Fungal infection and susceptible hosts

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Fungal infections

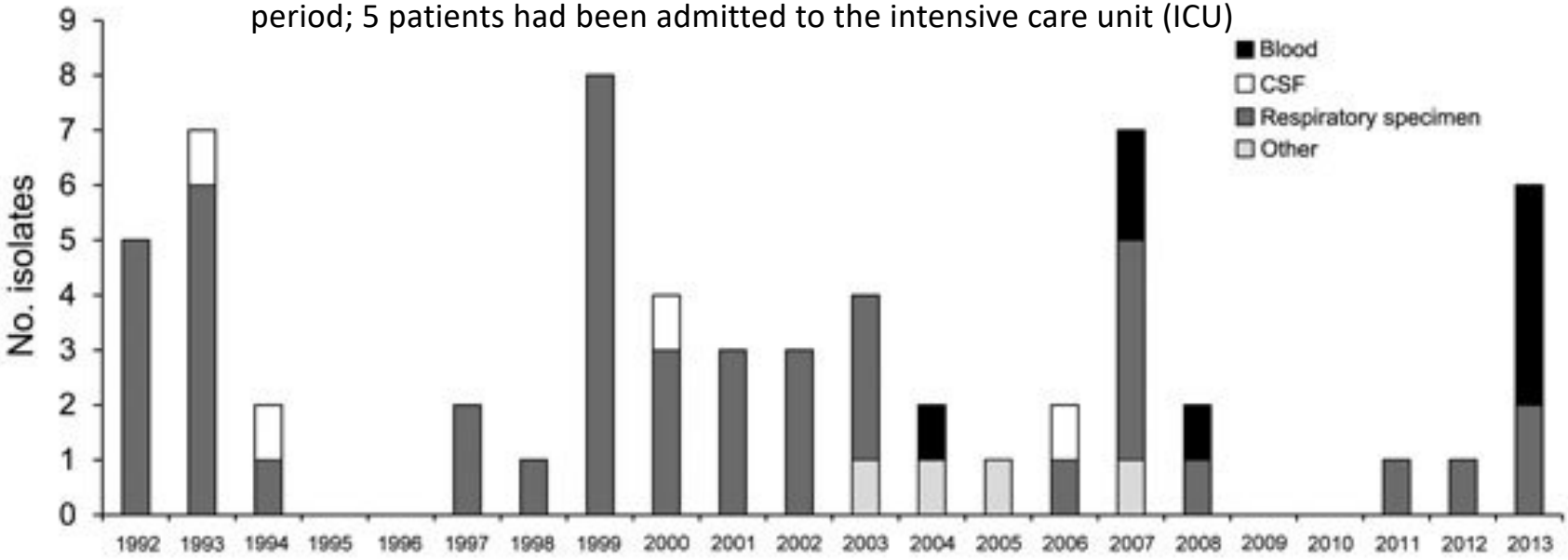
- Yeast
  - *Candida auris*
  - *Cryptococcus neoformans*

- Mould
  - *Aspergillus fumigatus*
  - *Scedosporium*
  - *Histoplasma capsulatum*

Cluster of *Cryptococcus neoformans* Infections in Intensive Care Unit, Arkansas, USA, 2013

Cluster of 6 during April–December 2013

- 4 bloodstream infection, 2 had respiratory infection; 3 infections occurred within a 10-day period; 5 patients had been admitted to the intensive care unit (ICU)



Emerg Infect Dis. 2015 Oct; 21(10): 1719–1724

Investigation findings

- Roof had been a roost for pigeons x 6 years
- Leaking roof x 3 years, off and on
- Environmental sampling negative for Cryptococcus

Patient seriously ill with new fungal infection at Glasgow superhospital

27 Jan 2019

Scottish Government announced a review into the design of the Queen Elizabeth University Hospital after the deaths of two patients

Two dead after pigeon droppings infection at Glasgow hospital

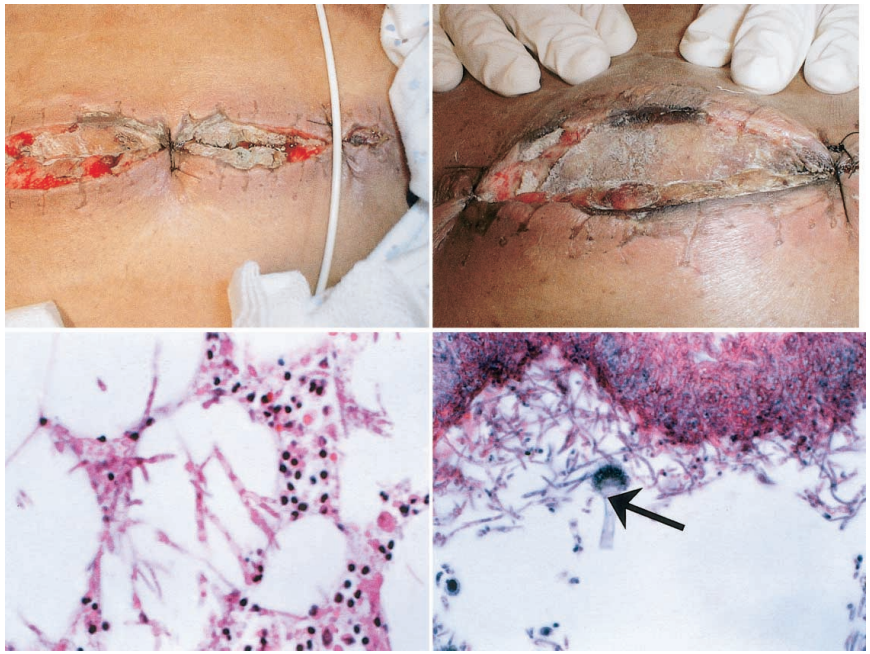
Patients believed to have inhaled Cryptococcus at Queen Elizabeth University hospital

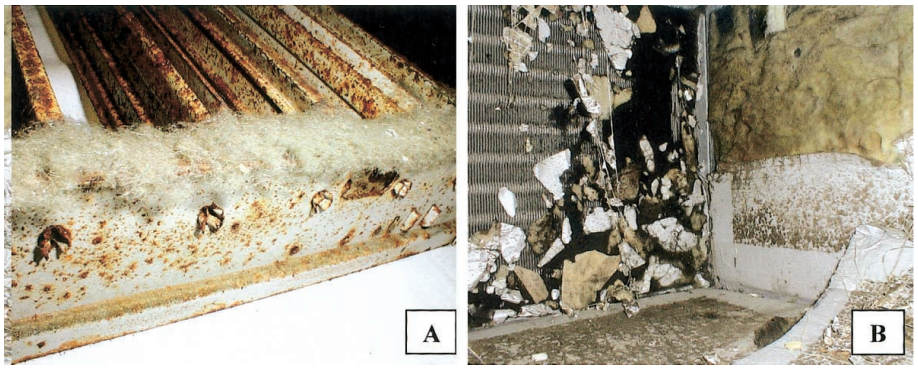
Outbreak of Invasive *Aspergillus* Infection in Surgical Patients, Associated with a Contaminated Air-Handling System

Clinical Infectious Diseases 2003; 37:786–93

Brock D. Lutz,[1] Jiankang Jin,[2] Michael G. Rinaldi,[3] Brian L. Wickes,[2] and Mark M. Huycke[1]

[1]The Muchmore Laboratories for Infectious Diseases Research, Department of Veterans Affairs Medical Center, and Departments of [2]Pathology and [3]Microbiology and Immunology, University of Texas Health Sciences Center, San Antonio, Texas

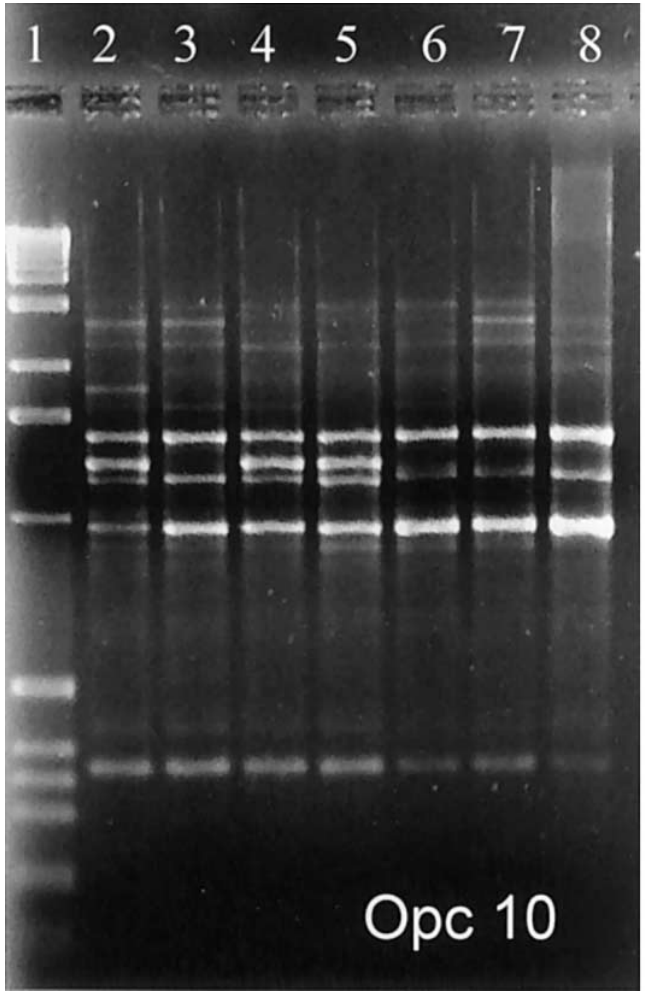


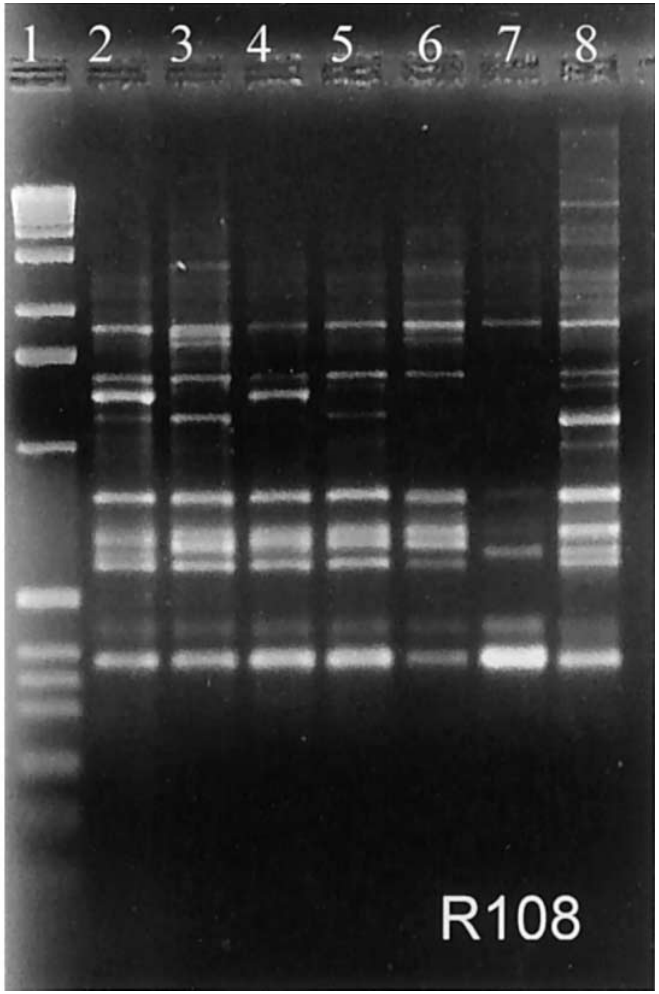


A, Operating room diffuser showing fiberglass fragments from insulation blown downstream from a variable airflow volume (VAV) unit. Severe rusting is indicative of intermittent or chronic condensation.

B, Interior view of a VAV unit showing deterioration of foil-lined fiberglass insulating material.

Random amplification of polymorphic DNA (RAPD) analysis of *Aspergillus fumigatus* isolates using 2 primers





Results of investigations

Findings

- Hot weather, frequent rains
  - Promoted condensation in air ducts in the operating theater
- All ORs received 15 ACH through individual variable airflow volume (VAV) units located in the ducts just downstream from final filters
  - VAV units allow adjustment in room air exchange rates via airflow dampeners and air temperature control via water-jacketed radiative elements
  - VAV units installed to improve energy efficiency through air- flow and temperature control

Recommendations

- VAV units should not be used downstream of humidification systems or be allowed to interfere with air exchanges in patient care area
- In general, no material should be installed in duct- work beyond final filters
- Facilities using VAV units in air-handlers for clinical areas where patients are at risk for nosocomial infection may wish to verify that interior insulating liners are not present or are in good condition.

Lessons learnt

- Design matters
  - Ventilation ducts
- Compliance to standards
- Maintenance matters
  - A leaking roof is not a small matter

REVIEW

Nosocomial aspergillosis in outbreak settings

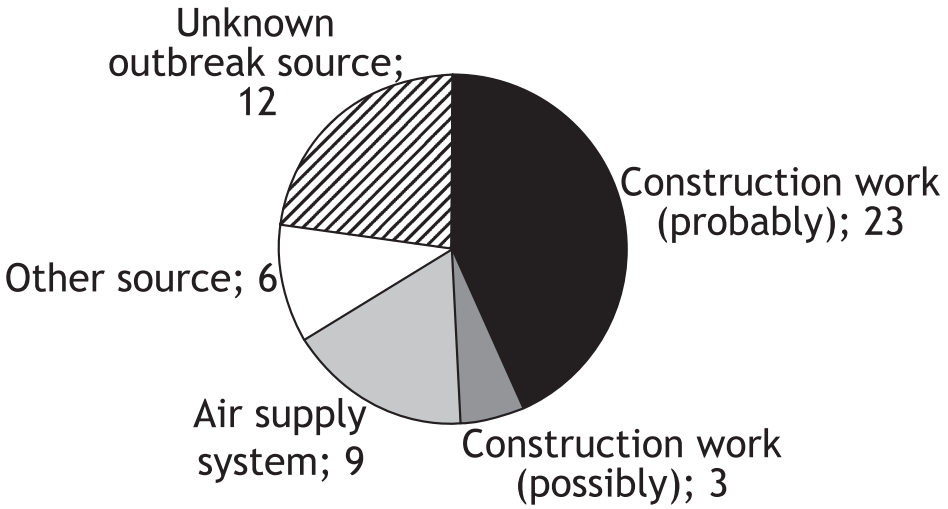
R-P. Vonberg*, P. Gastmeier

Journal of Hospital Infection (2006) 63, 246 - 254

Institute for Medical Microbiology and Hospital Epidemiology, Medical School Hannover, Germany

Table II Number of patients with different underlying diseases and associated mortality

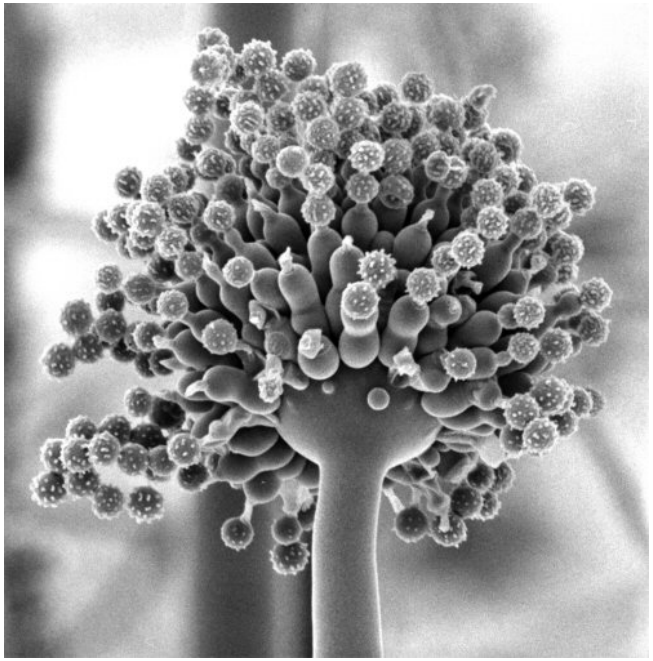
Underlying disease	No. of patients	Mortality (%)
Haematologic malignancy	299	57.6
Solid organ transplantation		55.9
Renal transplantation	36	
Liver transplantation	8	
Other immunocompromised patients		52.3
High-dose steroid therapy	15	
Neonates	5	
Other malignancy	4	
Chronic lung disease	2	
ICU patients ('high risk')	2	
No exact classification possible	49	
Patients without severe immunodeficiency		39.4
Thoracic surgery	25	
Cataract surgery	5	
ICU patients ('low risk')	5	
Other surgical patients	3	
Total	458	55.0



Distribution of sources of nosocomial aspergillus outbreaks

Aspergillus fumigatus

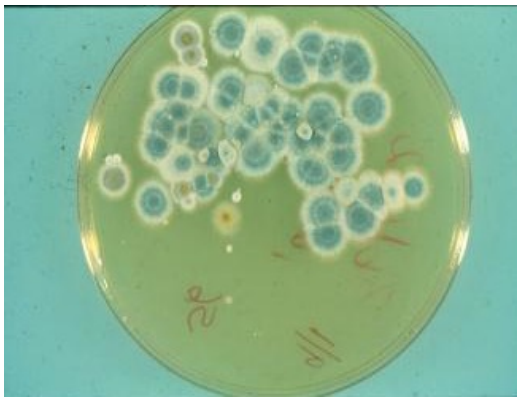
- Most common cause of invasive and non-invasive aspergillosis
- Causes >50% of invasive aspergillosis
- Capable of growth up to 55°C (131°F)



Epidemiology

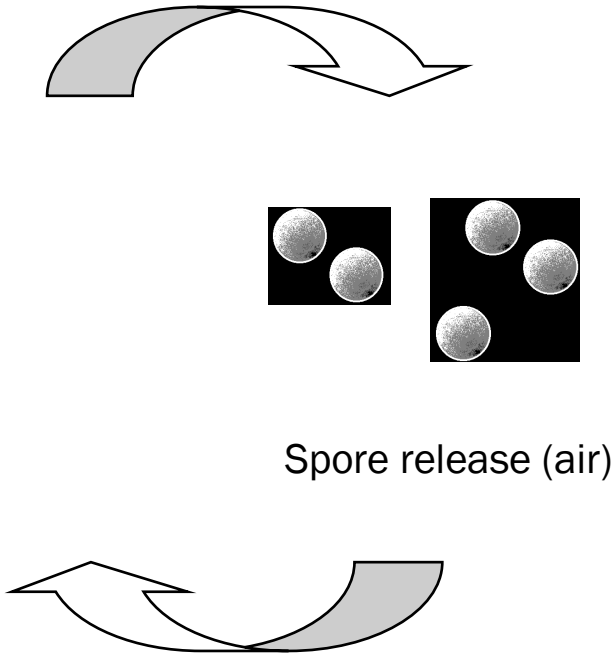
- *A. fumigatus* is a ubiquitous organism whose primary ecological niche is felt to be decomposing vegetable matter

- Ambient levels in outside air is considerable
  - Typical 1-15 spores/m3 with significant day to day variability
  - May reach tremendous levels near compost heaps and hay barns (106 spores/m3)



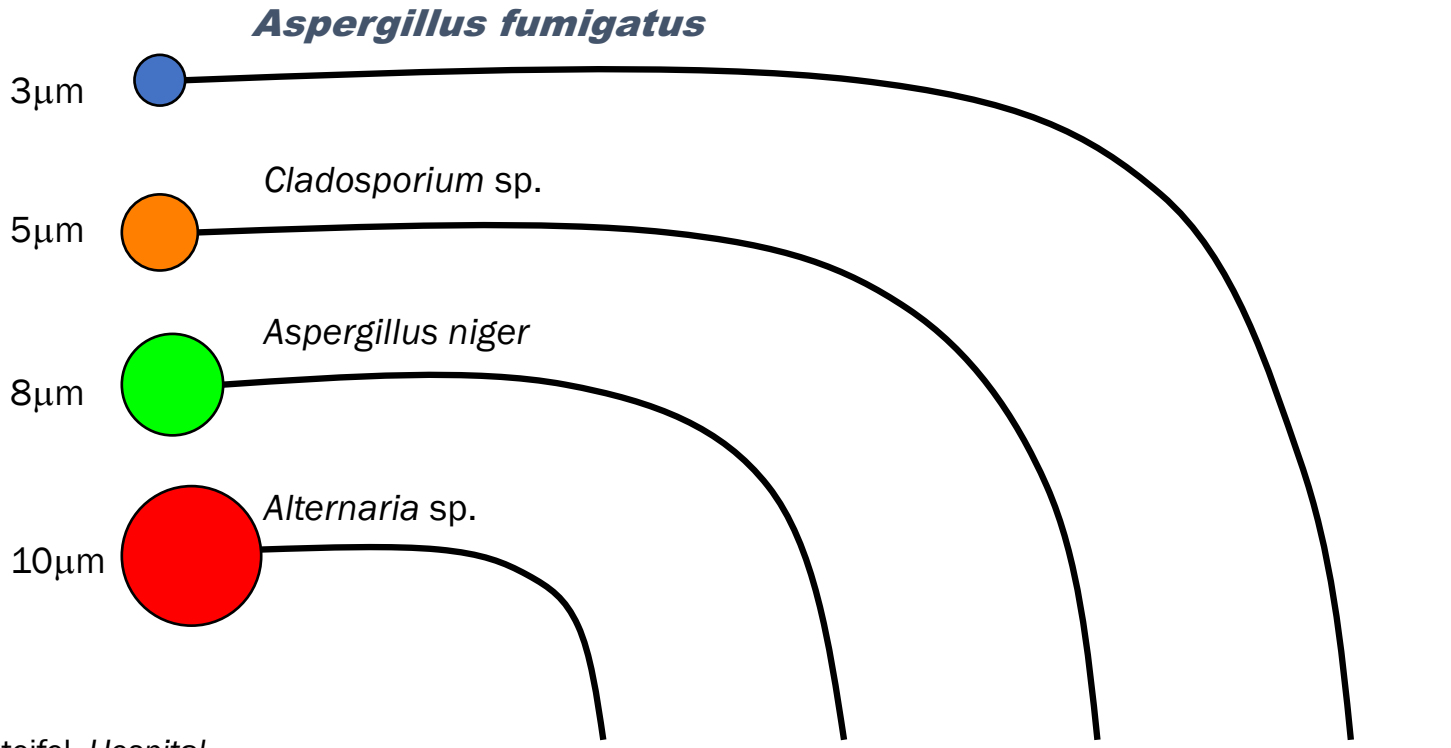
Aspergillus – basic life cycle

Fungal growth
(surfaces)

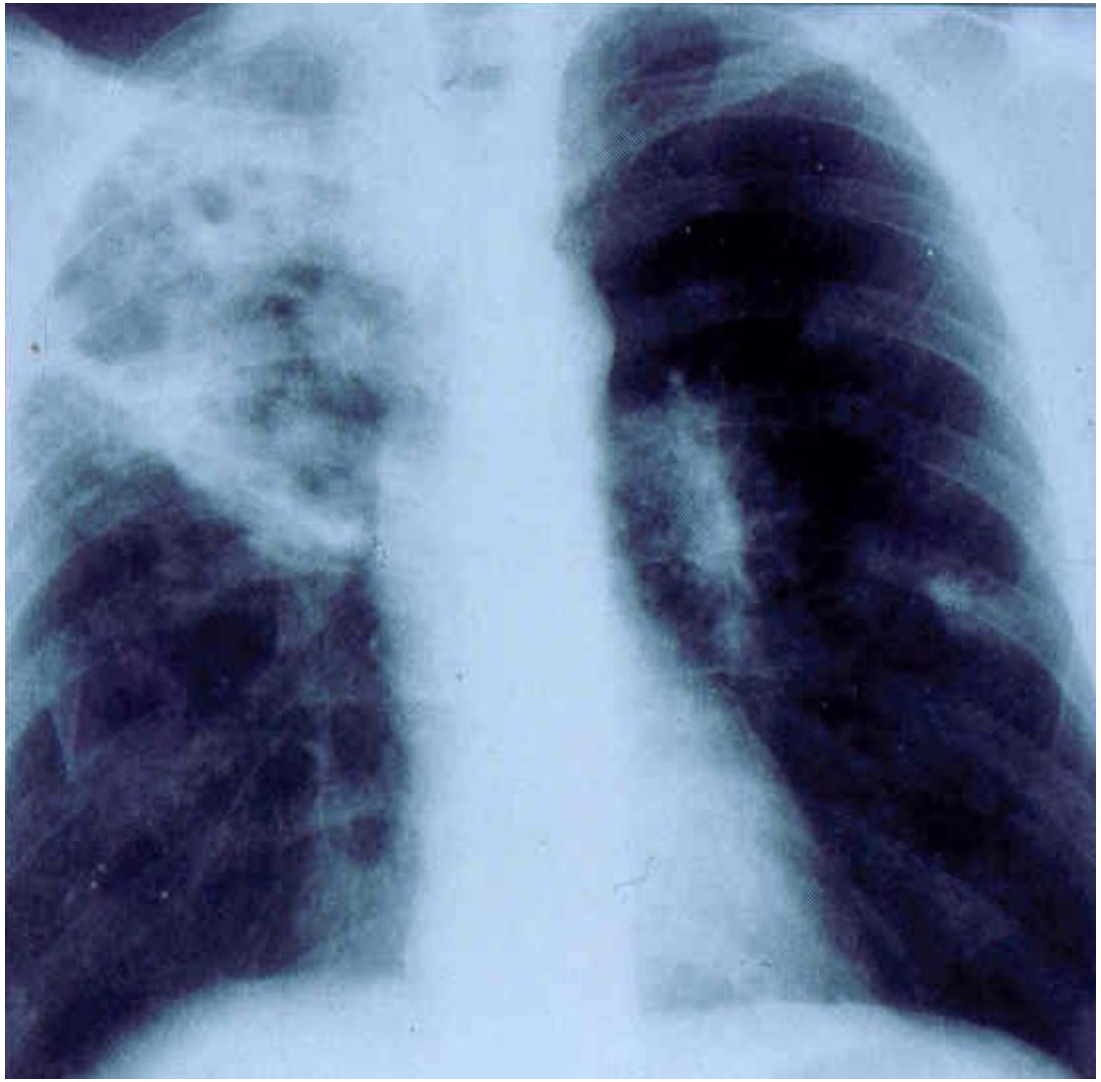


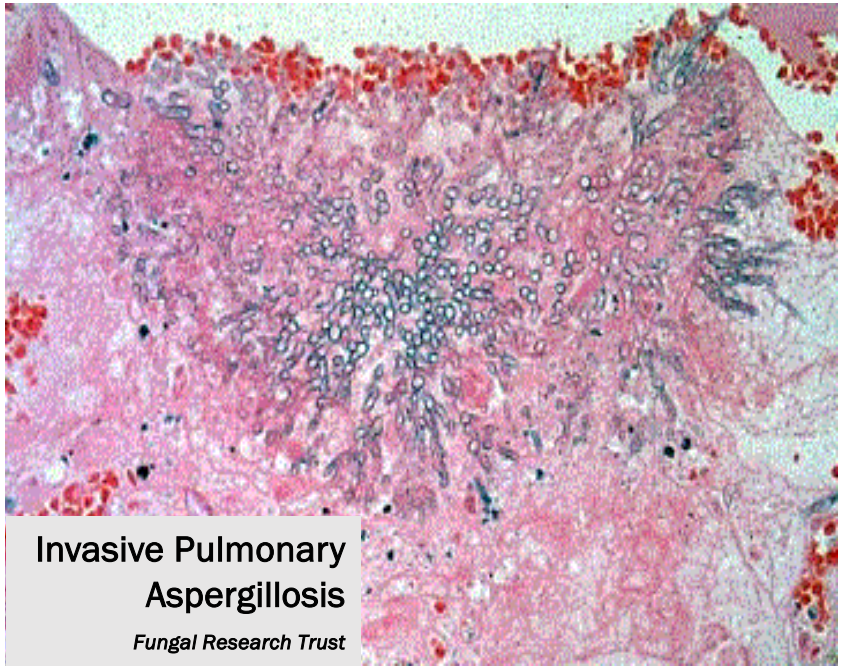
Spore release (air)

(Particle) size matters



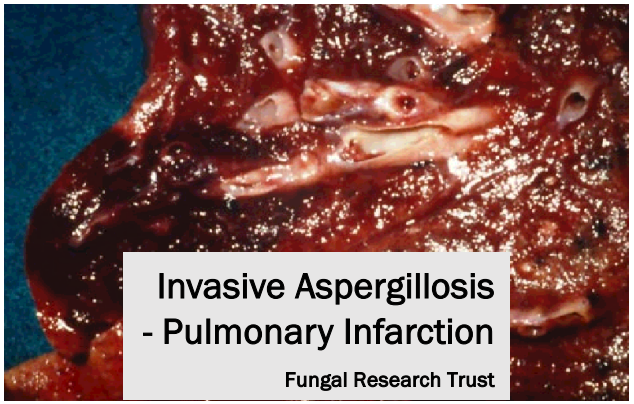
Adapted from Steifel, *Hospital Epidemiology and Infection Control*, 1999





Invasive Pulmonary Aspergillosis

Fungal Research Trust



Invasive Aspergillosis - Pulmonary Infarction

Fungal Research Trust

Aspergillus eye infection

Sources of *Aspergillus* sp

- Unfiltered air
- Ventilation systems
- Contaminated dust dislodged during hospital renovation and construction

- Horizontal surfaces

How do fungi get in?

- Fresh air intakes of HVAC systems
- Open doors and windows
- Attached to people's clothes, shoes, and skin
- Attached to new building materials

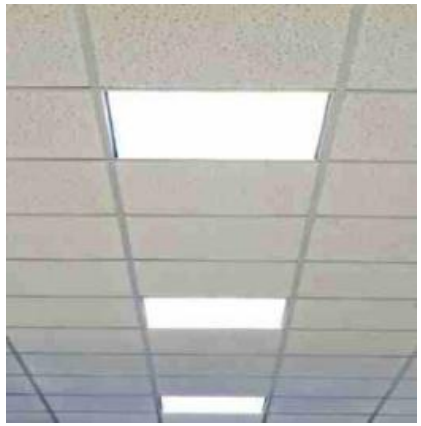
What do fungi need to grow?

- Nutrient Sources
- Warm temperature
- Moisture

Ideal conditions for *Aspergillus*

Nutrients

- Gypsum board
- Cellulose ceiling tiles
- Carpets
- Upholstery
- Fibreglass lined ducts
- Dirt on surfaces



Sources of moisture

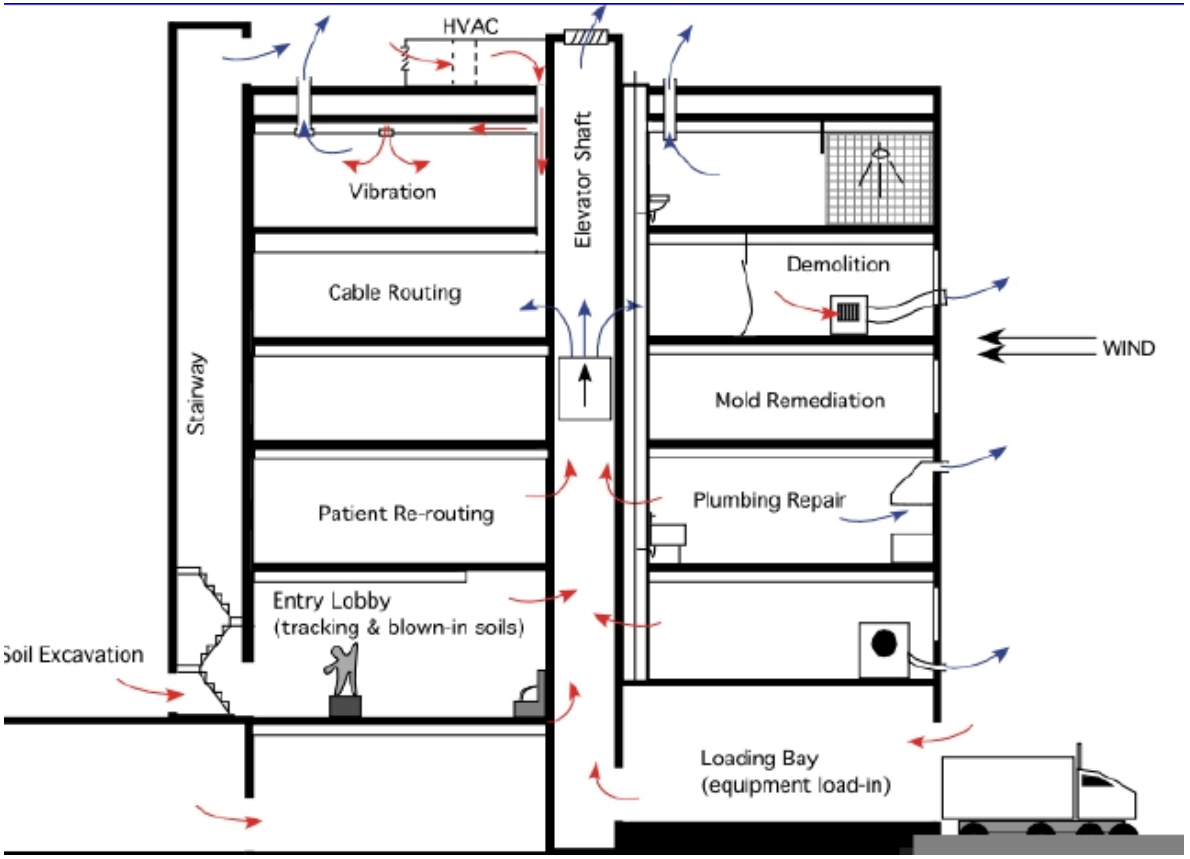
- Roof leaks
- Building envelope cracks
- Condensation on cold Surfaces
- Leaking pipes

Dust mats need to be maintained

Vibration may move ceiling boards!

- Watch out for dislodged ceiling boards.
- Call IPC

Dust moves!


HVAC
Vibration
Elevator Shaft
Cable Routing
Demolition
WIND
Stairway
Mold Remediation
Patient Re-routing
Plumbing Repair
Entry Lobby
(tracking & blown-in soils)
Soil Excavation
Loading Bay
(equipment load-in)

Aspergillus outbreak

Infect Control Hosp Epidemiol 2000; 21:18-23

- February, March 1996 – increase in invasive fungal infections noted in leukaemia and BMT patients at Johns Hopkins Hospital

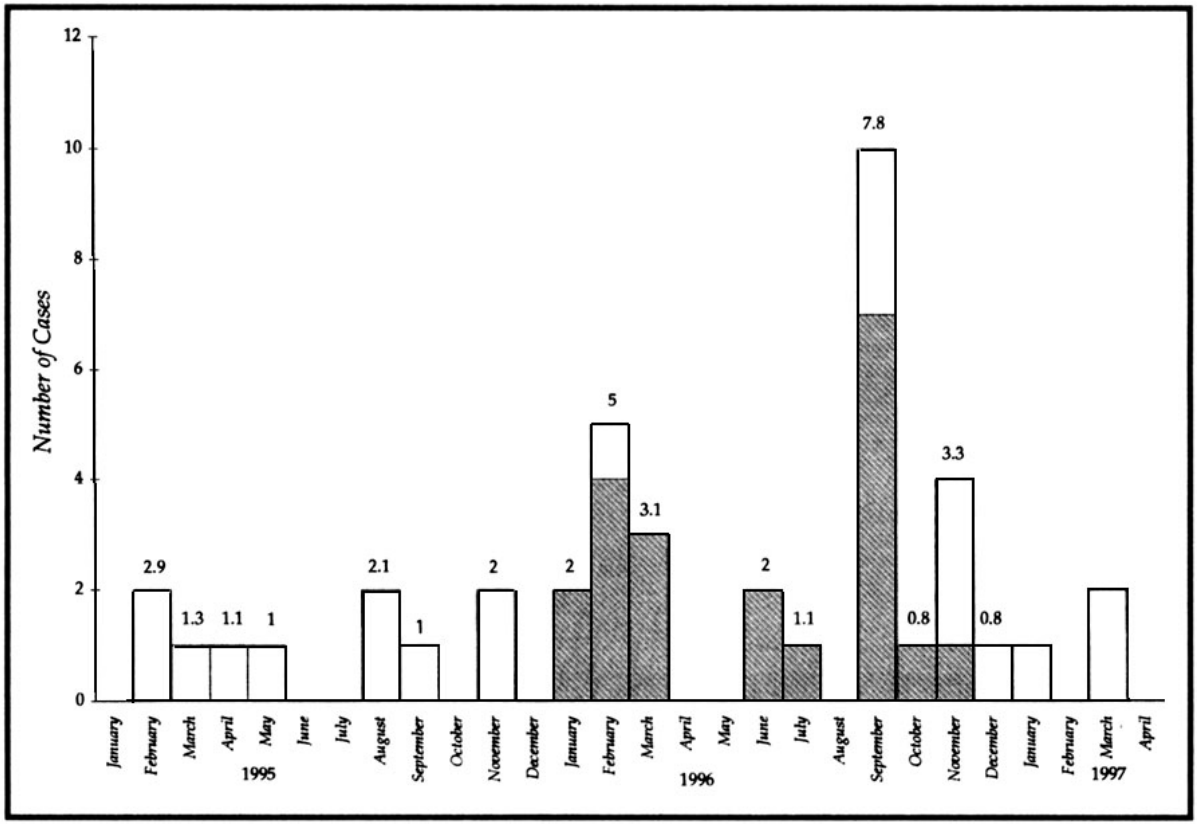
- September 1996 – 2nd outbreak

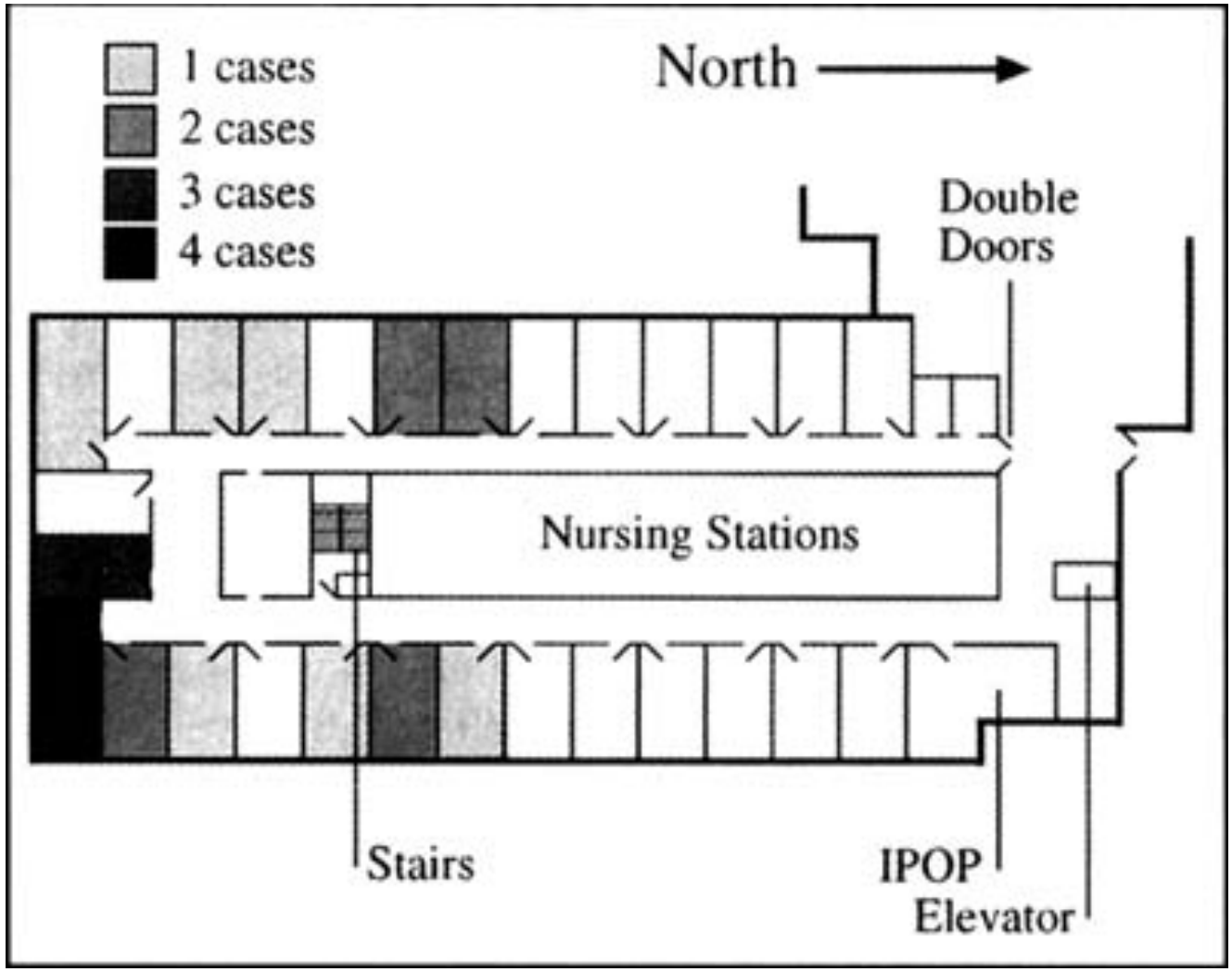
- Background
  - 940 bed facility; 63-bed Oncology Center is a 3-storey building connected to the hospital
  - 2 buildings separated by set of double doors
  - Oncology Centre's air went through 3 filters system; each room is HEPA filtered and positive P
  - Pressure differentials, HVAC system checked monthly

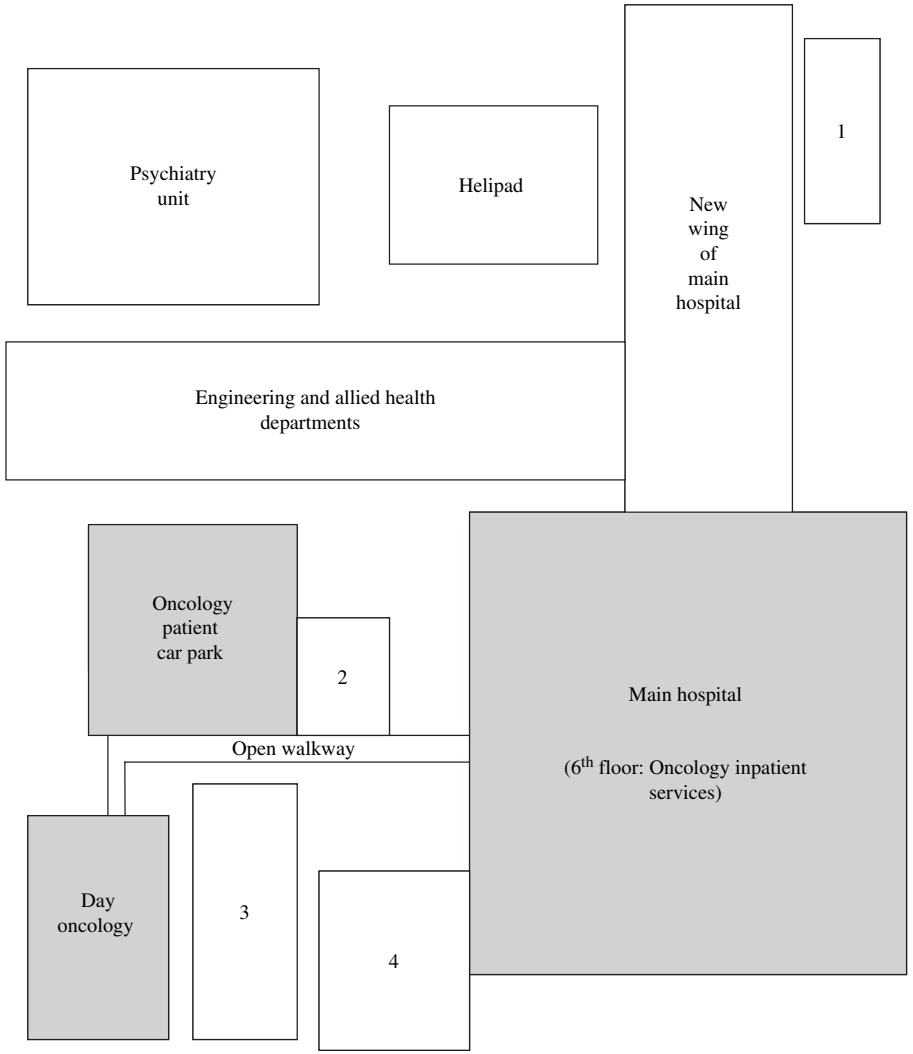
- Construction immediately adjacent to the Oncology Center

- *A. flavus* emerges, previously *A. fumigatus*

2 in 1996: Incidence increased from 2.9 and 1.3 per 1000 patient days in Feb and Mar 1995 to 5.0 and 3.1 per 1000 patient days in Feb and Mar 1996



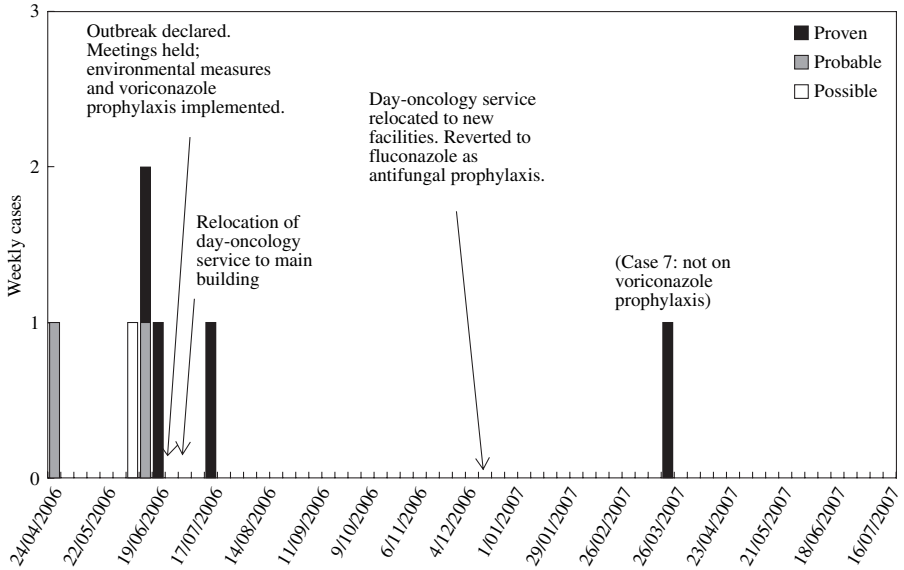

1 cases
2 cases
3 cases
4 cases
North
Double
Doors
Nursing Stations
Stairs
IPOP
Elevator



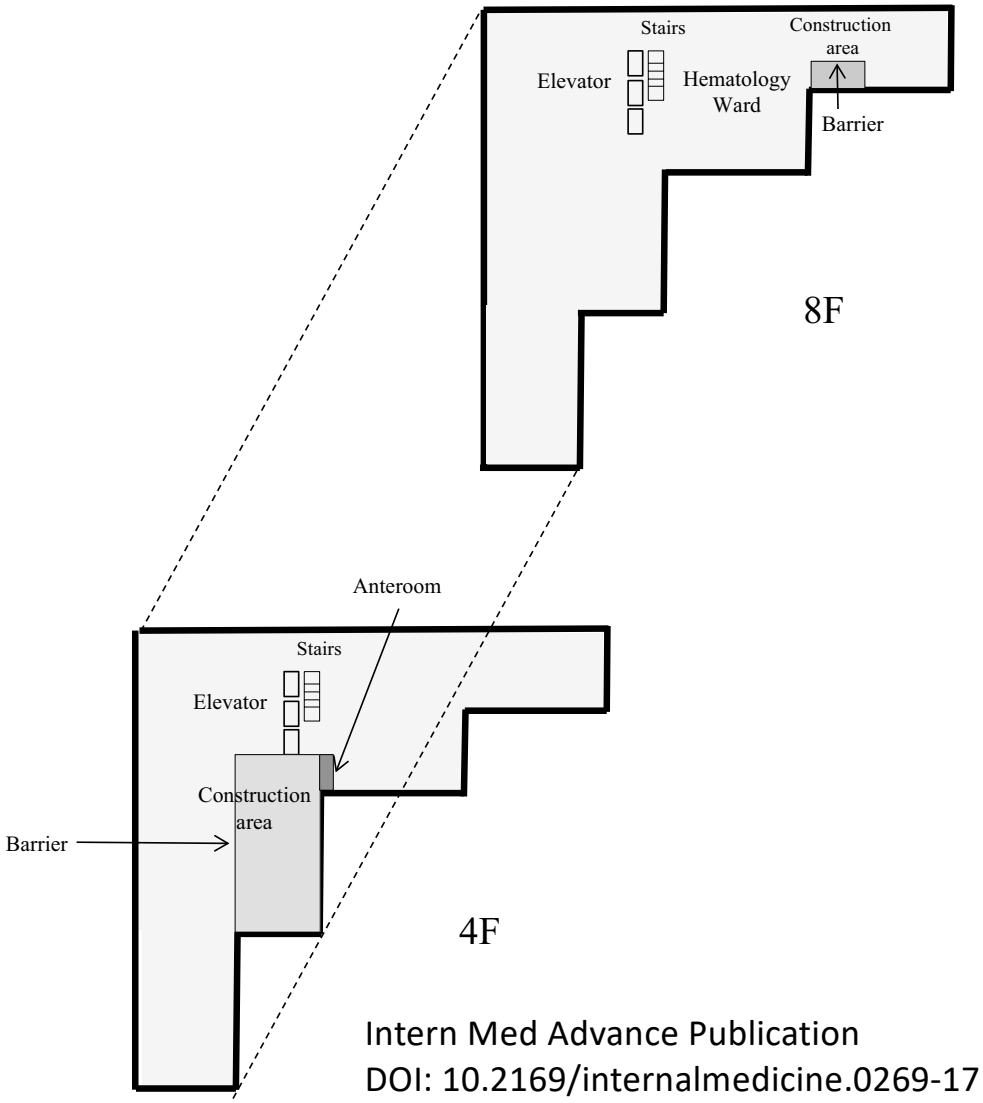
Successful control of an outbreak of invasive aspergillosis in a regional haematology unit during hospital construction works☆

C.C. Chang [a], A.C. Cheng [a], B. Devitt [b], A.J. Hughes [a], P. Campbell [b], K. Styles [c], J. Low [c], E. Athan [a,*]

[a] *Department of Infectious Diseases, Geelong Hospital, Geelong, Victoria, Australia*
[b] *Clinical Haematology Unit, Geelong Hospital, Geelong, Victoria, Australia*
[c] *Infection Prevention Unit, Geelong Hospital, Geelong, Victoria, Australia*



Journal of Hospital Infection (2008) **69**, 33—38



Intern Med Advance Publication
DOI: 10.2169/internalmedicine.0269-17

- 4th floor ICU was reconstructed from September 2013 to May 2014.
- Nurse call speakers were also repaired in the 8th floor hematology ward in December 2013.
- In addition, 2 large clean rooms for 4 patients in the hematology ward were constructed internally from January 2014 to February 2014.
- A partition was installed between the patient area and construction site.
- The source of the outbreak was suspected to be the construction area on the 4th floor, which did not have a sufficient negative pressure system to remove dust from construction workers.
  - A unit with a negative pressure system was subsequently constructed beside the construction area in January 2014.

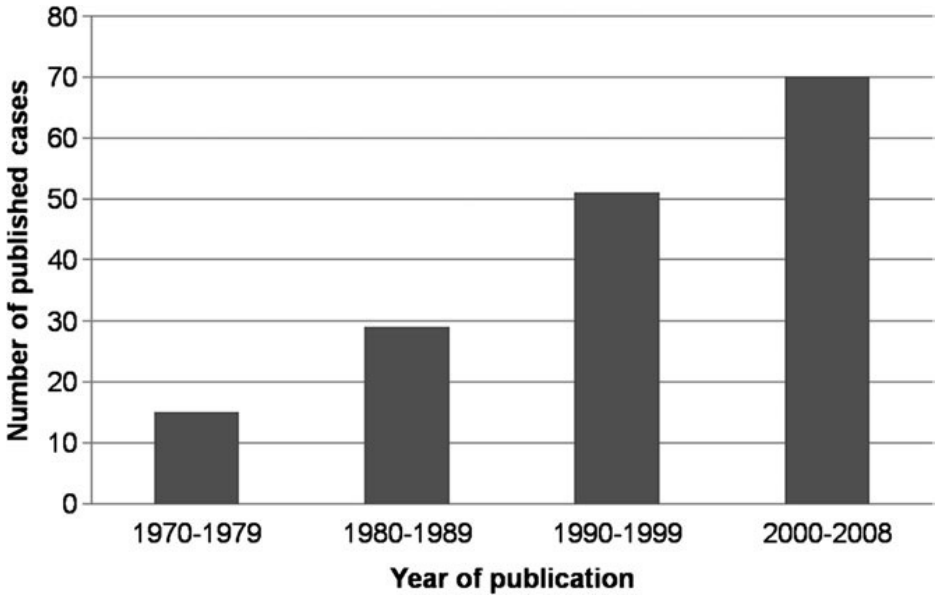
Lessons learnt

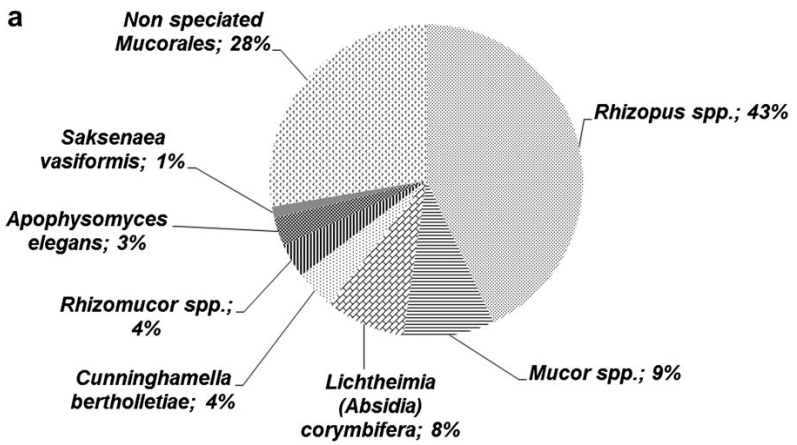
- Control measures – hoarding, etc

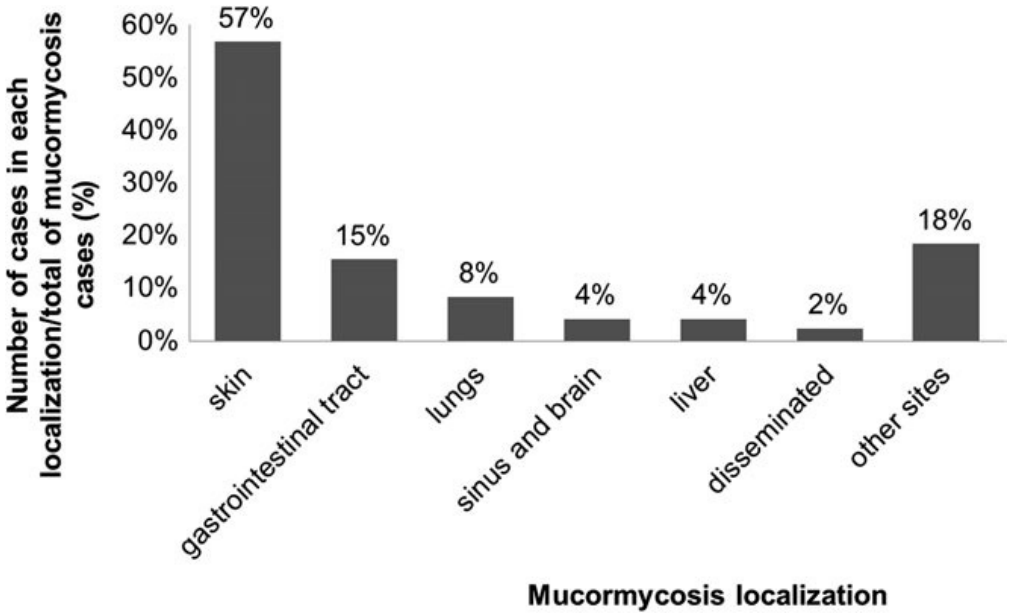
- Immunocompromised patients need added precautions
  - HEPA filtered ward,
  - May need to relocate patients esp. where construction is nearby and cannot be assured of protection from dust

Mucormycosis

- Adult Solid Organ Transplant Recipients at an Acute Care Hospital — Pennsylvania, 2014–2015 (MMWR)
  - Avoiding putting immunnocompromosed patients in negative P rooms
- Rhinocerebral mucormycosis at a hospital in Kansas (2014)
  - Nearby construction – leak on wall
  - Patients were placed in rooms that shared a hallway with construction traffic


Number of published cases
80
70
60
50
40
30
20
10
0
1970-1979
1980-1989
1990-1999
2000-2008
Year of publication


a
Non speciated Mucorales; 28%
Rhizopus spp.; 43%
Saksenaea vasiformis; 1%
Apophysomyces elegans; 3%
Rhizomucor spp.; 4%
Cunninghamella bertholletiae; 4%
Lichtheimia (Absidia) corymbifera; 8%
Mucor spp.; 9%


Number of cases in each localization/total of mucormycosis cases (%)
60%
50%
40%
30%
20%
10%
0%
57%
15%
8%
4%
4%
2%
18%
skin
gastrointestinal tract
lungs
sinus and brain
liver
disseminated
other sites
Mucormycosis localization

Contaminated products were produced by a single compounding pharmacy in Florida

- Fungal contamination of 2 different compounded products led to an outbreak involving 47 cases of fungal endophthalmitis
  - 21 cases linked to Brilliant Blue G intraocular dye (used during retinal surgery) contaminated with *Fusarium incarnatum- equiseti* species complex
  - 26 cases linked to intravitreal injection of triamcinolone acetate contaminated with *Bipolaris hawaiiensis*

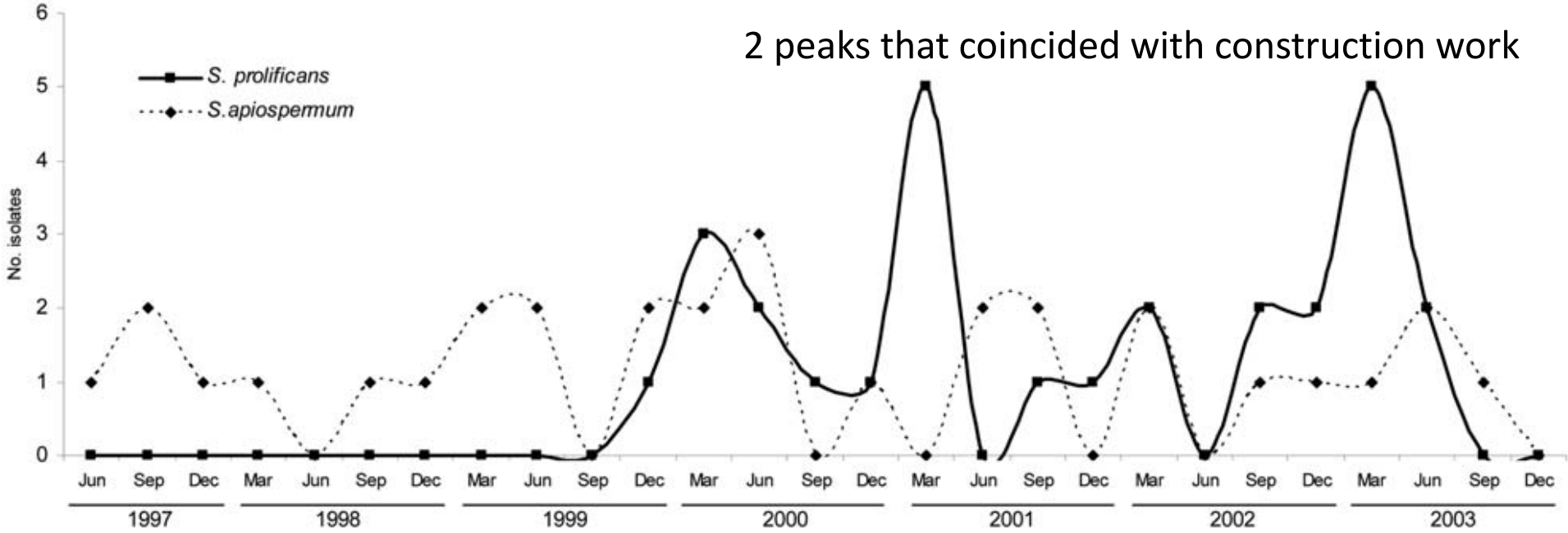
- Products were produced by a single compounding pharmacy in Florida

Compounding laboratory

- Design
- Maintenance
  - Are you kept informed of failed sterility tests?

Value of surveillance

2 peaks that coincided with construction work



Emerging Infectious Diseases Vol. 13, No. 8, August 2007

Mould growth on building materials

- Obvious indicators
  - Visible growth
  - Musty odour

- Water damage
  - Ceiling boards
  - Wallpaper

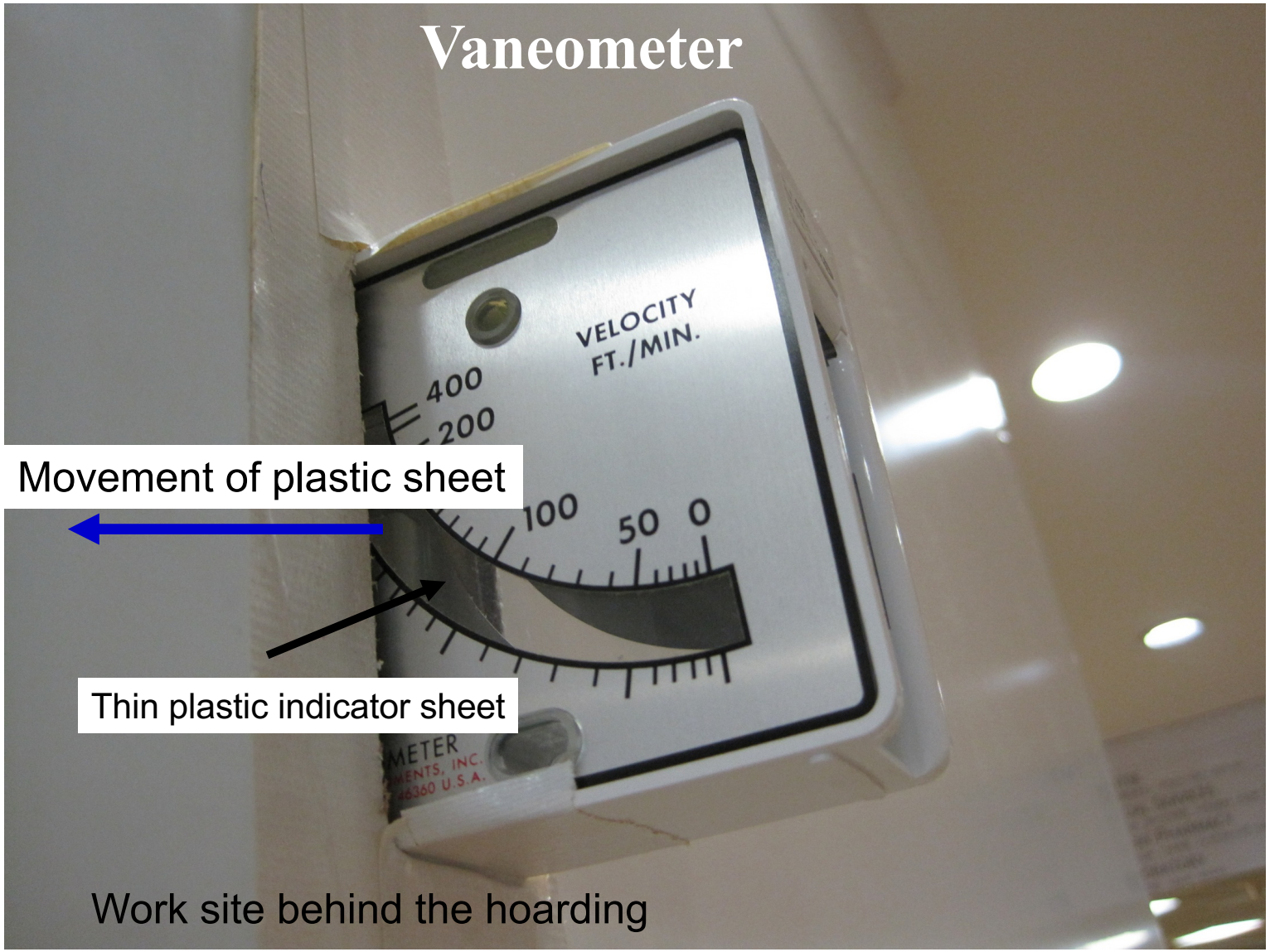
Control measures

- Keep dust in
- Protect patients
- Monitor and checks

Control measures to maintain negative pressure within the work site

- Isolate HVAC
  - Seal air vents, air intakes, grills
  - Shut down HVAC system
  - Add filters

Vaneometer


VELOCITY
FT./MIN.
400
200
100
50
0
Movement of plastic sheet
Thin plastic indicator sheet
Work site behind the hoarding

Lessons

- Be involved in design and planning
- The immunocompromised host is very vulnerable
  - Best for them to be relocated
- Look beyond Aspergillus……
- Surveillance
  - 2 cases of the same type of invasive fungal infections clustered in time and place should raise suspicion for an outbreak
  - Surveillance data should be reviewed over time and analysed
    - Correlate with construction and renovation activities