The case for culturable air sampling for opportunistic fungi during healthcare construction

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Introduction

Healthcare construction is a recognized risk factor for life-threatening infection from opportunistic fungi

• At risk patients
  – Cellular immune deficiencies
  – Cannot overcome everyday fungal exposure

• Opportunistic fungi
  – ~200: 50 common
  – *Aspergillus fumigatus, flavus, terreus, niger*
  – *Fusarium*
Introduction
Healthcare construction, infection control risk assessment (ICRA), & environmental monitoring

• Healthcare construction requires an ICRA
  – ICRA: How-to’s of dust control
  – Prevent at-risk patient exposure to opportunistic fungi

• Environmental monitoring
  – Verifies contractor ICRA compliance
  – Visual inspection, observation & moisture testing
  – Sampling & monitoring
Air sampling & monitoring

• No guidelines & discouraged by CDC

• Sampling & monitoring is “best practices”

• “Need for speed” favors
  – Laser particle counters
  – PCR air samples
  – Non-viable air samples

• “Need for speed” disfavors
  – Culturable air sampling
Air sampling & monitoring

• Each sampling & monitoring method has a purpose & limitations

• Cannot identify to species level

• Cannot determine viability or thermo-tolerance

Photo courtesy of the Aspergillus Website & Fungal Research Trust
Air sampling & monitoring

• Culturable air sampling addresses the limitation of the other sampling methods
  – Identifies opportunistic fungi to the species level
  – Determines viability
  – Determines thermotolerance

• Integral part of air sampling & monitoring plan
Culturable air sampling

• Determine species of interest
  – Consult with Infection Control Practitioner, Epidemiologist, or Infectious Disease Physician
  – Survey patient population

• Opportunistic species examples
  – Aspergillus
  – Fusarium
  – Curvularia
  – Coccidiodes immitis**
Culturable air sampling

• Consult with mycologist and determine appropriate media
  – Aspergillus species
    • Sabouraud dextrose + 0.1% chloramphenicol
    • Inhibitory mold agar
    • Malt extract
    • Czapek dox
    • Potato flake
  – 37°C for 7 days
Culturable air sampling

Select sampling method & sampler

- Filter method
  - 0.8 µm pore size polycarbonate or MCE filter
  - Culture on agar plate
  - Low or high volume air sampling pump
  - 500 – 1000(+) liter air sample
  - Reporting limit <1 to <2 CFU/m³
Culturable air sampling

Select sampling method & sampler

• Impactor
  – 2-3 µm spore size
  – <2 µm particle cut-off point

• Andersen, Aerotech N-6, SAS impactor
  – Single 500 – 1000(+) liter air sample
  – Serial/side by side sample collection (e.g. 7 – 3 minute samples)
  – Reporting limit <1 to <2 CFU/m³
Culturable air sampling

But what about . . . .

• Overloading?
  – Environment is
    • Highly-filtered (30% + 90% inpatient & diagnosis)
    • Frequently cleaned (terminal cleaning)
    • Outside air sample not relevant
Culturable air sampling

But what about . . .

• High volume sample & particle bounce?
  – Graesby Andersen – 30 minute maximum
  – SAS impactor
    • Lower flow rate
    • 500 liter sample
Culturable air sampling

But what about . . . .

• Incubation?
  – 37°C
  – 7 days
  – Check cultures at 1, 2, 3, 5 & 7 days

• Sampling plan?
  – Integrate your tool kit
    • Visual inspection & moisture measurements
    • Ventilation tubes
    • Particle counter
    • Culturable air sampling
Culturable air sampling

But what about . . . .

• Sampling plan?
  – Integrate your tool kit
    • Visual inspection & moisture measurements
    • Ventilation tubes
    • Particle counter
    • Culturable air sampling
Infection control commissioning

Purpose is to verify:

- Room/building pressure relationships
- Filter efficiency
- Terminal cleaning efficacy
- Acceptance for patient occupancy
Infection control commissioning

Room pressure relationships

• Ventilation tubes/micromanometer
  – Positively pressurized
    • Building ++ to outdoors
    • OR’s, protective environment, trauma room, procedure room, etc.
  – Negatively pressurized
    • Negative pressure rooms (e.g. ICU/TB)
    • Microbiology, autopsy, ER waiting room, etc.
Infection control commissioning

Filter efficiency

- Particle counter
  - Cumulative setting
  - 0.5 µm +
  - Outdoor & diffuser comparison (expected percent reduction in particles)
Infection control commissioning

Terminal cleaning efficiency

• Particle counter
  – Cumulative setting (0.5 µm +)
  – Experienced rule of thumb
    • 200 to 1,000 particles acceptable
Infection control commissioning

Terminal cleaning efficiency

• Culturable air sampling suggested criteria
  – *Aspergillus* species
  – 0-2 CFU/m$^3$ - OK
  – 2-4 CFU/m$^3$ – Reclean/test (w/patient)
  – 4-10 CFU/m$^3$ – Reclean/test (remove patient)
  – >10 CFU/m$^3$ – Reclean (remove patient & investigate)
Thank you

A. lentulus – Courtesy The Aspergillus Website and The Fungal Research Trust
Culturable air sampling successes

Orthopedic clinic

• 100 CFU/m³ A. fumigatus
Culturable air sampling successes

Emergency Department
• West wing cleared
• Center core - throughout
  – 2 to 10 CFU/m³ A. fumigatus
Culturable air sampling successes

Investigation

• Particle counts
  – 7,000 to 16,000

• Ventilation tubes
  – Core negative to adjacent spaces & outdoors
  – Construction and ....
Culturable air sampling successes

Atrium
- Compost
- Soil
- Wood chips
- Plants
Conclusion

Culturable air sampling

– Addresses non-culturable method limitations
  • Identifies opportunistic fungi at species level
  • Determines viability & thermotolerance

– Valuable tool in a hospital environmental monitoring plan