

Type A Inspections and general upkeep activities	Type B Small scale, short duration activities, which create minimal dust	Type C Any work that generates a moderate to high level of dust	Type D Major demolition and construction projects
Includes but not limited to: removal of ceiling tiles for visual inspection (limited to 1 tile per $5m^2$; painting (but not sanding); installation of wall covering; electrical trim work; minor plumbing; any activities that do not generate dust or require cutting into walls or access to ceiling other than for visual inspection.	Includes, but is not limited to, installation of telephone and computer cabling, access to chase spaces, cutting into walls or ceilings where the dust migration can be controlled.	Includes, but is not limited to, demolition or removal of built-in building components or assemblies, sanding of wall painting or wall covering, removal of floor covering/ wallpaper, ceiling tiles and casework, new wall construction, minor ductwork or electrical work above ceiling, major cabling activities.	Includes, but is not limited to, heavy demolition, removal of a complete ceiling system and new construction.

This document can be made available in alternative formats on request for a person with disability.