INFECTION CONTROL MONITORING IN RENOVATION AND CONSTRUCTION

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Monitoring

- During construction
  - Audits to check compliance to IC measures
- After completion
  - Commissioning to check for compliance to specifications

Objectives of monitoring during construction

- Control dust generation
- Prevent dust from infiltrating occupied (or completed) areas
- Prevent generation of aerosols from contaminating water sources
- Prevent mold and bacteria growth
- Prevent dust infiltration into HVAC systems
- Maintaining ambient interior temperature and humidity controls and controlling or preventing dust and debris build up, a future source of nutrients for spores and bacteria is minimized.
- Turn-over of the completed facility would be sooner, with less need to address final deficiencies, such as, re-cleaning duct work, or addressing expansion or shrinkage of sensitive finish material installations.

During construction monitoring: safety measures

- Signage
- Entry and exit paths
- Dust containment
- Housekeeping
- Water sampling or air sampling indicated if there is suspicion of an associated outbreak or outbreak is identified

Audit checks

- Keeping construction area clean
  - Suppressing dust with wetting agents
  - Cleaning up immediately after activities producing high dust
  - Keeping duct ends sealed with plastic to reduce dust filtration into mechanical system when not in use
  - Intact hoardings
  - Construction waste is bagged and transported in covered carts

- Frequency of audits to be planned
  - Create a checklist

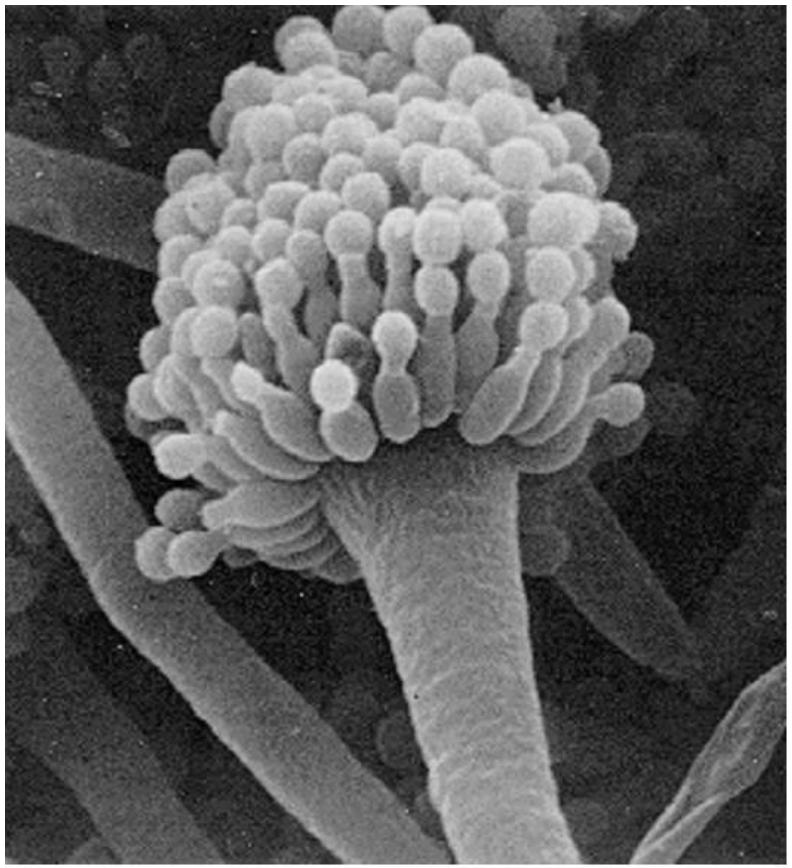

WORKS IN PROGRESS

ROLE OF AIR MONITORING FOR FUNGUS

Why monitor fungi?

- Root cause of hospital-acquired Aspergillosis
  - via unfiltered air and environmental contamination during construction and renovation
- Aspergillosis is a major opportunist infection in immunocompromised patients
- Air concentration of fungal spores and exposure duration affect patients' risks

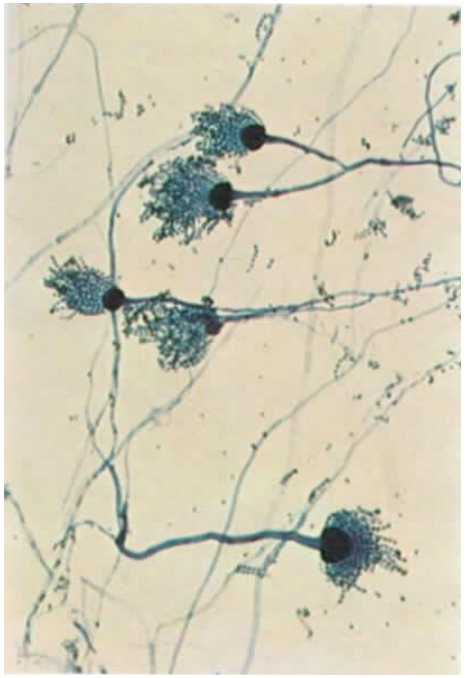
Aspergillus fumigatus



- Most common cause of invasive and non-invasive Aspergillosis
- Causes >50% of invasive Aspergillosis
- Capable of growth up to 55^0C (131^0F)

VanCutsem, et. al. 1984

Construction-related nosocomial infections: *Aspergillus* sp



Fungal counts

Vary depending on:

- Activity levels
- Fluctuations in temperature
- Fluctuations in humidity
- Fluctuations in air flow
- Changes in light level

General guide

Area	Counts/m^3
Outdoor	100 – 105 cfu
No air filtration	5 conidia
HEPA filtered air	<0.1 cfu

Total > 1cfu/m^3 needs attention

Look out for trend

Indications for sampling

- To monitor levels of contamination prior to occupancy of special controlled environments e.g. to determine efficiency of HEPA filters in laminar flow facilities
- To identify potential sources of nosocomial Aspergillosis when a case has been identified
- To predict environmental spore contamination from outside sources
- To identify defects/breakdown in hospital ventilation/filtration systems
- To correlate outbreaks of invasive Aspergillosis with hospital construction or demolition work
- To monitor efficiency of procedures to contain hospital building wards where at-risk patients are managed

Do not perform routine air sampling

- Centres for Disease Control (CDC) as of February 2001 do not recommend routine airborne sampling :
  - Lack of standards linking fungal spore levels with infection rates (what is a safe level of exposure?)
  - Lack of standard protocols for testing (what sampling intervals, number / location of samples?)
  - Need for substantial laboratory support
  - New, complex PCR analytical methods
  - Unknown incubation period for *Aspergillus* spp. infection

Do not do routine air sampling

- Variability of sampler readings
- Sensitivity of the sampler used (i.e. the volumes of air sampled)
- Lack of details in the literature about describing sampling circumstances such as unoccupied rooms verses ongoing activities
- Expected fungal concentrations, rate of outdoor air penetration
- Lack of correlation between fungal species and strains from the environment and clinical specimens

Do not do routine air sampling

- Confounding variables with high-risk patients such as visitors, time spent outside of protective environment without protective respiratory equipment

- The need for a slit or sieve impactor sampler capable of collecting large volumes of air in short periods of time to detect low numbers of fungal spores in highly-filtered areas.

Frequency of air sampling

- Operating theaters (Western Australian Guidelines)
  - As part of commissioning of an operating theatre
  - After any major structural refurbishment
  - As deemed necessary by the Infection Control Department

- Always remember to factor in the costing during the pre-tendering of the project (new project)

- Discuss with the stakeholders and contractors on the frequency of sampling
  - More frequent during the initial period when most activities occurring
  - Scale down at later part

Reference: http://www.ihea.org.au/files/InfectionControlManual.pdf

Journal of Hospital Infection (2008) 70, 259–264

Available online at www.sciencedirect.com

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www.elsevierhealth.com/journals/jhin

Environmental sampling of particulate matter and fungal spores during demolition of a building on a hospital area

D. Hansen*, B. Blahout, D. Benner, W. Popp

Hospital Hygiene, University Hospital Essen, Essen, Germany

- During demolition building was sealed and water sprayed to minimize dust emission
- Particle and fungal concentrations monitored before and during demolition
- Particle concentrations significantly higher during demolition
- No difference in molds cultured at 37^0C before and during demolition

Particle count vs microbial count

Particle count

- Less costly
- Real time result
- No need to purge the air
- Early warning system for failures of the internal environment
- Cannot identify the microbes

Microbial Count

- More costly
- Need more than 3 days for result
- Need to purge the air
- Can identify the microbes

Particle counting

- IQAir Particle Scan Pro Airborne Laser Counter
- 0.3µm - 5µm

Fungal air sampling

- More accurate determination of indoor air quality compared to air particulate count

Type of air samplers

Complete and accurate range of microbial air samplers available

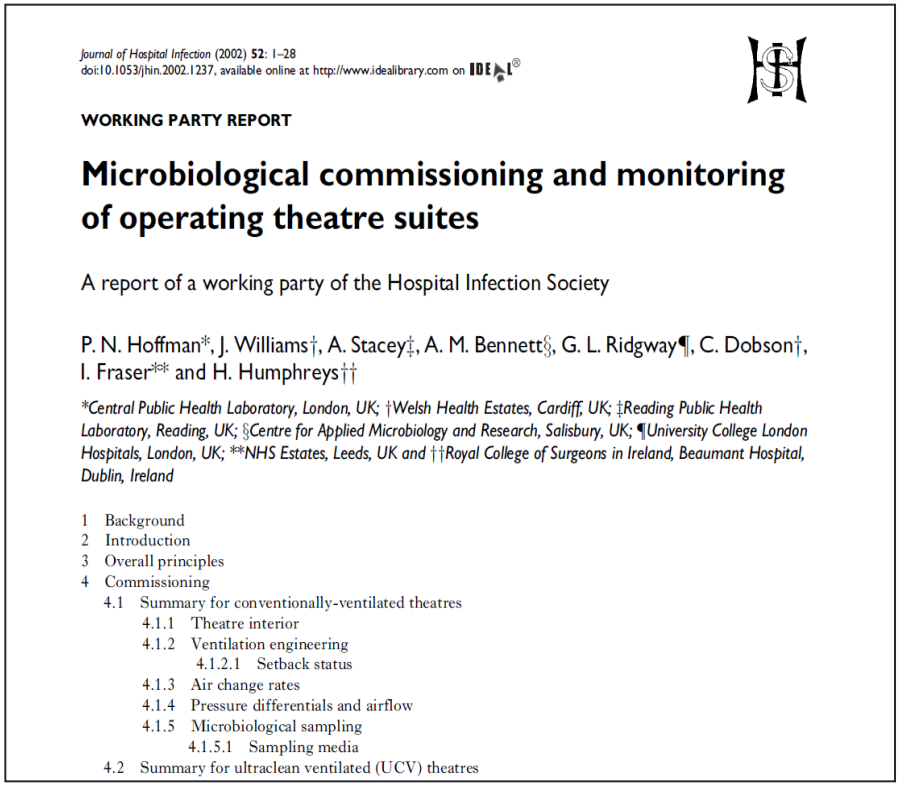
Hand held device

How to sample

- Open sites
  - No specific preparation except rooms with HEPA filters
    - On the filters night before the sampling
- Operating theatres
  - All new or refurbishment work has been completed
  - All engineering commissioning procedures have been completed
  - Clean OT
  - Seal off the place
  - Ventilation system has been running for 24 hours before date and time of sampling
- Clean rooms (such as pharmacy)
  - Similar as OT

How to interpret results

- Open sites: no international benchmark
  - Look at your institutions' trend
- Operating theatres (empty)
  - Conventional: 35 cfu/m^3
  - Laminar air flow: < 1 cfu/m^3



Journal of Hospital Infection (2002) **52**: 1–28
doi:10.1053/jhin.2002.1237, available online at http://www.idealibrary.com on IDEAL®

WORKING PARTY REPORT

Microbiological commissioning and monitoring of operating theatre suites

A report of a working party of the Hospital Infection Society

P. N. Hoffman*, J. Williams†, A. Stacey‡, A. M. Bennett§, G. L. Ridgway¶, C. Dobson†, I. Fraser** and H. Humphreys††

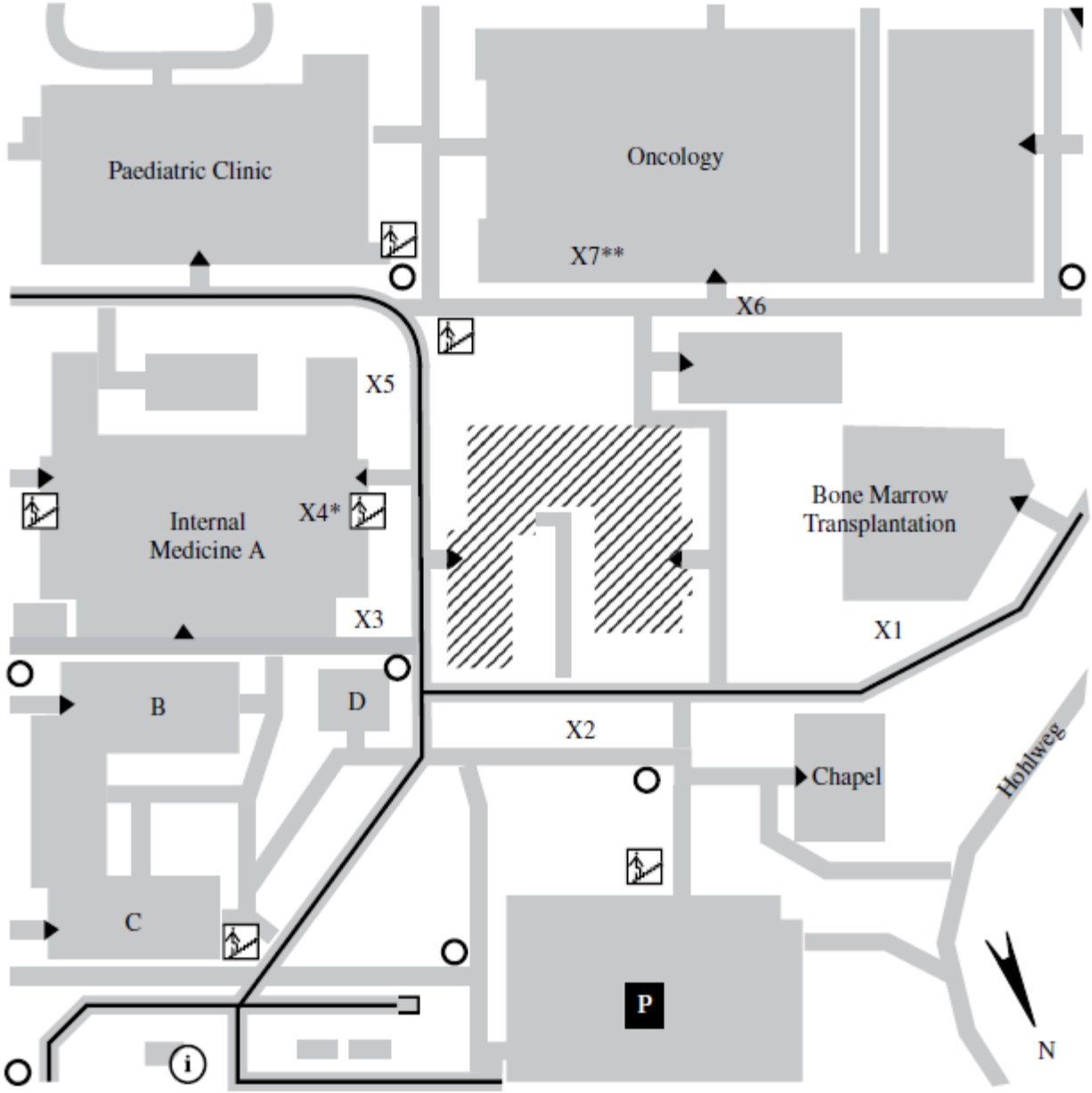
**Central Public Health Laboratory, London, UK; †Welsh Health Estates, Cardiff, UK; ‡Reading Public Health Laboratory, Reading, UK; §Centre for Applied Microbiology and Research, Salisbury, UK; ¶University College London Hospitals, London, UK; **NHS Estates, Leeds, UK and ††Royal College of Surgeons in Ireland, Beaumant Hospital, Dublin, Ireland*

http://www.his.org.uk/files/5213/7338/2929/Microbiological_Commissioning_and_Monitoring.pdf

Location of sampling

- Choice of sampling height is 1.2 metres for room hygiene, with other samples taken for exploratory purposes near suspected or potential sources of contamination

- Multiple samples are preferable to a single sample
  - For temporal and spatial variation in spore levels within any environment


Paediatric Clinic
Oncology
X7**
X6
X5
Internal
Medicine A
X4*
X3
Bone Marrow
Transplantation
X1
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X2
Chapel
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- Multiple air sampling over period of time is preferred to single sample

Fungal counts

- Vary depending on:
  - Activity levels
  - Fluctuations in temperature
  - Fluctuations in humidity
  - Fluctuations in air flow
  - Changes in light level

- Outdoor air
  - Total = 10^3 to 10^5 cfu/m^3
- HEPA filtered air (>95% efficiency and >10 ACH)
  - <0.1 cfu/m^3
- No air filtration
  - 5 conidia/m^3
- **Total > 1cfu/m^3 needs attention!**

Recommended to do further investigation of sources of contamination

- Total indoor counts > outdoor counts
- Comparison of indoor and outdoor levels of fungal organisms show one of the following:
  - Organisms are present in the indoor sample and not in the outdoor sample
  - The predominant organisms found in the indoor sample is different from the predominant organism in the outdoor sample
- A monoculture of an organism is found in the indoor sample. It may be absent from samples taken in other areas of the building
- Persistently high counts

Further actions

- Start appropriate antifungal prophylaxis or pre-emptive therapy if not already used
- Perform an intensive retrospective review of microbiological, histopathological and post-mortem records for other cases
- Alert clinicians caring for high risk patients to the possibility of infection
- Establish a system for prospective surveillance of patients and their environment for additional cases
- If further cases arise in the absence of a nosocomial source consider monitoring home environments of patients pre-admission

Airborne *Aspergillus* contamination during hospital construction works: Efficacy of protective measures

Isabelle Fournel, MD,[a] Marc Sautour, PhD,[b] Ingrid Lafon, MD,[c] Nathalie Sixt, MD,[b] Coralie L'Ollivier, PhD,[b] Frédéric Dalle, PharmD, PhD,[b] Pascal Chavanet, MD, PhD,[d] Gérard Couillaud, MD,[e] Denis Caillot, MD,[c] Karine Astruc, MD,[a] Alain Bonnin, MD, PhD,[b,f] and Ludwid-Serge Aho-Glélé, MD[a]
Dijon, France

	Before work		During work		
Air treatment system	**N**	**%**	**N**	**%**	***P***
None	58/93	62.4	53/95	55.8	.36
HEPA filtration	0/134	0	2/234	0.8	.54
Plasmair	42/248	16.9	85/497	17.1	.95
Aspergillus airborne contamination	100/475	21.1	140/826	16.9	.07

AJIC major articles

The impact of portable high-efficiency particulate air filters on the incidence of invasive aspergillosis in a large acute tertiary-care hospital

Zakir-Hussain Abdul Salam, MBBS, MS, MPH,[a] Rubiyah Binte Karlin, BHSc,[b] Moi Lin Ling, MBBS, FRCPA,[b] and Kok Soong Yang, MBBS, MMedPH[a]
Singapore (Am J Infect Control 2010;38:e1-e7.)

Table 1. Incidence rates and RRs of IA in different ward groups during the study period

Ward group	Ward type	Incidence rate (per 1000 patient-days) Period I (December 2005 to November 2006)	Period II (December 2006 to June 2008)	*P* value	RR (95% CI)
Group I	Wards with portable HEPA filters deployed December 2006	0.35	0.17	.013	1.98 (1.11-3.51)
Group II	Wards with only fixed HEPA filters during the entire study period	0.16	0.31	.061	0.51 (0.28-0.93)
Group III	Wards with no HEPA filtration	0.088	0.075	.623	1.17 (0.44-3.10)

End of construction checks

- Area is cleared, cleaned and decontaminated with disinfectant
- Work area is vacuumed with HEPA filtered vacuums
- Hoardings are removed and disposed properly
- Air and water testing, if ordered

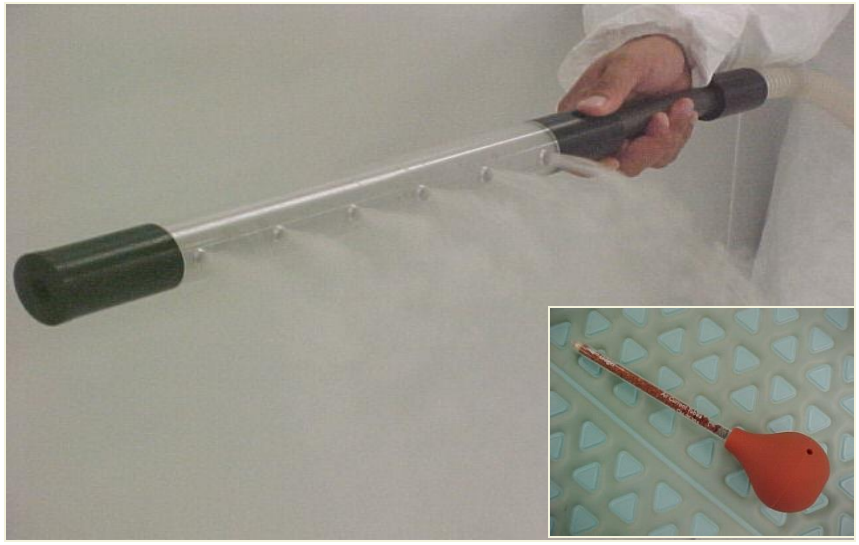
Monitoring

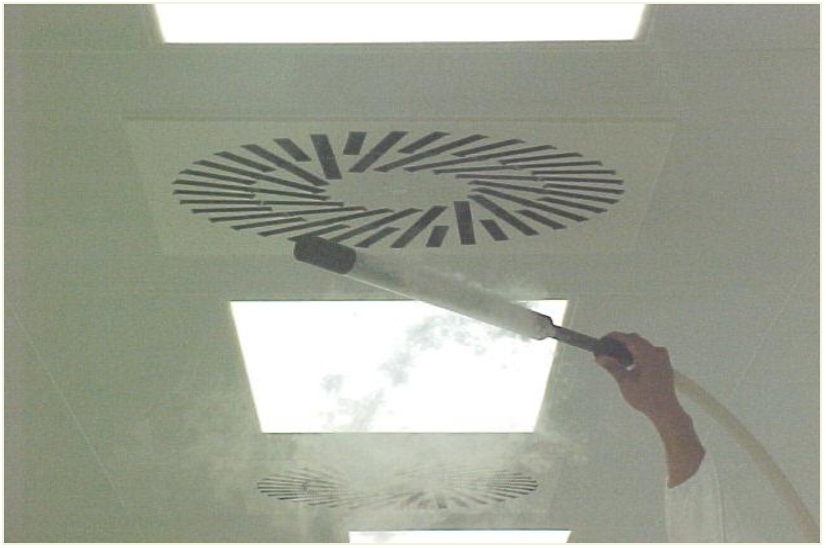
- Air flow
- Air sampling
- Air particle counting
- Microbiological water testing
- Water temperature
- Humidity

After construction monitoring: commissioning

- Are sinks properly located and functioning?
- Do sinks in critical patient care areas have properly functioning fixtures?
- Are soap and towel dispensers filled and functioning?
- Are surfaces in procedure and service areas appropriate for use? (e.g. are they smooth, nonporous and water resistant?)
- Has air balancing been completed according to specifications? (air particle count, air microbial count, etc)
- Does air flow into negative pressure rooms and out of positive pressure rooms? (smoke test)

Smoke test





Digital pressure gauge

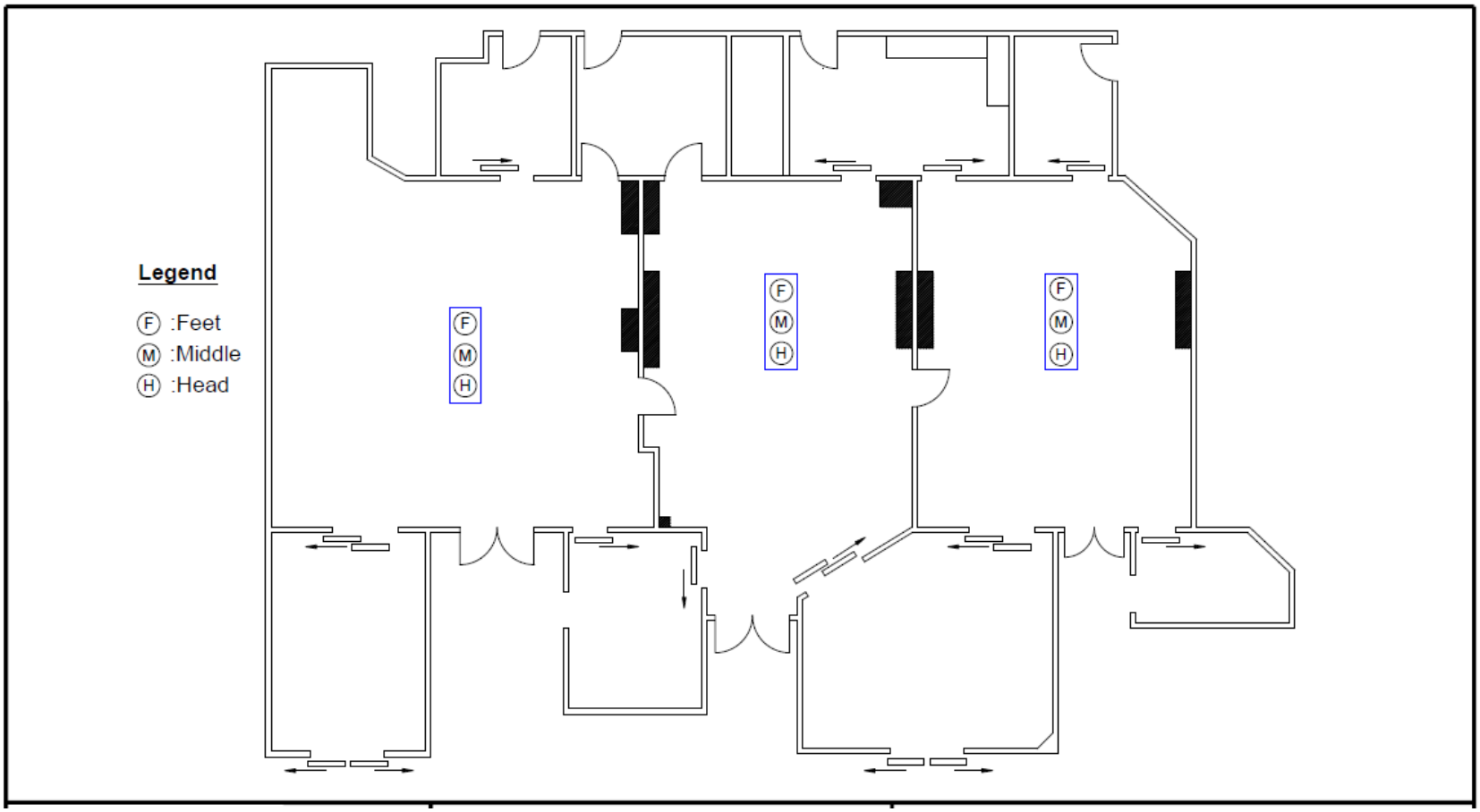
- Is used to monitor the differential pressure of a room with the adjacent areas.
- Could be used during or after renovation, or after construction of rooms with positive or negative pressure

Air Flow Meter

TSI 8380 AccuBalance Air Capture Hood Balometer Manometer

The TSI 8380 AccuBalance Air Capture Hood is an electronic multipurpose air balancing HVAC test instrument generally used to efficiently take readings of direct air flow volume at grilles and diffusers.

Water sampling to monitor water-associated infectious agent


Legend
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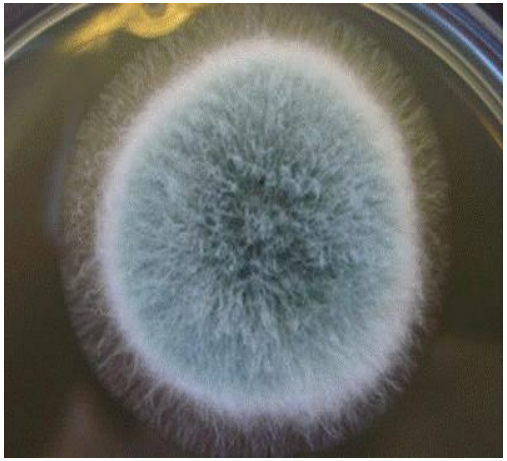
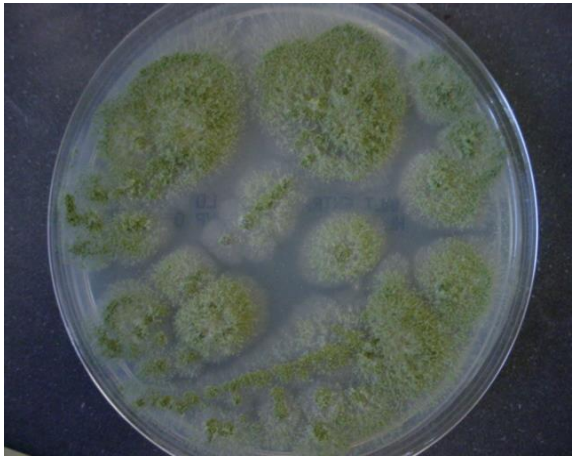
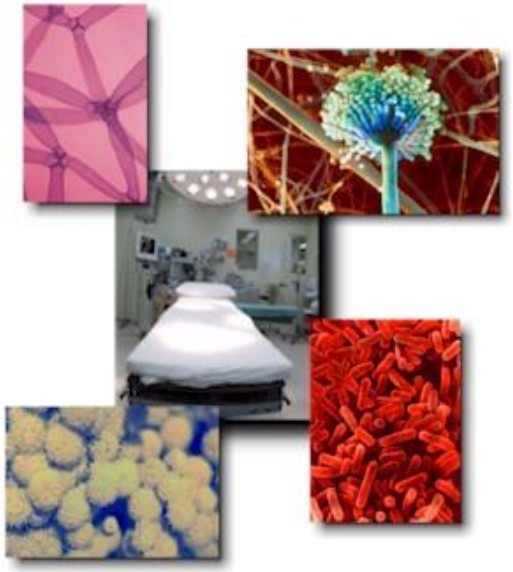
Summary

Effective planning and strict implementation of Infection Control Guidelines related to Renovation and Construction will prevent construction-related healthcare-associated infection







Thank you