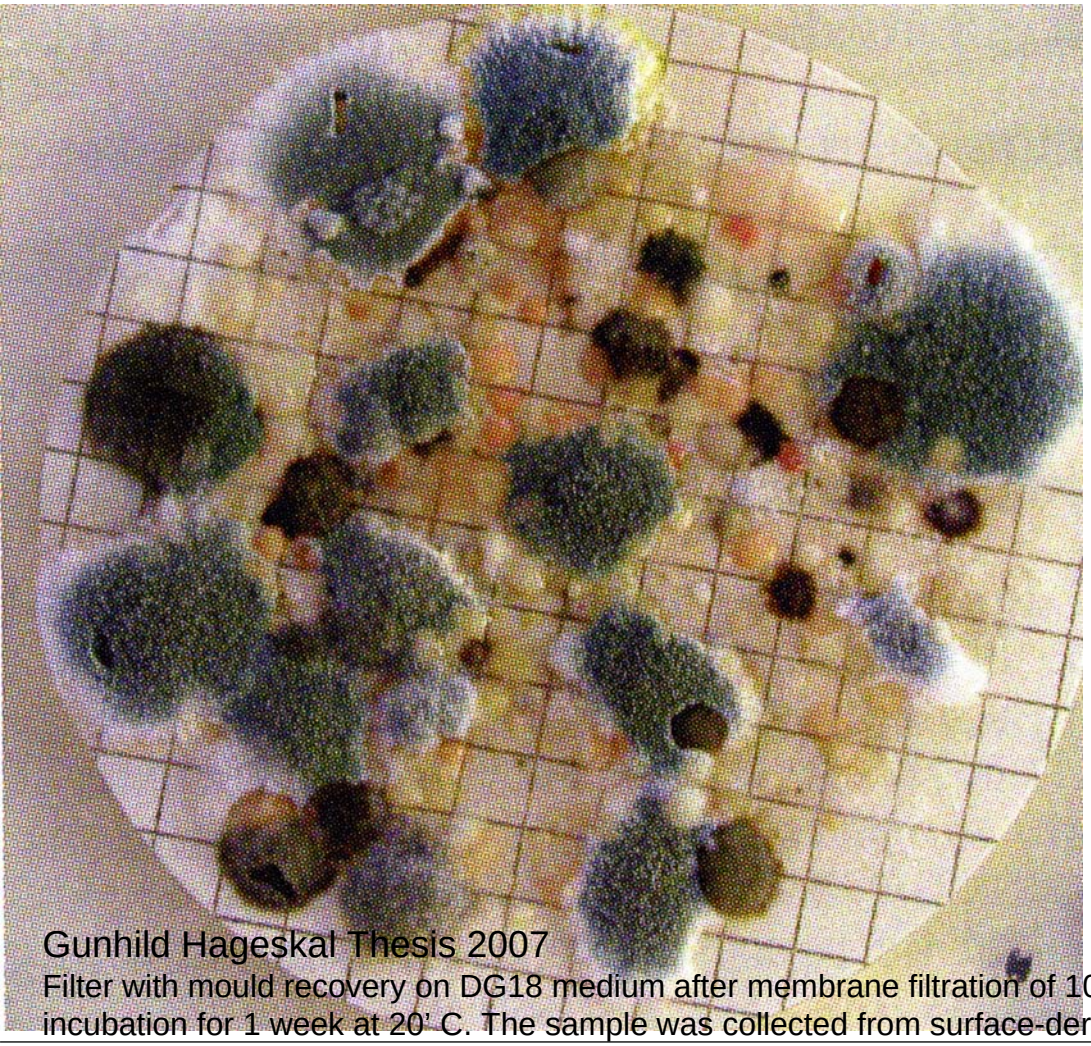
Hospital water and invasive fungal infection

Peter Gaustad

Rikshospitalet University Hospital

Oslo, Norway

Water sample collected from Norwegian surface-derived raw water



Gunhild Hageskal Thesis 2007
Filter with mould recovery on DG18 medium after membrane filtration of 100ml and incubation for 1 week at 20’ C. The sample was collected from surface-derived raw water

Moulds are present in water samples

Moulds gives infections by exogenous route

Will not discuss yeasts (less number in water; endogenous infections)

Issues we are going to discuss

1) Can humans be infected from moulds in water?
2) Are moulds present in potable and hospital water?
3) Routes of entry for infecting moulds from water
4) Connections between water and IFI
5) Can we eliminate moulds from hospital water
6) Significance of moulds in hospital water for human health – clinical impact

Waterborne moulds infections

No definitive proof that water is an important source of human infection

"Wet route of transmission":

Invasive Pulmonary and Central Nervous System aspergillosis After Near-Drowning of a child Leroy P et al Pediatrics 2007

IFI after near-drowing: Pseudallescheria boydii/Scedosporium apiospermum

Aspergillus spp

Presence of Pneumocystis DNA in pond water Casanova-Cardiel L J Ekaryot Microbiol 1997

Moulds in potable and hospital water

Several studies – geographic variations

Species giving IFI are present

The amount of moulds in water is variable and we do not know infecting dose

- Ground water/surface water
- In countries

Surface water from intake reservoir to taps and showers in hospital.

Table II *A. fumigatus recovered from water samples*

Location	Total samples	Positive samples	Mean cfu*
Intake reservoir	20	17 (85%)	3.1
Untreated water	10	8 (80%)	3.8
Treated water	10	9 (90%)	2.4
Hospital	168	63 (37.5%)[a]	2.0[b]
Main pipe	36	14 (39.8%)[c]	2.1[d]
Taps	96	47 (49%)[e]	1.9[f]
Showers	36	2 (5.6%)[g]	1.0[h]

cfu, colony forming units; *mean colony forming units expressed as number of cfus divided by the total number of positive samples.
[a]$P<0.001$ vs. intake reservoir; [b]$P=0.001$ vs. intake reservoir;
[c]$P=0.001$ vs. intake reservoir; [d]$P=0.002$ vs. intake reservoir;
[e]$P=0.001$ vs. intake reservoir; [f]$P<0.001$ vs. intake reservoir;
[g]$P<0.001$ vs. taps, main pipe and intake reservoir; [h]$P=0.002$ vs. main pipe, $P<0.001$ vs. taps and intake reservoir.

A. Warris J Hosp Infect 2001;47:143

Moulds in water pipes: 30 genera including 94 different species

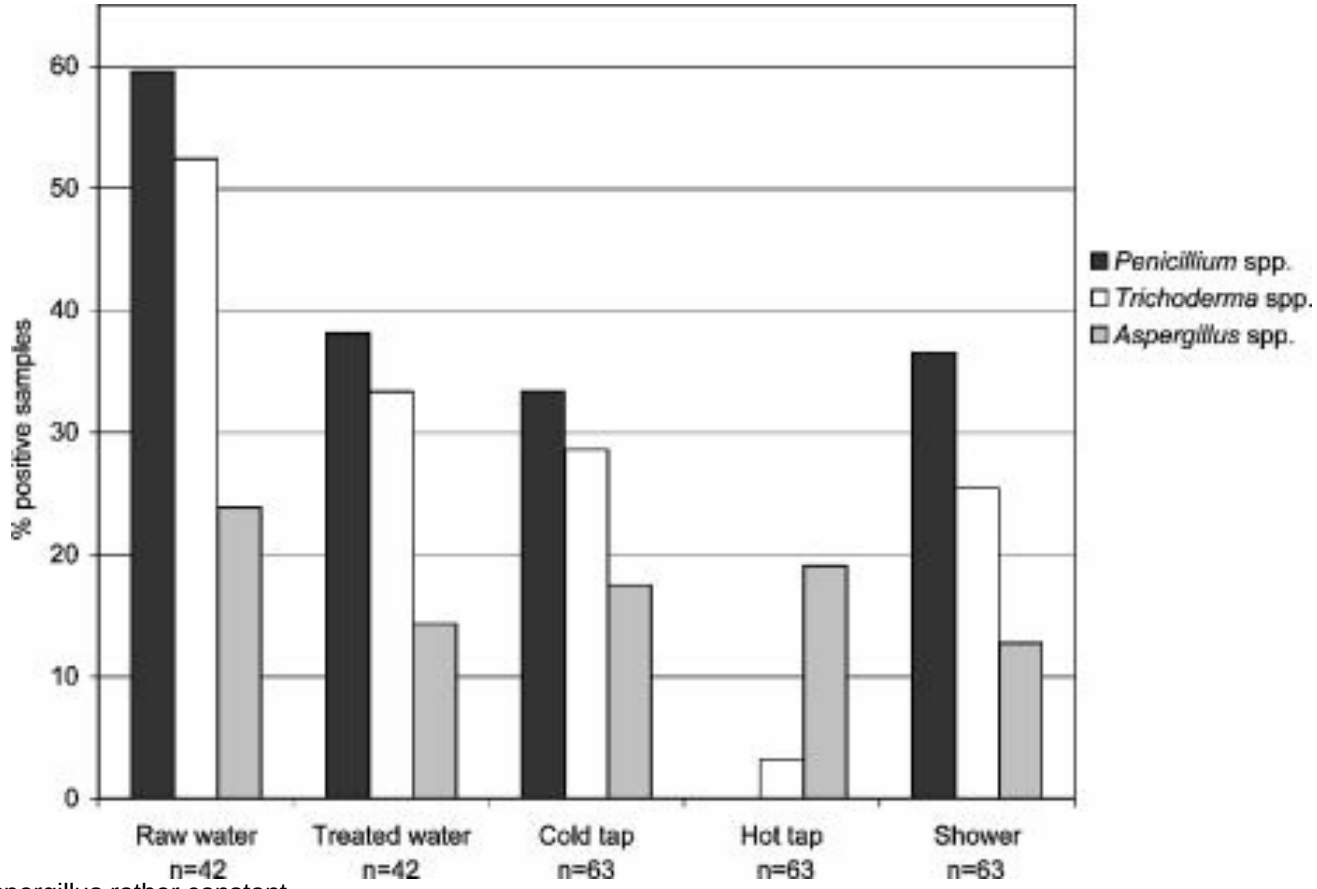
Dominating: *Penicillum, Aspergillus,*
Also present: *Absidia, Fusarium, Mucor*.

Sampling location	**Positive samples**	**Mean CFU/100 ml**	**Min – Max CFU/100 ml**
Raw water	81 %	15	2 – 36
Treated water	69 %	9	1 – 31
Private home			
Cold tap	71 %	7	1 – 28
Hot tap	21 %	2	1 – 5
Shower	69 %	10	1 – 100
Hospital			
Cold tap	91%	9	1 – 28
Hot tap	24 %	6	1 – 16
Shower	67 %	6	1 – 13

Cold water in hospitals have higher number of positive samples than raw water and private homes. Long complicated watertubes, dead ends, Biofilm?

G Hageskal 2007

Trends in the distribution of the three genera with the highest isolation frequencies. The water system installations (cold-water taps, hot-water taps, and showers) represent both private homes and hospitals. n, number of samples.



Amount of Aspergillus rather constant

G Hageskal Appl Environ Microbiol. 2006; 72: 7586.

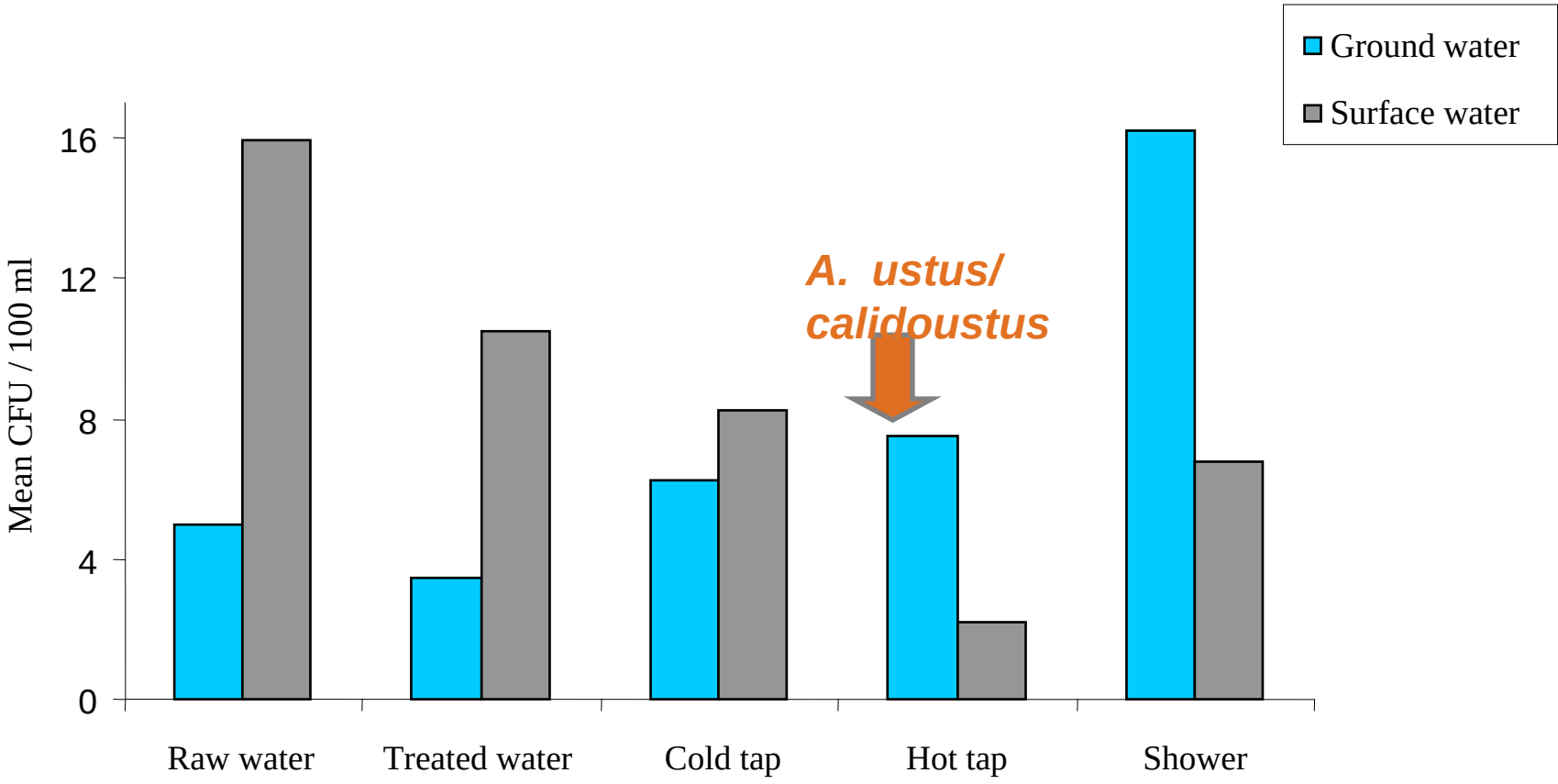
Moulds in waterpipes (Norway): Distributions of different species recovered at the sampling points

Norwegian groundwater: moulds are present. In contrast to studies from Greece and the Netherlands

Sampling point	No. of samples	Total no. of species	No. of species in:	
			Surface water	Groundwater
Raw water	42	51	48	3
Treated water	42	51	43	8
Private home				
Cold-water tap	42	46	43	3
Hot-water tap	42	7	5	2
Shower	42	44	37	7
Hospital				
Cold-water tap	21	36	29	7
Hot-water tap	21	3	2	1
Shower	21	27	22	5

G Hageskal Appl Environ Microbiol. 2006; 72: 7586.

A.ustus/calidoustus: *in Norwegian hot water*, forms biofilms, emerging pathogen, reduced susceptibility.

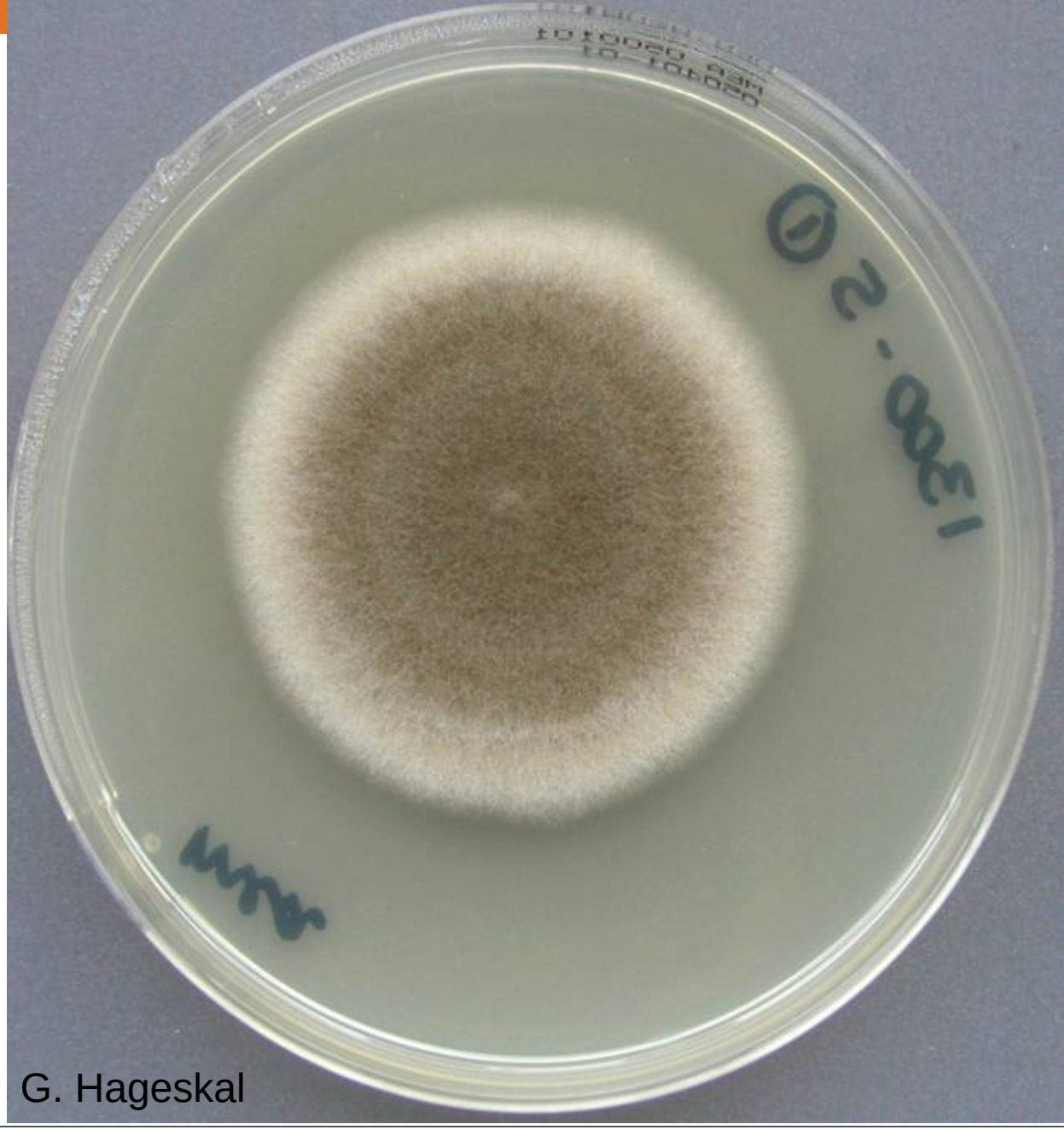


G Hageskal Appl Environ Microbiol. 2006; 72: 7586.

Aspergillus Ustus

In potable water

I. Skaar,



G. Hageskal

P. Gaustad, Rikshospitalet University Hospital, Norway

RIKSHOSPITALET

Warm water, Svalbard. Mainly growth of A. ustus

Can we reduce the possible health risk of moulds from hospital water?

Water disinfection:

- Ineffective: chlorination

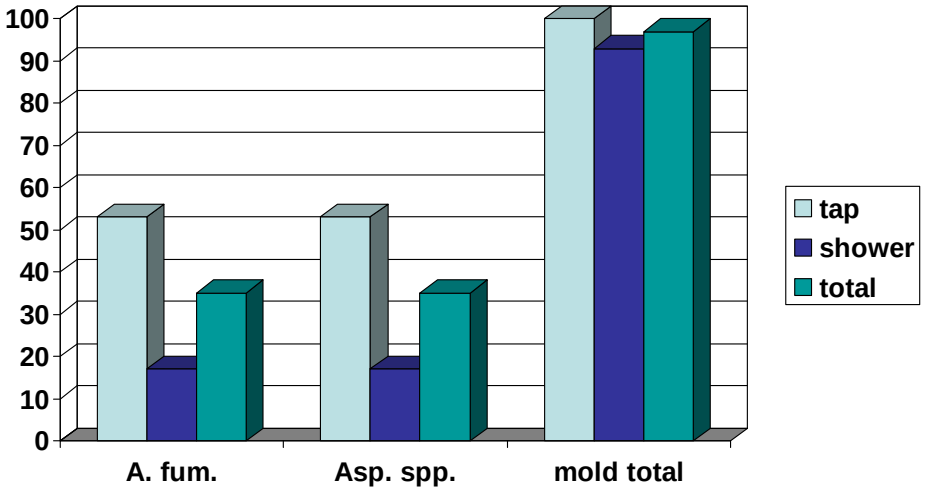
  Effecitve: boiling/distillation
- Flash Heating?
- Filtration – point of use filters

- Sterile/bottle water for drinking

CDC recommendations:

- Avoid showering (use sponge bath)
- Avoid exposure to faucet water
- Cleaning and repair of water leaks to prevent mould proliferation

Percent positive water samples paediatric BMT unit



April 2005 water samples were taken from 10 showers (hot water) and 10 sink taps (cold water).

The samples were collected in sterile glass bottles on three different days in an 8-day period.

Then, point-of-use filters (Pall-Corporation®) were installed on the taps and showerheads.

The filters were deposited on Sabouraud glucose agar, incubated for 7 days and examined for fungal species and identified to the species level.

Onken A et al, Poster ECCMID Barcelona

Percentage of positive water samples and level of contamination				
	Before point-of-use filters		With point-of-use filters	
	Sink taps (n=30)	Showers (n=30)	Sink taps (n=10)	Showers (n=10)
Filamentous fungi	100 % (3.4 cfu/500mL)	93 % (2.3 cfu/500mL)	0	0
Aspergillus spp.	53 % (1.0 cfu/500mL)	17 % (0.2 cfu/500mL)	0	0
A. fumigatus	53 % (1.0 cfu/500mL)	17 % (0.2 cfu/500mL)	0	0

Onken A et al, Poster ECCMID Barcelona

Conclusions of the study

The installation of point-of-use filters retained the fungal contamination of the hospital water completely.

Due to a high level of organic material in the Norwegian water, the filters were blocked after being in use for only 1 or 2 days.

Pre-filtration at the inlet of the water into the paediatric oncology department should be carried out to get rid of the organic materials.

Our findings indicate that point-of-use filters might be useful unless the water contains much organic material blocking the filters.

Onken A et al, Poster ECCMID Barcelona

Route of transmission

1. Direct ingestion → infections of GIT (primary lesions by *Mucorales* and *Aspergillus*)
2. Aspiration → pulmonary infection
3. Inoculation (In infants contamination of wounds/fragile skin by direct inoculation
4. Aerosolization leading to inhalation of spores originating from water

Waterborne moulds infections

No definitive proof that water is an important source of human infection

"Wet route of transmission":

Invasive Pulmonary and Central Nervous System aspergillosis After Near-Drowning of a child Leroy P et al Pediatrics 2007

IFI after near-drowing: Pseudallescheria boydii/Scedosporium apiospermum

Aspergillus spp

Presence of Pneumocystis DNA in pond water Casanova-Cardiel L J Ekaryot Microbiol 1997

Case evidence: Isolate of A. fumigatus from patient dying of IA had DNA profile identical to isolates from patient room water, but different from isolates from other locations Anaissie E, Abstract ICAAC 2000

Molecular investigations of patients and environmental moulds isolates

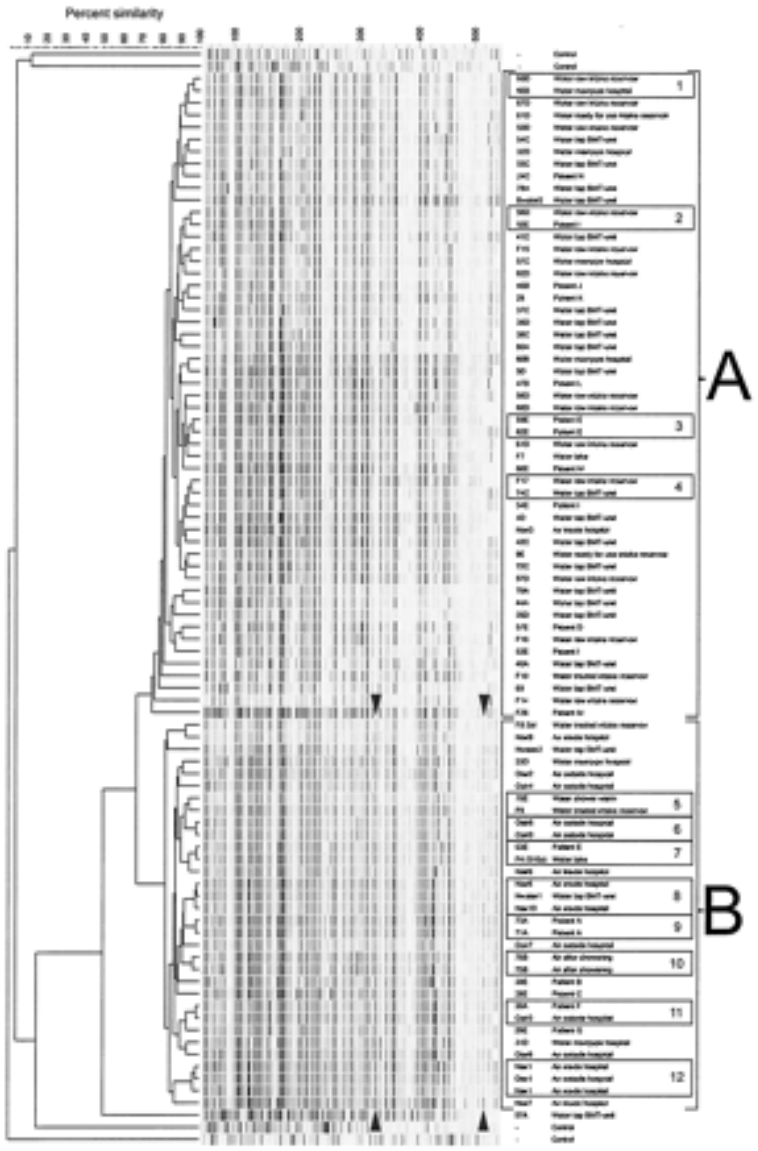
Genotyping methods:

AFLP amplified fragment length polymorfism

Microsatellite analysis short tandem repeat analysis

AFLP is more universally applicable, but short tandem repeat analysis offers better discriminatory power and should be the preferred method for standardizing typing of clinical isolates of Aspergillus fumigatus.

de Valk HA et al J Clin Microbiol. 2007



The study demonstrated:

(i) *A. fumigatus* isolates recovered from air and water are clustered in different genetic groups,

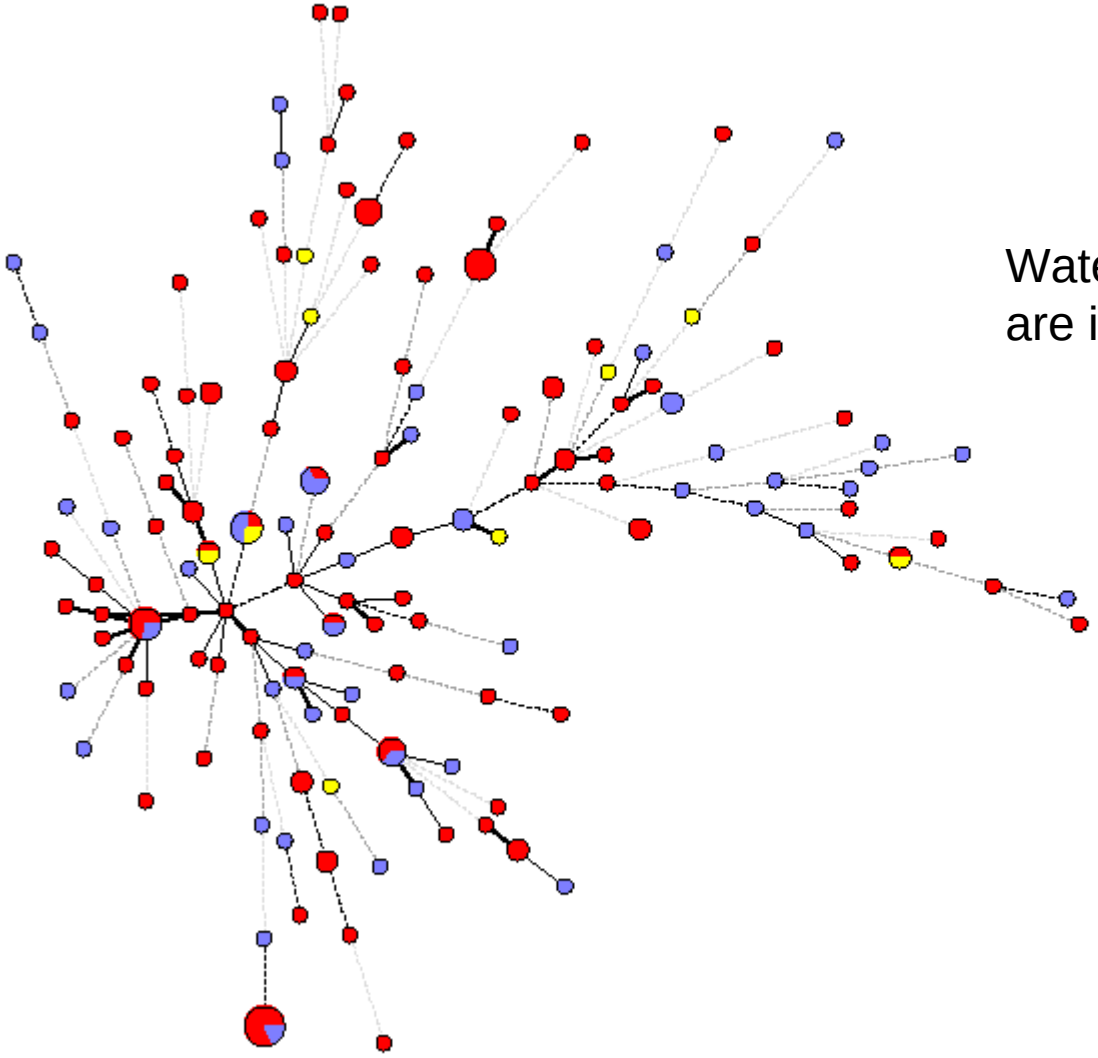
(ii) *A. fumigatus* isolates from patients were grouped in either the water or the air cluster or both,

(iii) *A. fumigatus* isolates recovered from water showed genetic relatedness with isolates recovered from patients, and

(iv) the intake reservoir is the source of *A. fumigatus* strains found in tap water inside the hospital.

A Warris J Clin Microbiol, 2003, 41: 4101

Microsatellite analysis:



- Patient strain
- Water strain
- Unknown origin

Water and patient strains are identical

C Klaasen not published

Acknowledgements

Nijmegen, The Netherlands:

Canisius Wilhelmina Hospital

Corné HW Klaassen

Jacques Meis

University St. Radboud,

Adilia Warris

Paul Verveij

Oslo, Norway

Rikshospitalet University Hospital

Annette Onken

Tore Abrahamsen

Norwegian School of Veterinary Science

Gunnhild Hageskal

Ida Skaar