IPC IN SPECIALIST SETTINGS

DR ELAINE CLOUTMAN-GREEN

WHAT INTERESTS YOU?

WHAT IS AUGMENTED CARE?

- (HTM 04-01) Augmented care units/settings: There is no fixed definition of “augmented care”. In broad terms, these patient groups will include:
- a. those patients who are severely immunosuppressed because of disease or treatment: this will include transplant patients and similar heavily immunosuppressed patients during high-risk periods in their therapy;
- b. those cared for in units where organ support is necessary, for example critical care (adult paediatric and neonatal), renal, respiratory (may include cystic fibrosis units) or other intensive care situations;
- c. those patients who have extensive breaches in their dermal integrity and require contact with water as part of their continuing care, such as in those units caring for burns.

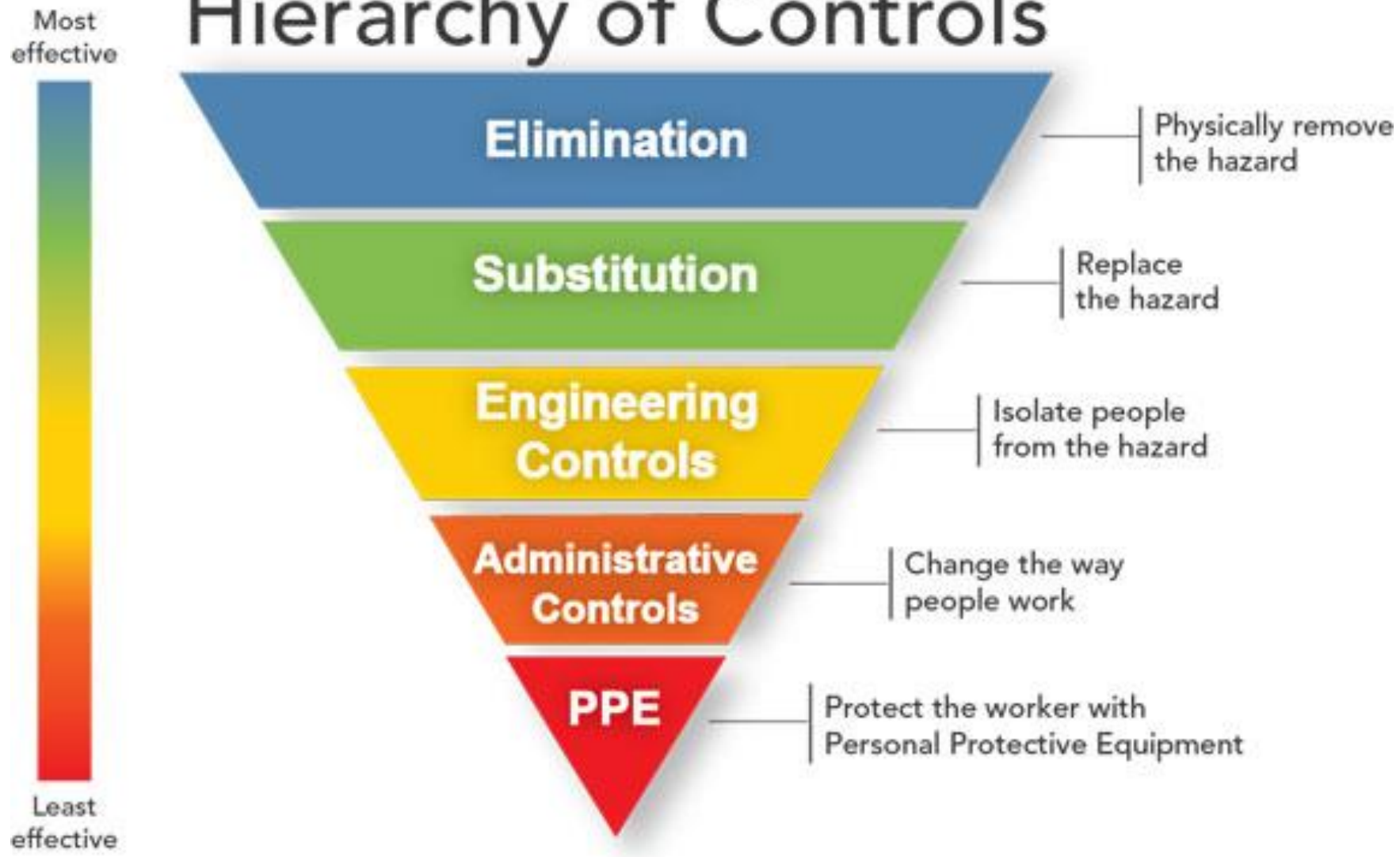
WHY IS AUGMENTED CARE DIFFERENT?

- Length of stay
- Number and term of indwelling devices
- Acuity of underlying condition
- Immune status
- Susceptibility to unusual/difficult to treat organisms
- Number of daily encounters/manipulations

RISK ASSESSMENT

- Routes of transmission
- Patient loads
- Environmental persistence
- Infectious dose
- Colonised/infectious state
- Patient susceptibility
- Timing of infection (community vs hospital acquired)
- Endogenous vs exogenous
- Surveillance
  - Clinical (active vs symptom lead)
  - Environmental

Hierarchy of Controls



ELIMINATION/SUBSTITUTION

CDC BIG FOUR HCAI

Type of infection	CDC timescale
Superficial surgical site infection	Infection occurs within 30 days after the operative procedure
Deep incisional surgical site infection and Organ/space surgical site infection	Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if an implant is in place and the infection appears to be related to the operative procedure
UTI (catheter associated)	Patient has a urinary catheter or had one removed in the previous 48 hours
BSI (catheter associated)	Patient has had a cardio vascular access device inserted in place for greater than 48 hours
VAP (ventilator-associated pneumonia)	Patient diagnosed with pneumonia where the patient has been on a ventilator for greater than 48 hours

WHAT IMPACT COULD ELIMINATION HAVE?

- a review by Umscheid et al, 2011 confirmed with current evidence-based strategies that many common HCAIs might be preventable:
- 65%–70% of cases of CLABSI and CAUTI
- 55% of cases of VAP and SSI

- CLABSI having the highest number of preventable deaths and the highest cost impact

(Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol 2011;32:101–114.)

ACTIVE SCREENING

Active screening and decolonization for MRSA in a study by Lee et al (2015) was independently associated with a decrease in in-hospital MRSA infections (adjusted odds ratio: 0.3; 95% CI: 0.1 to 0.8) and 90-day mortality (adjusted hazard ratio: 0.8; 95% CI: 0.7 to 0.99). Cost analysis showed that $22 medical costs can be saved for every $1 spent on the intervention.

(Lee YJ, Chen JZ, Lin HC, et al. Impact of active screening for methicillin-resistant Staphylococcus aureus (MRSA) and decolonization on MRSA infections, mortality and medical cost: a quasi-experimental study in surgical intensive care unit. *Crit Care*. 2015;19(1):143.)

MRSA has been identified as a significant cause of neonatal morbidity and mortality and there is a role for active screening in this patient group outside of the surgical setting

(Dong Y, Glaser K, Speer CP. New Threats from an Old Foe: Methicillin-Resistant Staphylococcus aureus Infections in Neonates. Neonatology. 2018;114(2):127-134)

DECOLONISATION

- Decolonization therapy = administration of antimicrobial/antiseptic agents to eradicate/suppress carriage
  - For MRSA
    - Intranasal antibiotic or antiseptic (e.g., mupirocin, povidone-iodine)
    - Topical antiseptic (e.g., chlorhexidine)
    - +/-Systemic antibiotics
- Selective digestive decontamination
  - Example: (i) a parenteral antibiotic, cefotaxime, administered for a few days to prevent primary endogenous infections typically occurring 'early'; (ii) the topical antimicrobials polymyxin E, tobramycin and amphotericin B

DECOLONISATION

- CDC recommends daily bathing of hospitalized patients with 2% Chlorhexidine gluconate (CHG) in the intensive care and bone marrow transplant settings to reduce CLABSIs
  - Compliance is variable (between 23–77%) (Reynolds SS, Woltz P, Keating E, Neff J, Elliott J, Hatch D, Yang Q, Granger BB. Results of the CHlorhexidine Gluconate Bathing implementation intervention to improve evidence-based nursing practices for prevention of central line associated bloodstream infections Study (CHanGing BathS): a stepped wedge cluster randomized trial. Implement Sci. 2021 Apr 26;16(1):45.); Ridenour G, Infect Control Hosp Epidemiol 2007; Evans HL, Arch Surg, 2010; Climo MW, Crit Care Med, 2009; Karki S, J Hosp Infect, 2012; Climo MW, N Engl J Med, 2013)
  - 2% CHG contraindicated in neonates and so 1% CHG or soap and water bathing preferred

REMOVAL/MANAGEMENT OF INDWELLING DEVICES

NEONATAL CARE BUNDLE FROM LEEDS TEACHING HOSPITAL

(CARE BUNDLE FOR VASCULAR ACCESS ON THE NEONATAL UNIT (LEEDSTH.NHS.UK) – ACCESSED 18/04/2022))

LINE TEAM

Aims & objectives

- To train any operator wishing to learn vascular access techniques.
- To regularly assess operators to ensure standards maintained

LINE TEAM

Members

All qualified ANNPs

All consultants

Any senior trainee assessed as competent.

DECONTAMINATION

STAPH CAPITIS

- Key themes:
  - *S. capitis* was present in a much higher percentage of NICU blood stream infection samples than adult samples. (39.1% vs 1.0%)
  - *S. capitis* frequently has the capacity to produce biofilm, which has been linked to high levels of environmentally mediated outbreaks. This supports the need for improvements in environmental control and decontamination in order to prevent transmission.
  - *S. capitis* infection was a risk factor for severe morbidity when compared to other coagulase negative Staphylococci. (55.4% compared to 32%). With the highest risk in those that had vancomycin prior to *S. capitis* colonisation.
  - The outbreak clone (NRCS-A) harbors a novel SCCmec-SCCcad/ars/cop composite island, with Vancomycin resistance acquisition 1.9 fold faster in strains with NRCS-A clone. Outbreak clone isolates from Australia, Belgium, France, UK demonstrated >80% similarity

ENGINEERING CONTROLS

WHAT IS MEANT BY THE ENVIRONMENT?

Air

- Mechanically ventilated environments

Water

- Water sources on wards
  - Taps
  - Sterile water
  - Equipment

Surfaces

- Near patient and shared area

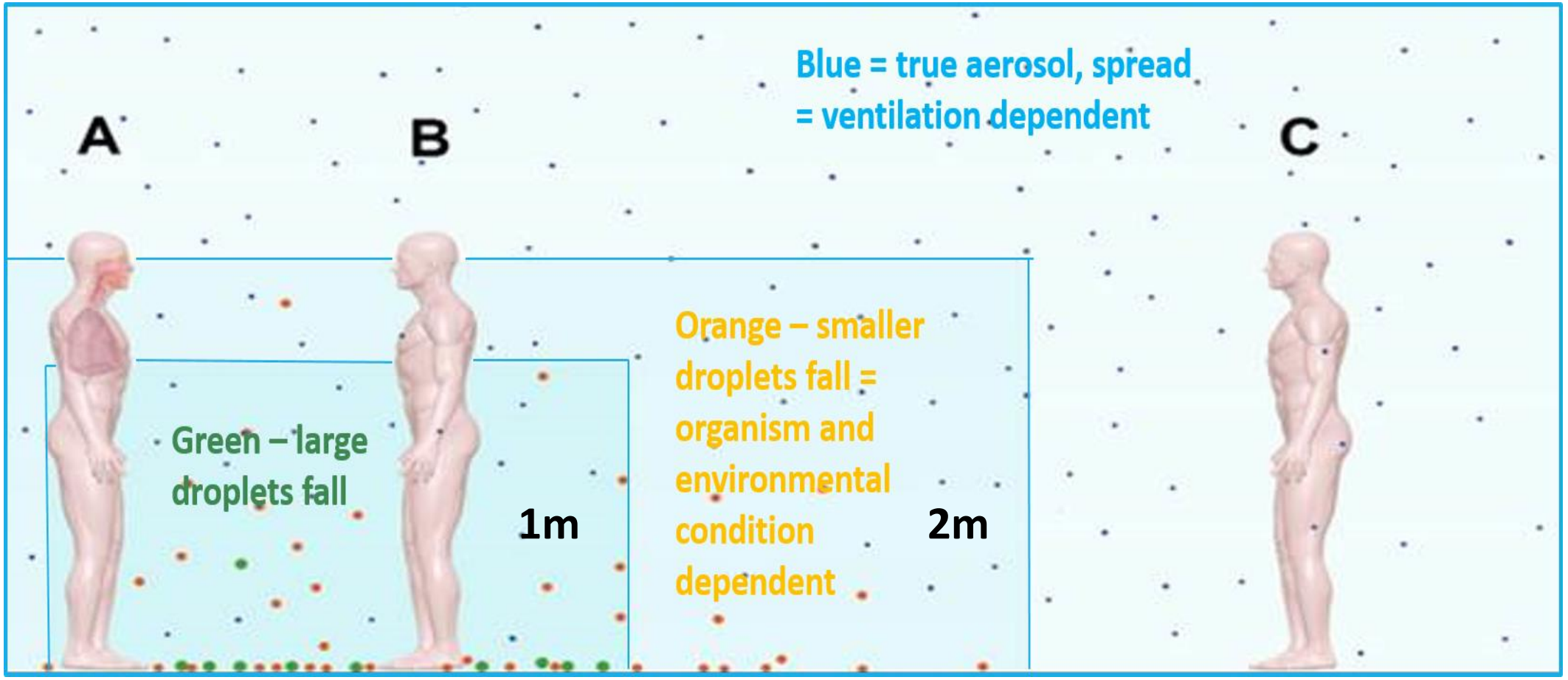
WHAT NEEDS TO HAPPEN FOR THE ENVIRONMENT TO BE A RISK?

Microorganisms must be able to contaminate the environment:

- Skin scales
- Aerosols/droplets
  - Vomit
  - Diarrhoea
  - Respiratory secretions
  - Water droplets
- Dust

Once there microorganisms need to be able to survive and get into/onto patients

CLASSICAL VS EMERGING VIEW



- Kramer A, Schwebke I, Kampf G. BMC Infectious Diseases. 2006;6(1):130.
- Weinstein RA, Hota B. Contamination, Disinfection, and Cross-Colonization: Are Hospital Surfaces Reservoirs for Nosocomial Infection? Clinical Infectious Diseases. 2004;39(8):1182-9.

Organism	Infectious Dose (if known)	Length of Survival on Surfaces
Staphylococcus aureus	<15 Colony Forming Unit/10^6 (oral dose)	7 days – >1 year
Clostridium difficile	1CFU (in mouse models)	5 months
Klebsiella spp.	No experimental evidence	<1 hour – 30 months
E. coli	10 CFU	<1 hour – 16 months
Acinetobacter spp.	No experimental evidence	3 days - 5 months
Adenovirus	<150 viral copies	7 days – 3 months
Norovirus	10 – 100 viral copies	Norovirus (including Feline Calicvirus) 8 hours – 14 days
Pseudomonas aeruginosa	10^8 (oral dose)	6 hours – 16 months
VRE	No experimental evidence	5 days – 4 months

A RETROSPECTIVE VIEW

1968 E. H. Spaulding three categories of surfaces within clinical environments:

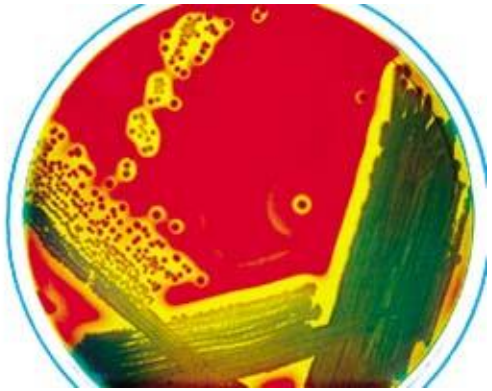
- Non-critical
- Semi-critical
- Critical

Maki (1982) said that the inanimate environment contributed negligibly to HCAI

Despite this both the CDC and DoH have issued guidance on the frequency and standard of cleaning that should be reached

SO WHAT'S CHANGED?

Microorganisms & Detection Techniques



Antibiotics & Treatments

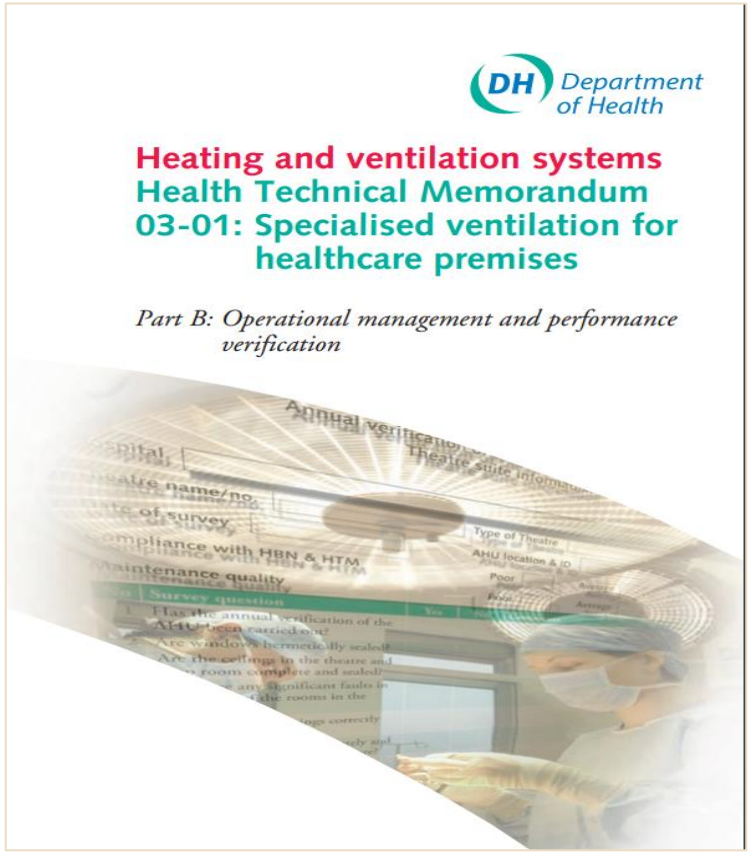
Patients

Healthcare Environments

SO WHAT ARE THE UK GUIDELINES?

- ISO 17025
- Health Technology Memorandum
- Health Building Notes
- Department of Health Guidance – Field Safety Notices and PHE documents
- Choice Framework for Local Policy and Procedures (CFPP)
- Health and Social Care Act (updated 2015)
- BSI guidance

MANAGEMENT OF VENTILATION SYSTEMS



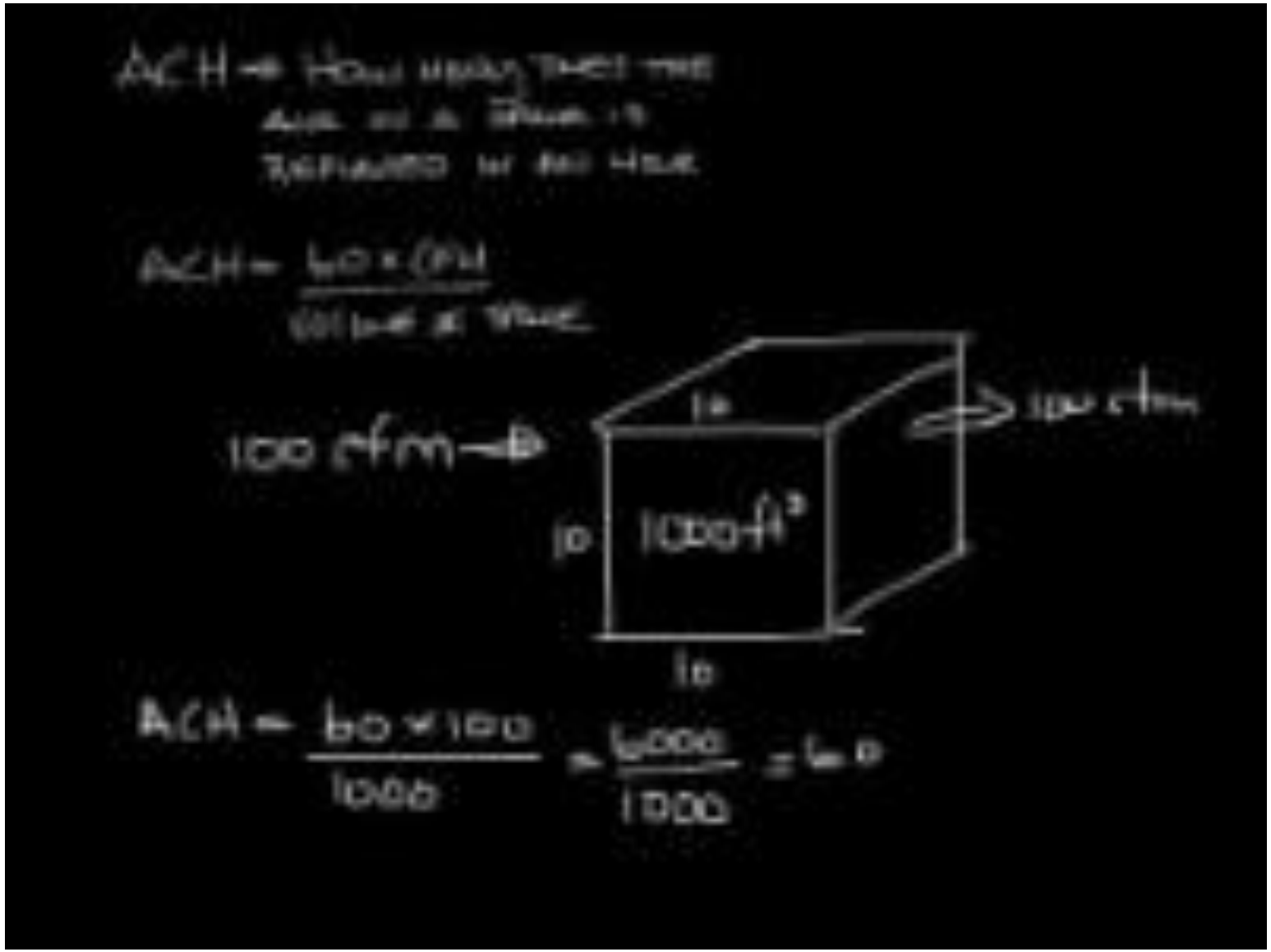
HTM 03-01 (and previously HTM 2025)

Describes how to set up mechanical ventilations systems including:

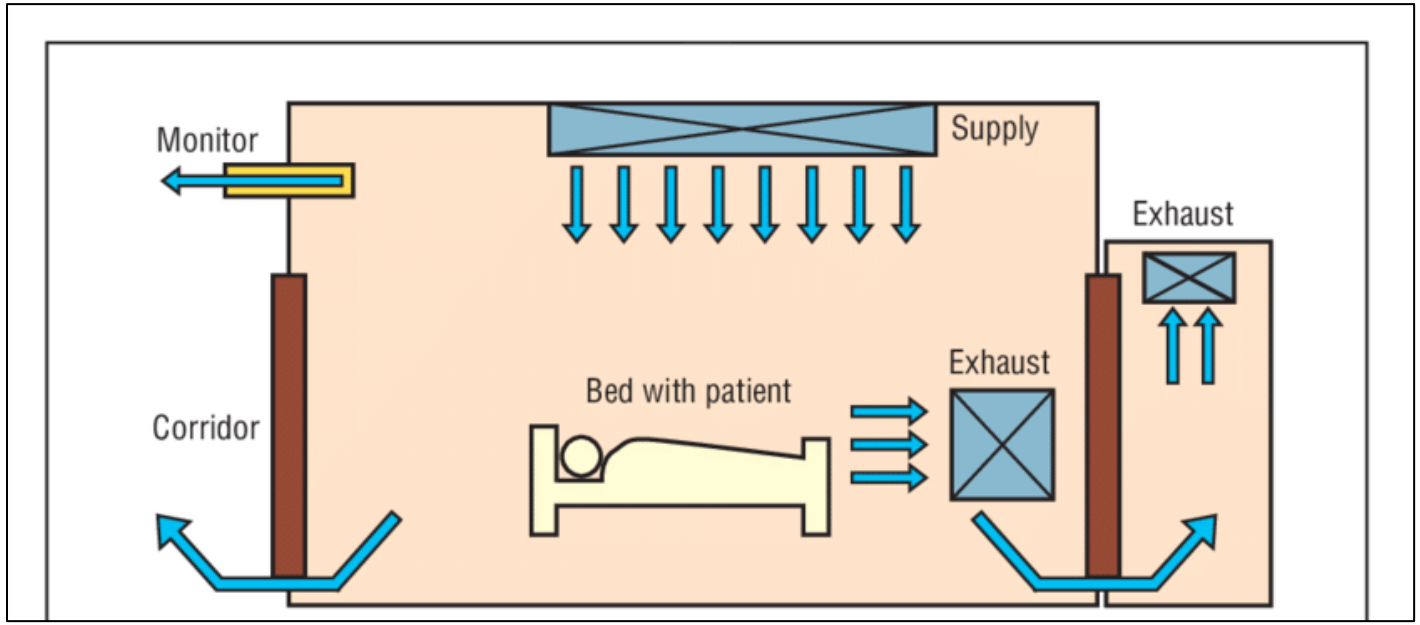
Laboratories and mortuaries	Patient isolation cubicles	Theatres

Sets out what microbiological sampling is needed when building open and annually

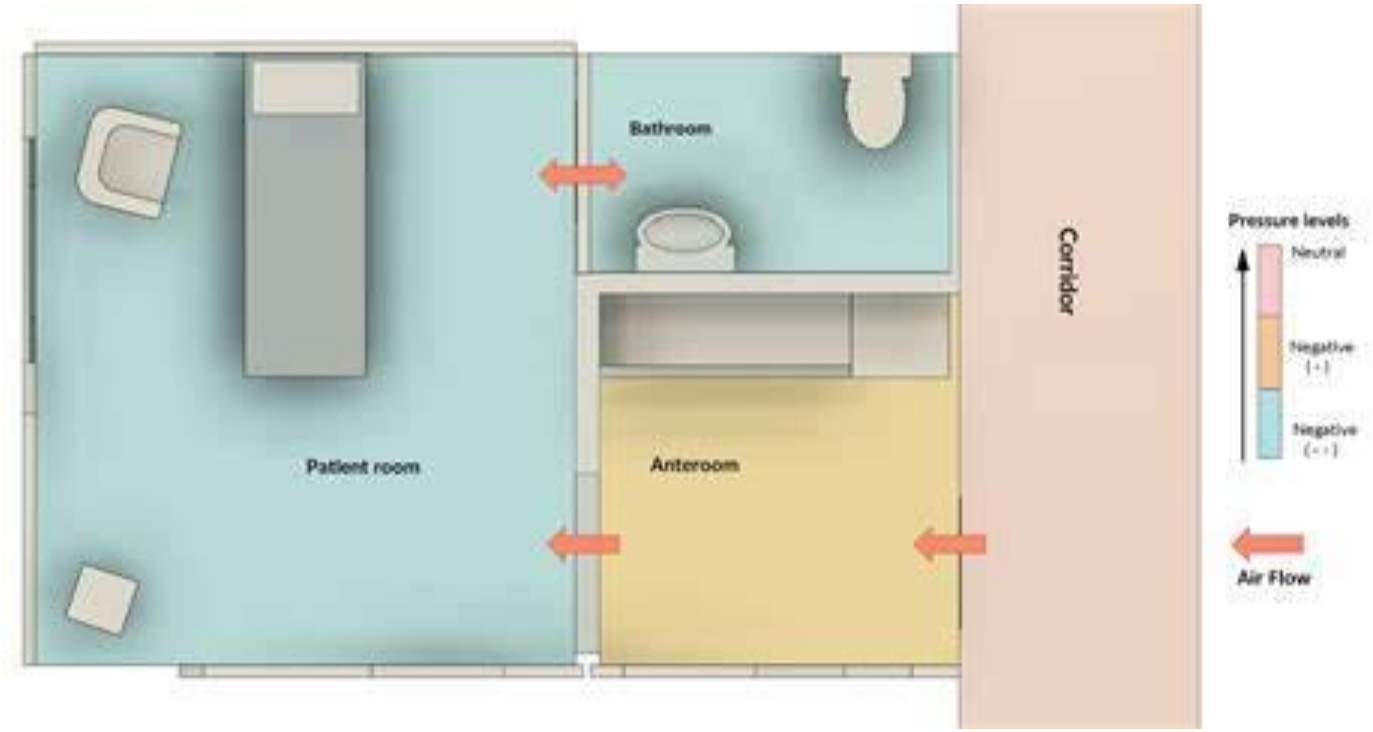
No UKAS accreditation


ACH =
ACH = 60 × CFM / Volume of Room
100 cfm
10
10
1000 ft³
10
ACH = 60 × 100 / 1000 = 6000 / 1000 = 6.0

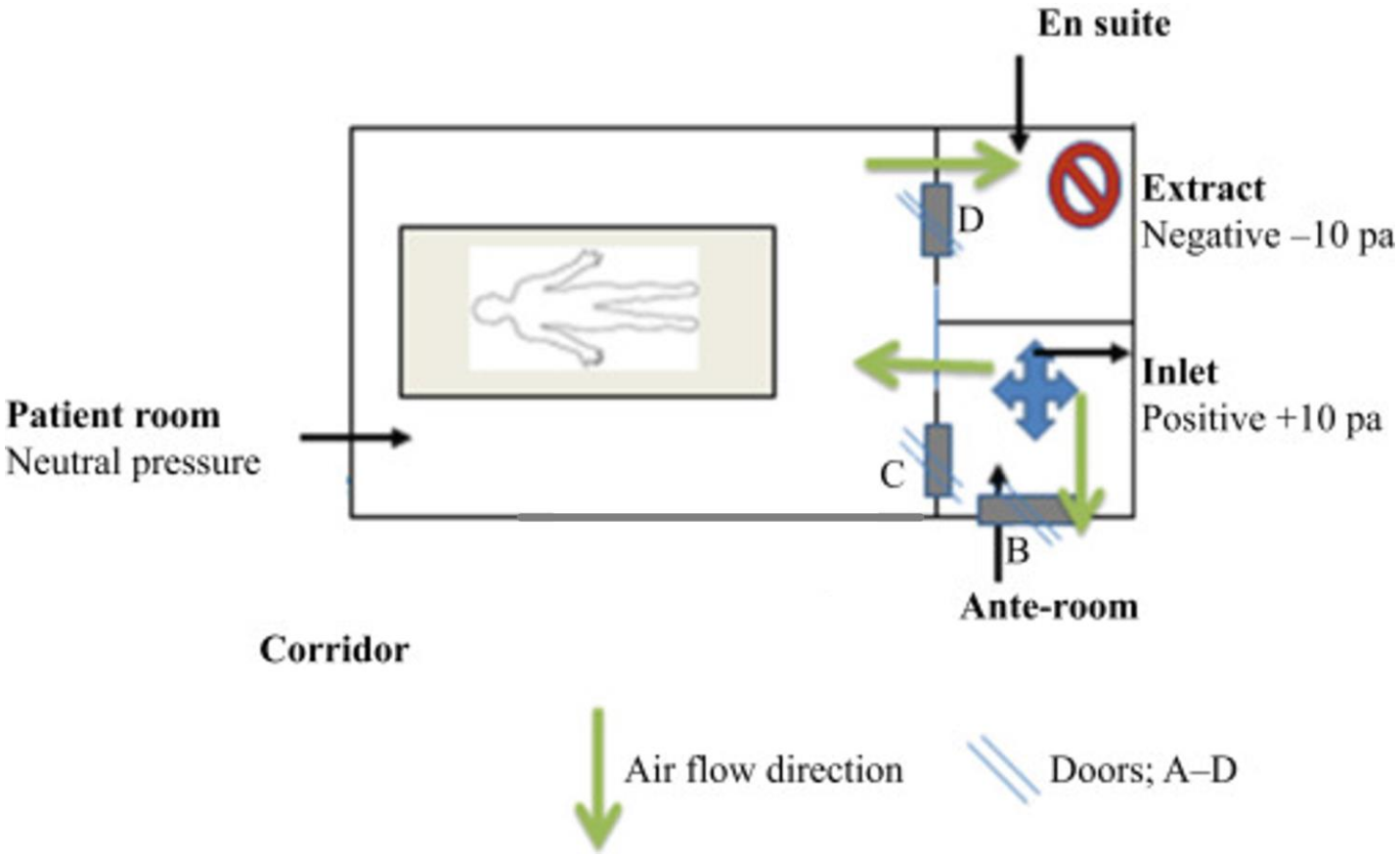
POSITIVE PRESSURE VENTILATION

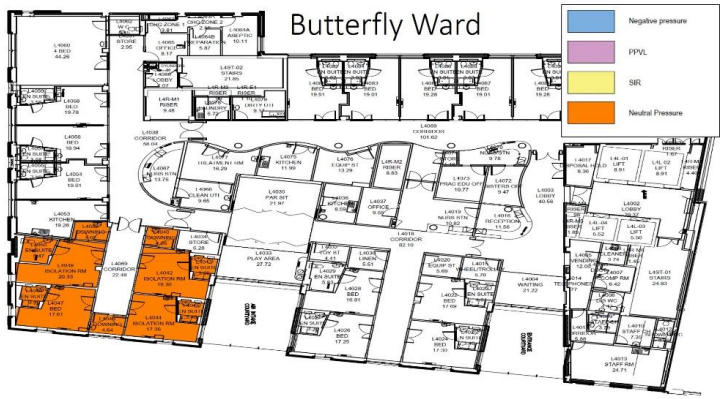


NEGATIVE PRESSURE ROOM

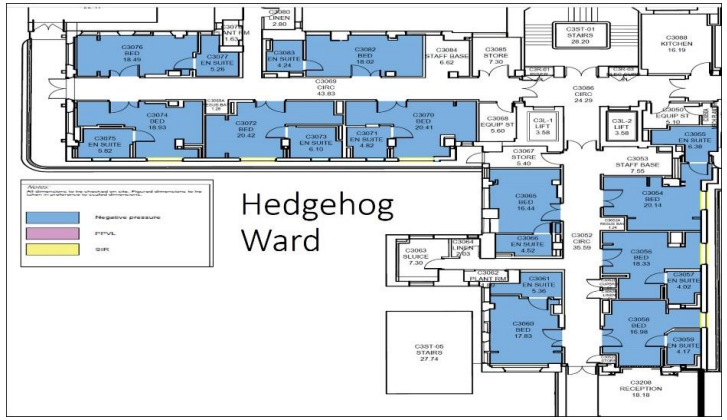


POSITIVE PRESSURE VENTILATED LOBBY ROOMS





ONE SIZE FITS ALL?



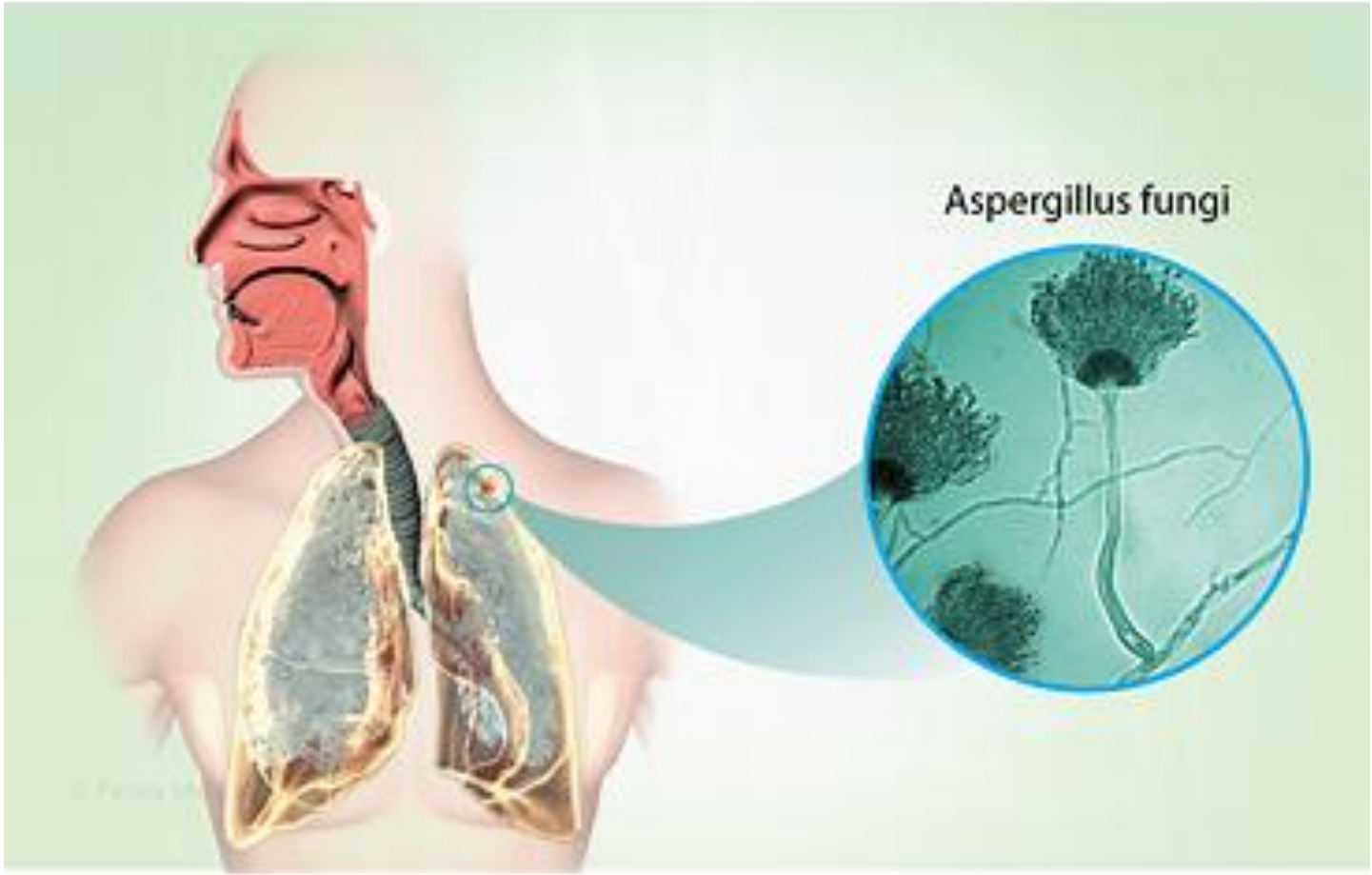
Appendix 2 – Recommended air-change rates

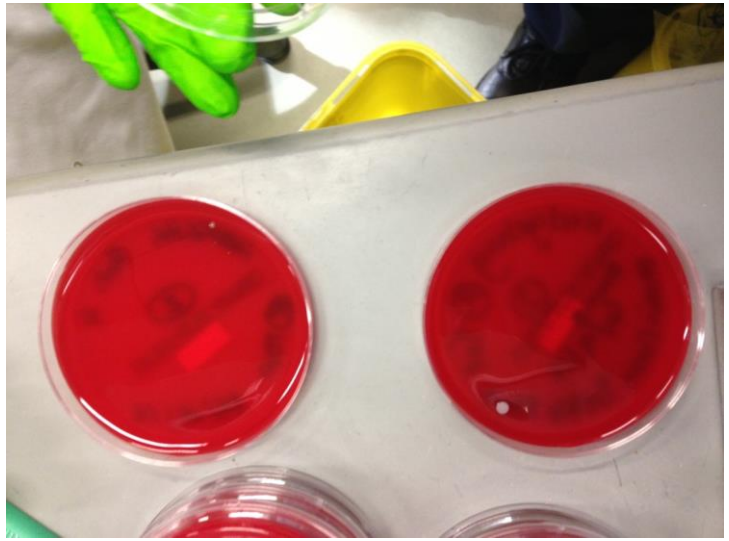
Application	Ventilation	AC/hr	Pressure (Pascals)	Supply filter	Noise (NR)	Temp (°C)	Comments (for further information see Chapter 4)
General ward	S/N	6	–	G4	30	18–28	
Communal ward toilet	E	6	–ve	–	40	–	
Single room	S/E/N	6	0 or –ve	G4	30	18–28	
Single room WC	E	3	–ve	–	40	–	
Clean utility	S	6	+ve	G4	40	18–28	
Dirty utility	E	6	–ve	–	40	–	
Ward isolation room	–	–	–	–	–	–	See Health Building Note 04-01 (Supplement 1)
Infectious disease isolation room	E	10	–5	G4	30	18–28	Extract filtration may be required
Neutropenic patient ward	S	10	+10	H12	30	18–28	
Critical care areas	S	10	+10	F7	30	18–25	Isolation room may be –ve pressure
Birthing room	S & E	15	–ve	G4	40	18–25	Provide clean air-flow path
SCBU	S	6	+ve	F7	30	18–25	Isolation room may be –ve pressure
Preparation room (lay-up)	S	>25	35	F7	40	18–25	
Preparation room/bay (sterile pack store)	S	10	25	F7	40*	18–25	*30 NR if a bay in a UCV theatre
Operating theatre	S	25	25	F7	40	18–25	
UCV operating theatre	S	25*	25	H10 or greater	50	18–25	*Fresh-air rate; excludes recirculation
Anaesthetic room	S & E	15	>10	F7	40	18–25	Provide clean air-flow path
Theatre sluice/dirty utility	E	>20	–5	–	40	–	
Recovery room	S & E	15	0	F7	35	18–25	Provide clean air-flow path
Catheterisation room	S	15	+ve	F7	40	18–22	
Endoscopy room	S	15	+ve	F7	40	18–25	
Endoscopy cleaning	E	>10	–ve	–	40	–	
Day-case theatre	S	15	+ve	F7	40	18–25	
Treatment room	S	10	+ve	F7	35	18–25	
Pharmacy aseptic suite	S	20	#	H14	–	18–22	# See EGGMP (Orange guide) *
Category 3 or 4 containment room	#	>20	#	H14*	–	18–22	# See ACDP guide; *Filter in extract
Post-mortem room	S & E	S = 10 E = 12	–ve	G4	35	18–22	Provide clean air-flow path
Specimen store	E	–	–ve	–	–	–	Fan accessible from outside of store

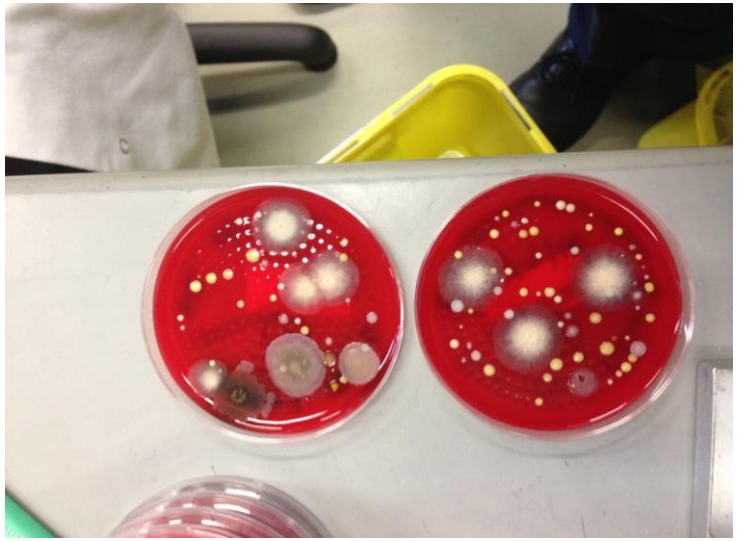
Notes: 18–22°C indicates the range over which the temperature may float.
18–22°C indicates the range over which the temperature should be capable of being controlled.
S = supply
E = extract
N = natural ventilation
a – European guidelines on good manufacturing practice published by the Medicines and Healthcare products Regulatory Agency (MHRA)

ASPERGILLUS INFECTIONS

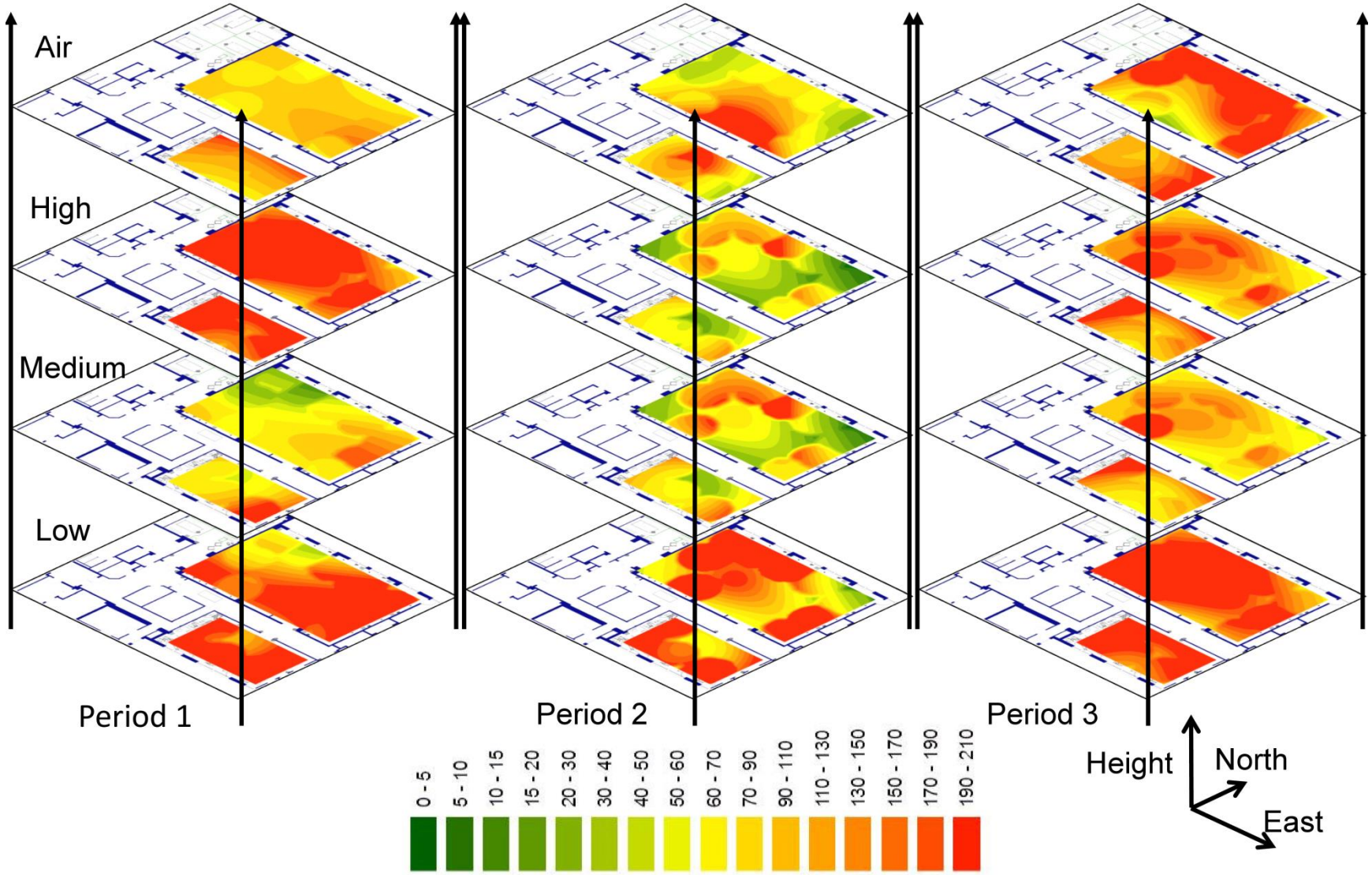
- Invasive aspergillosis risk is modified by the use of HEPA filtration combined with dilution
- Lag time from exposure to disease is often long – range of 36 hours – 3 months
- *Aspergillus fumigatus* has both the highest growth rate and the smallest spore size – which facilitates passing of spores deep within the lung
- Spores are recalcitrant to decontamination





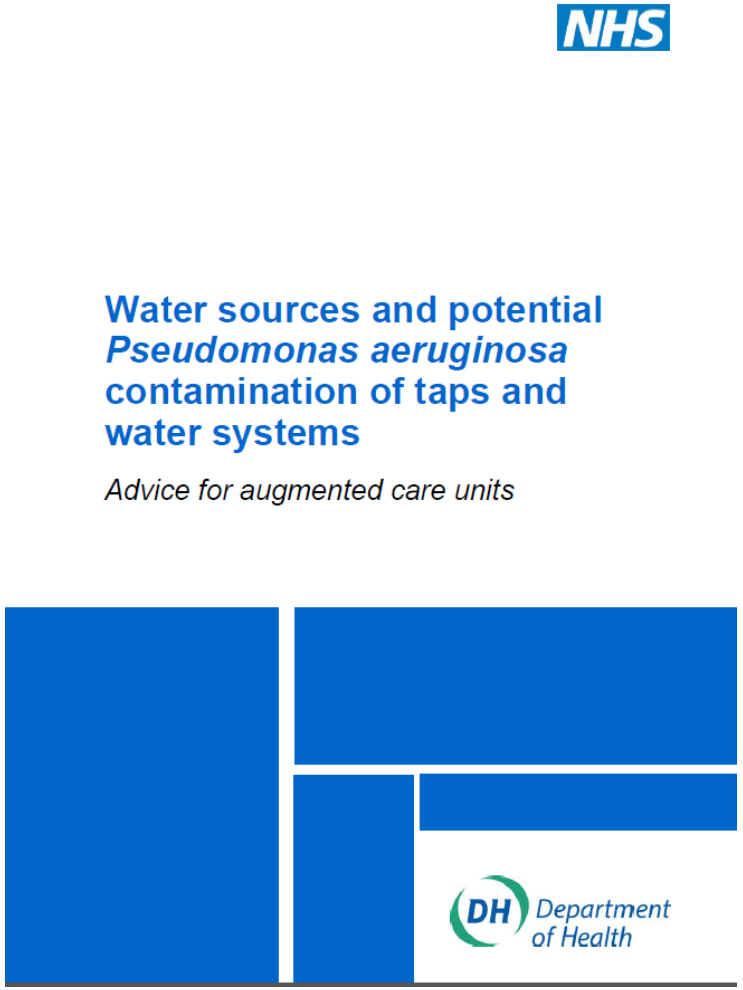


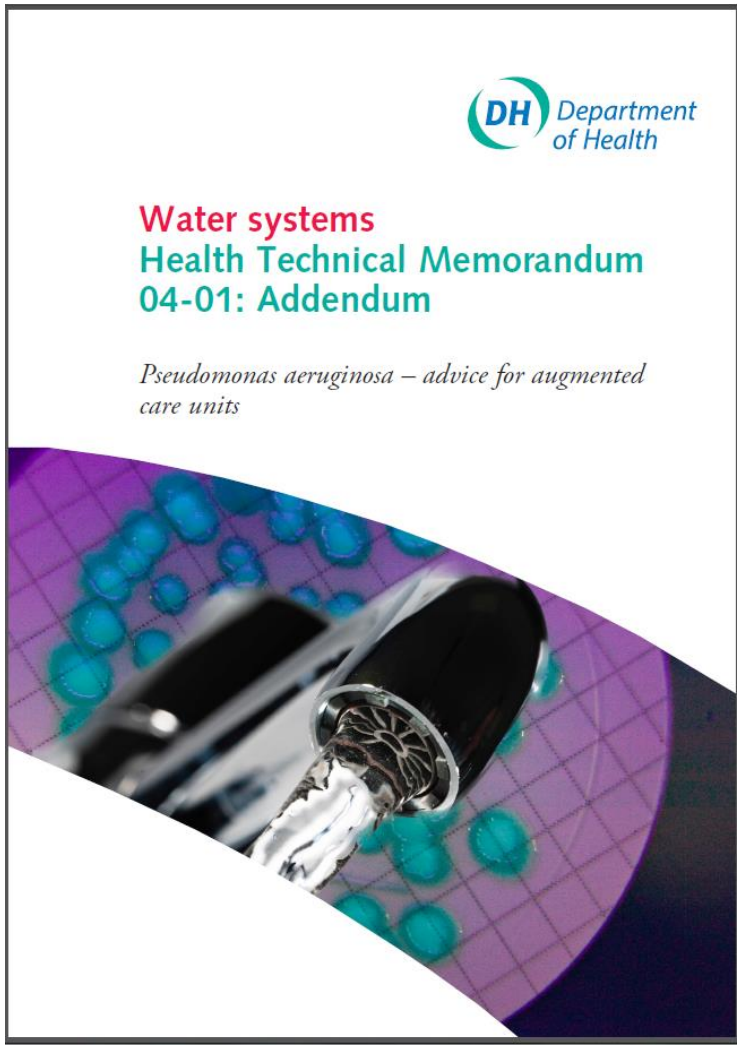

AES
Samplair
DANGER
CONTAMINATED
SHARPS ONLY
REXAM


Air
High
Medium
Low
Period 1
Period 2
Period 3
0 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 90
90 - 110
110 - 130
130 - 150
150 - 170
170 - 190
190 - 210
Height
North
East

GUIDANCE ON WATER

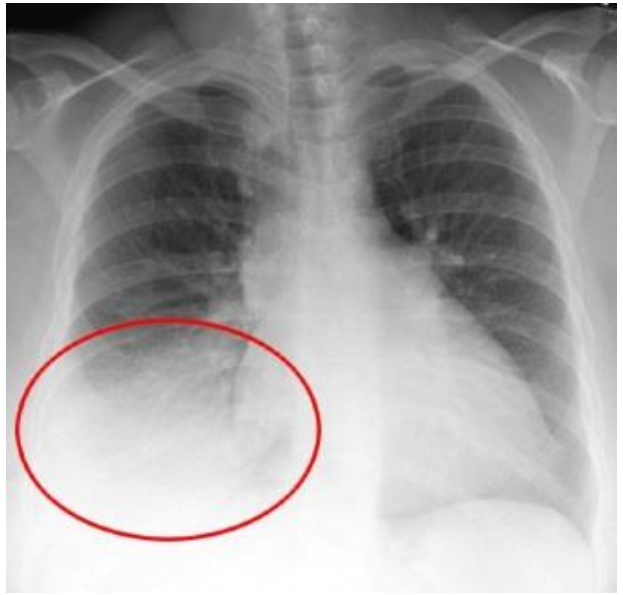
- HTM 04-01 (plus associated documents) gives guidance on water
- Includes how to sample
  - How to physically sample water
  - A bit on how to process
- How often you need to sample
- How to interpret the results
- Focusses on *Pseudomonas aeruginosa* and *Legionella pneumophila*
- Links in with UKAS accreditation





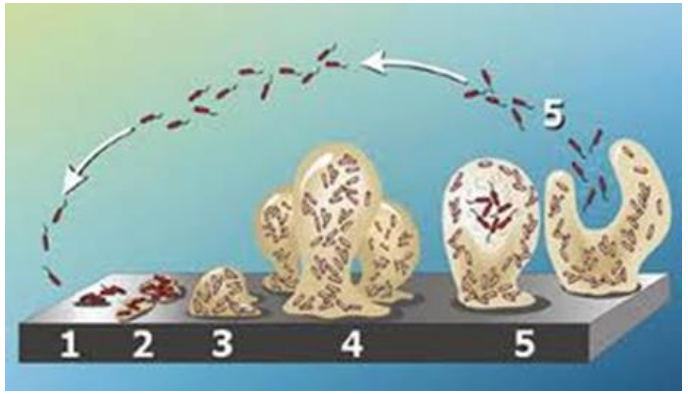
LEGIONELLA PNEUMOPHILIA

- Gram-negative aerobic bacteria
- Opportunistic pathogen
- Causes two main infections: Legionnaires' disease and Pontiac fever
- Exposure via water droplets, often associated with poorly maintained water sources
- Pontiac fever = not associated with pneumonia and often resolves without treatment
- Legionnaires' = atypical pneumonia confirmed on chest X-ray (mortality ~10%)



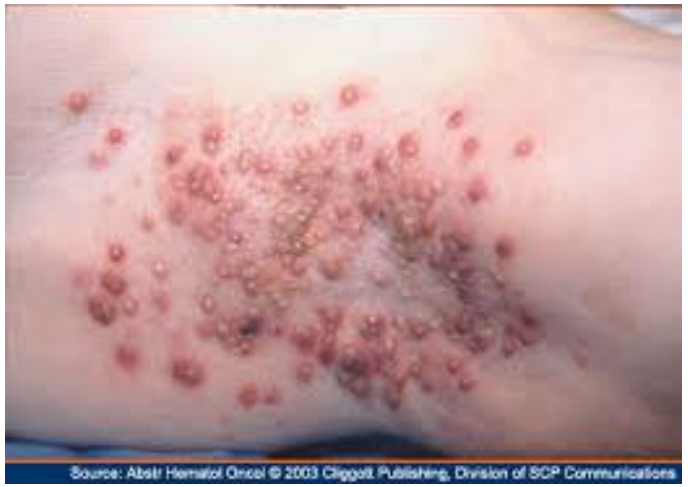
PSEUDOMONAS AERUGINOSA

- Pseudomonads are a group of related Gram-negative aerobic bacteria of which *P. aeruginosa* is the most clinically significant
- *P. aeruginosa* is motile and ubiquitous in moist environments and it is found in many natural and domestic reservoirs including hospital sites
- First cultured in 1850
- Survives by produce biofilm that allows it to survive under a wide range of conditions
- Viable organisms are still detectable 48 h after drying even on dry surfaces

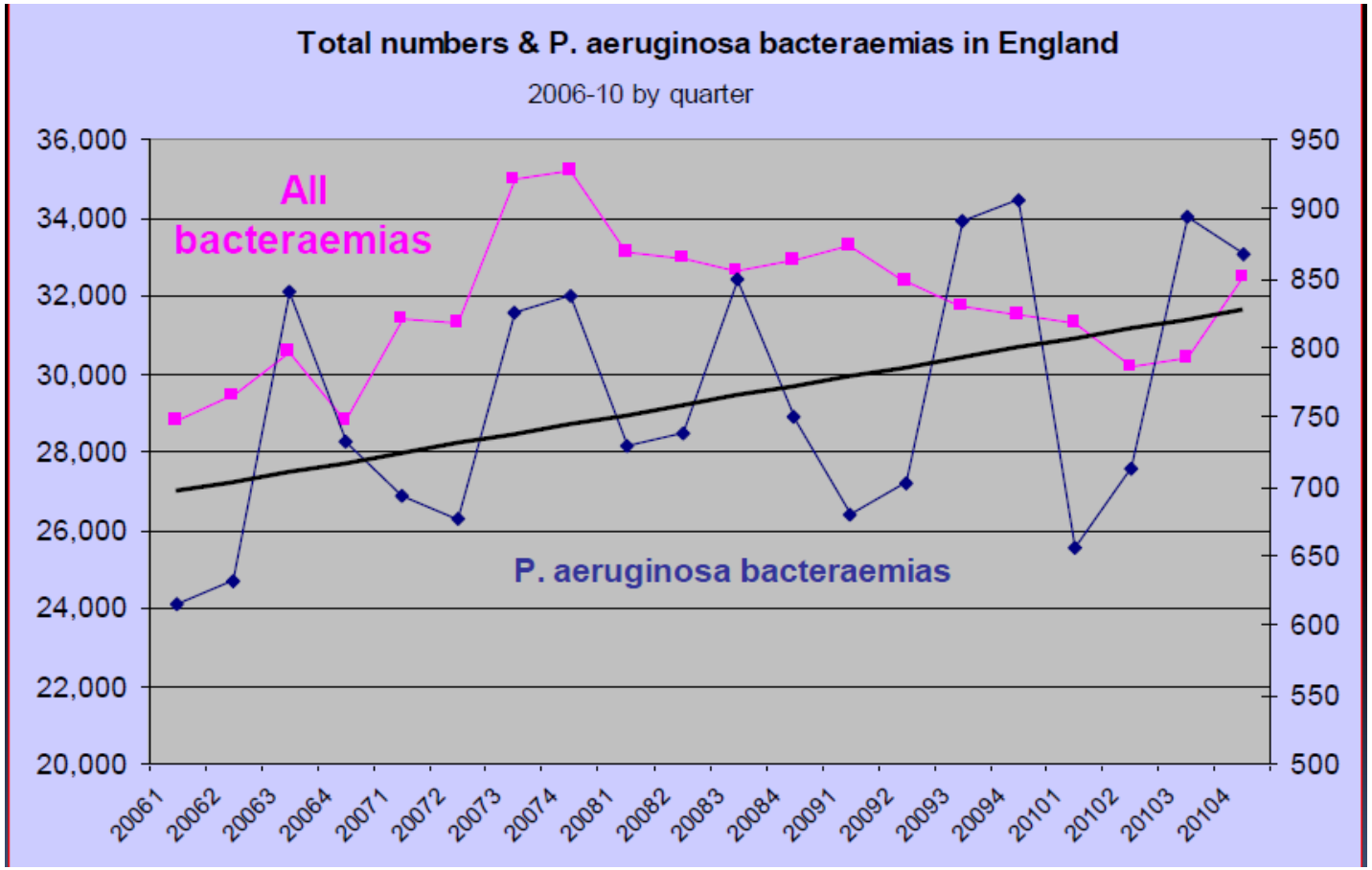


CLINICAL PICTURE

- Opportunistic pathogen
- Important cause of mortality and morbidity in the immunocompromised
  - *Pseudomonas aeruginosa* is the most commonly isolated Pseudomonas species
- Causes infections such as
  - blood transfusion-related septicaemia
  - catheter-related bacteraemia
  - peritonitis in peritoneal dialysis patients
  - ventilator associated pneumonia
  - skin and wound infections esp. burns
  - major source of infection in Cystic Fibrosis patients



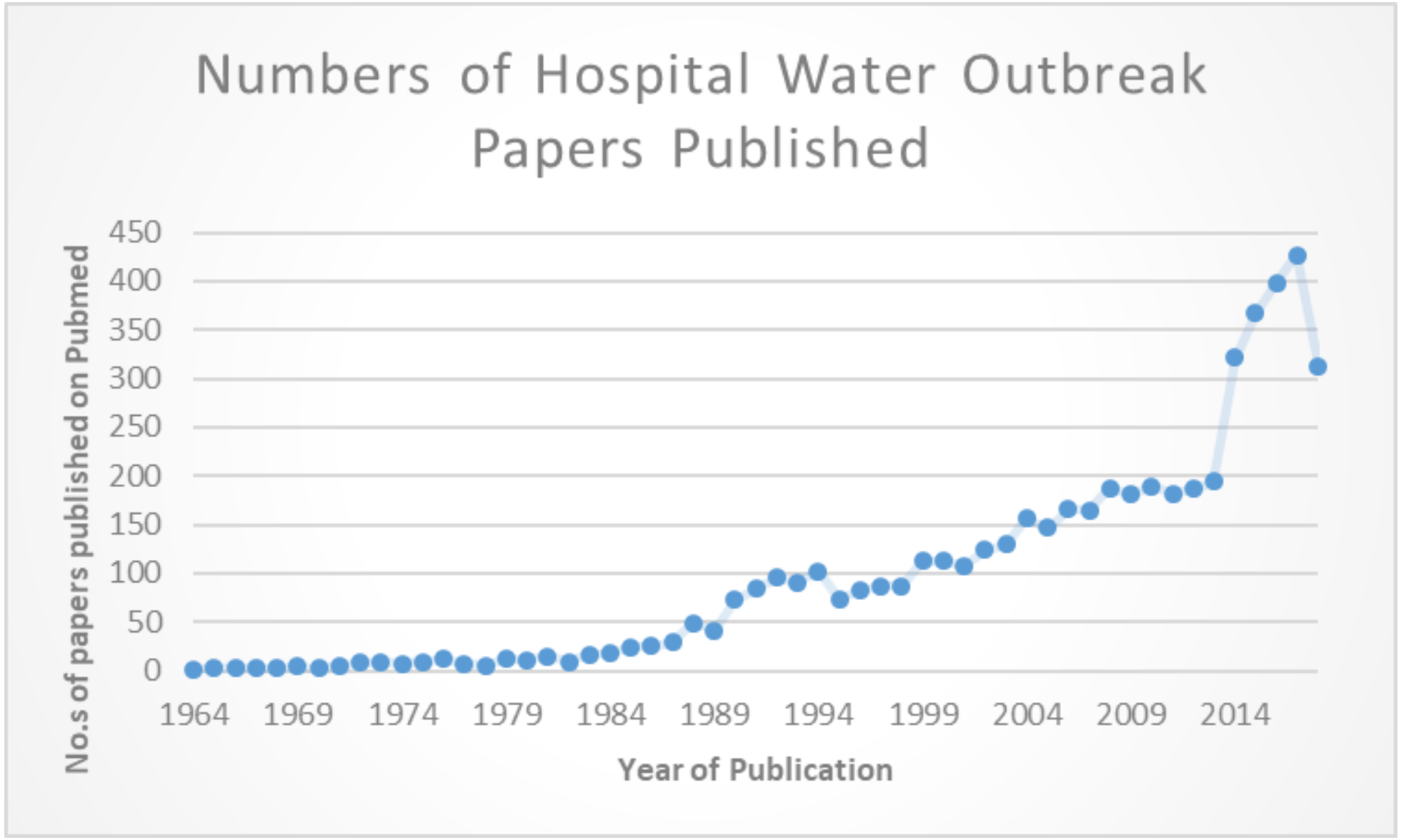
P. AERUGINOSA BACTERAEMIAS



Between 2004 and 2008 the number of *Pseudomonas aeruginosa* bacteraemias increased by 24%

EXAMPLES OF SINK/WATER RELATED OUTBREAKS

- *Pantoea agglomerans* outbreak on an oncology ward linked with multiple sinks, both in ward and pharmacy, plus an ice machine (BMC Infect Dis 2016 May 2016;16:203)
- *Klebsiella pneumonia* outbreak linked to a contaminated sink within a single occupancy room (J Hosp Infect 2016 Jun;93(2):152-4)
- Prolonged outbreak of resistant *Pseudomonas aeruginosa* linked with contaminated sinks and contaminated ultra filtration bags (Infect Control Hosp Epidemiology 2017 Mar, 38(3):314-319)
- 18 infants colonized with *Pseudomonas aeruginosa* linked to a sink on a neonatal intensive care unit (Acta Paediatr. 2015 Aug;104(8):e344-9)
- 4 handwashing sinks identified as the source for a *Klebsiella oxytoca* outbreak (J Hosp Infect 2014 Jun;87(2)126-30)


Numbers of Hospital Water Outbreak Papers Published
No.s of papers published on Pubmed
450
400
350
300
250
200
150
100
50
0
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
2014
Year of Publication

PSEUDOMONAS AERUGINOSA OUTBREAKS

16 outbreak papers	6 with antibiotic resistant strains (MDR or GIM producing)	1 = immersion	8 = taps	2 = drains
1 = shower	2 = sink surfaces	1 = toilet	1 = water bath	Plus 2 outbreaks of *Pseudomonas fluorescens*

Healthcare Outbreaks Associated With a Water Reservoir and Infection Prevention Strategies.
Kanamori H[1], Weber DJ[1], Rutala WA[1]. Clin Infect Dis. 2016 Jun 1;62(11):1423-35.

WHAT ABOUT THE OTHER 57 OUTBREAKS?

OTHER GRAM NEGATIVES

- *Stenotrophomonas maltophilia* (2)
- *Enterobacter cloacae* (4)
- *Acinetobacter ursingii*
- *Serratia marcescens*
- *Acinetobacter baumannii*
- ***Klebsiella pneumoniae*** (2)
- ***Elizabethkingia meningoseptica***
- *Klebsiella oxytoca* (2)

- *Ochrobactrum anthropic*
- *Sphingomonas paucimobilis*
- *Chryseobacterium* (2)
- *Alcaligenes xylosoxidans*
- *Burkholderia cepacia* (3)

Healthcare Outbreaks Associated With a Water Reservoir and Infection Prevention Strategies.
Kanamori H[1], Weber DJ[1], Rutala WA[1]. Clin Infect Dis. 2016 Jun 1;62(11):1423-35.

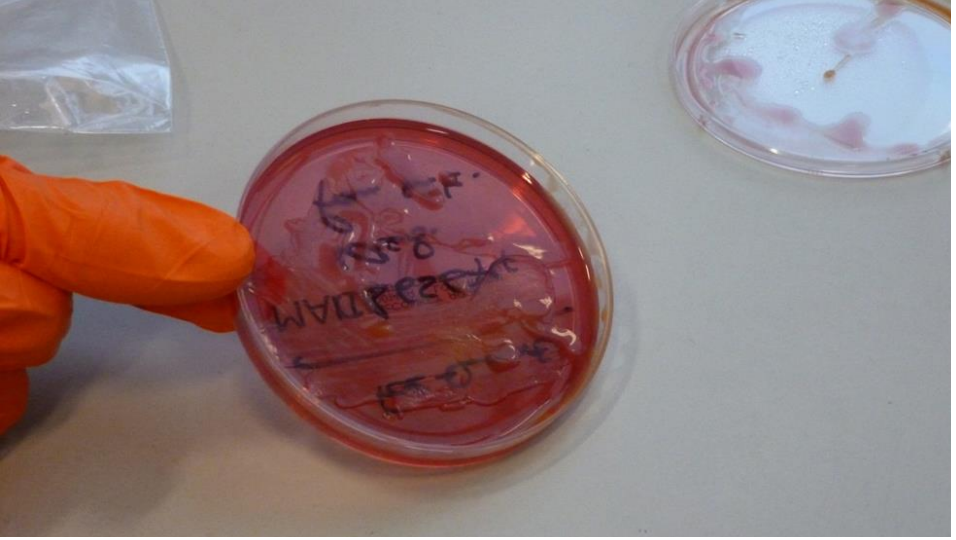
SO WHAT ARE THE OTHER ORGANISMS MATTER?

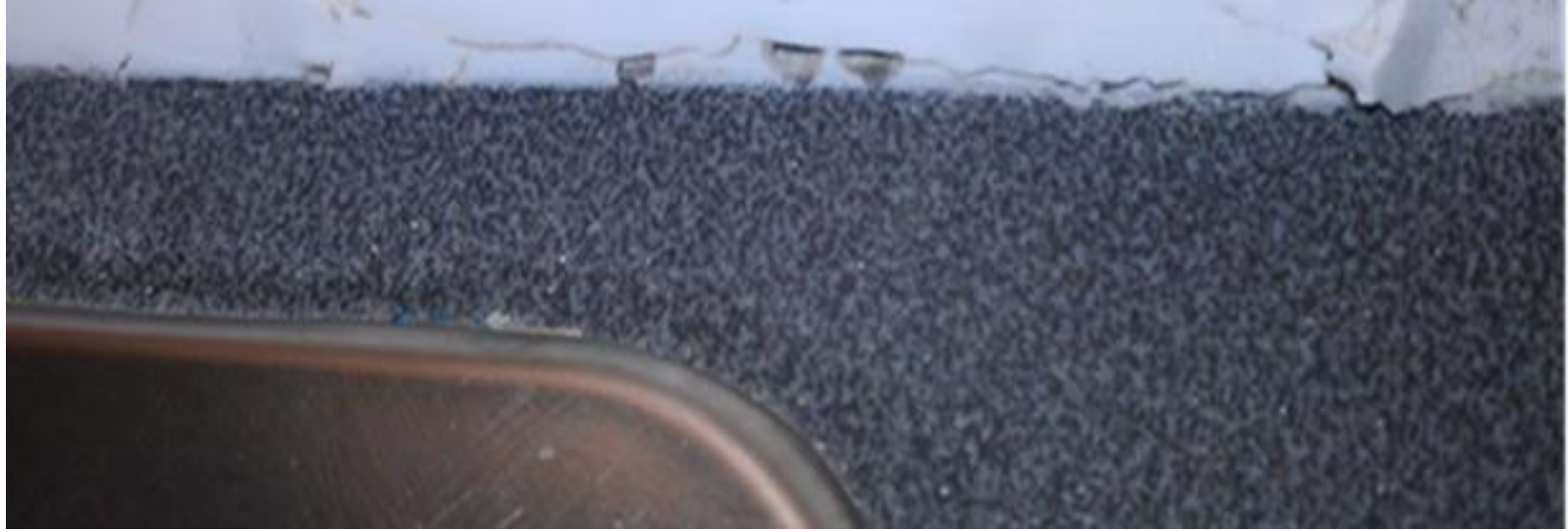
- *Legionella pneumophila (8)*
- Fungi:
- *Exophiala jeanselmei*
- *Fusarium*
- *Aspergillus fumigatus*
- *Aspergillus flavus*
- *Rhizomucor pusillius*

- *Mycobacterium avium complex*
- *Mycobacterium chelonae*
- *Mycobacterium fortuitum*
- *Mycobacterium porcinum*
- *Mycobacterium abscessus*
- *Mycobacterium genavense*
- *Mycobacterium simiae*
- *Mycobacterium mucogenicum (5)*
- ***Mycobacterium chimaera***

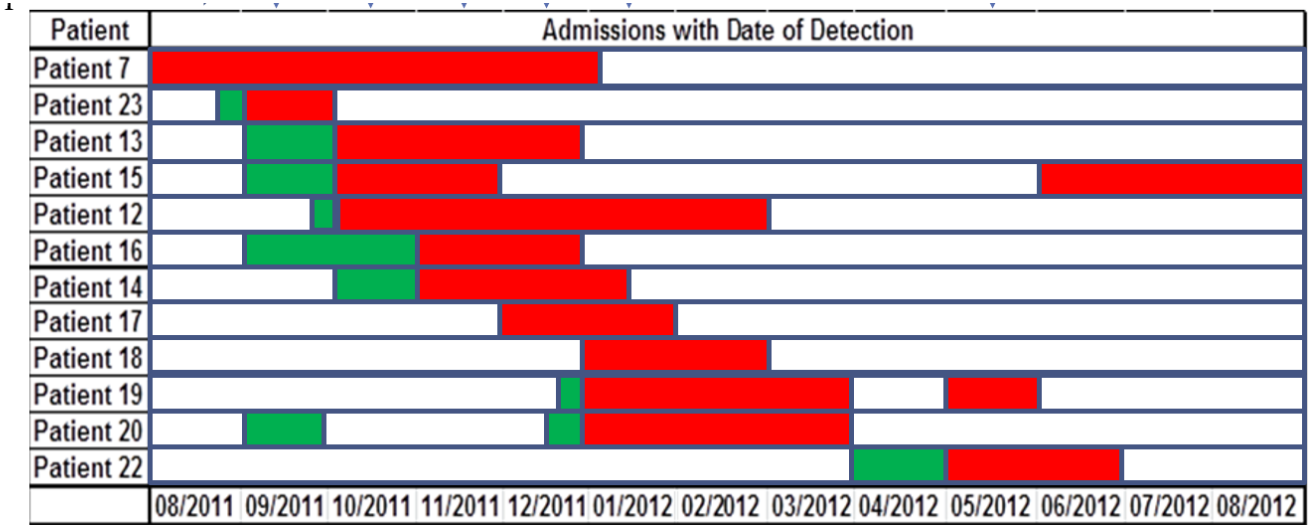
Healthcare Outbreaks Associated With a Water Reservoir and Infection Prevention Strategies.
Kanamori H[1], Weber DJ[1], Rutala WA[1]. Clin Infect Dis. 2016 Jun 1;62(11):1423-35.

Fluorescent dye on the sieve illustrates the extent of splatter





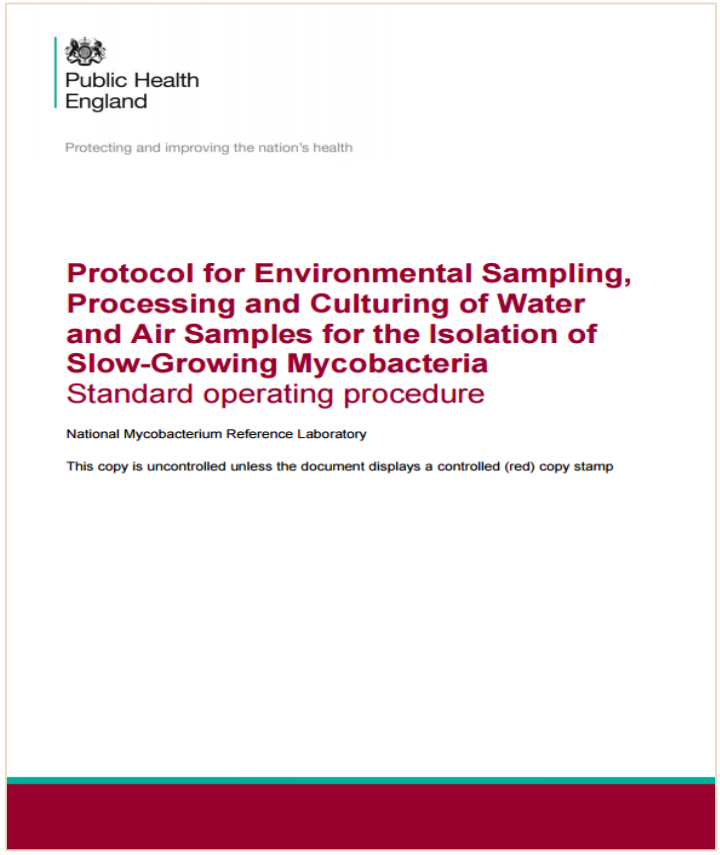
THAT SINKING FEELING



Klebsiella pneumoniae outbreak timeline by month. Green = un-colonised period of admission, Red = colonised period of admission. (manuscript in preparation)

WHAT DOES THIS MEAN FOR PATIENTS?

FIELD SAFETY NOTICES



Periodically alerts are issued linked to specific pieces of equipment

These usually include clinical and microbiological advice

Can cause laboratory issues:

Unusual agars	Lack of validation information	Requirement for rapid implementation	Additional laboratory costs

ZURICH

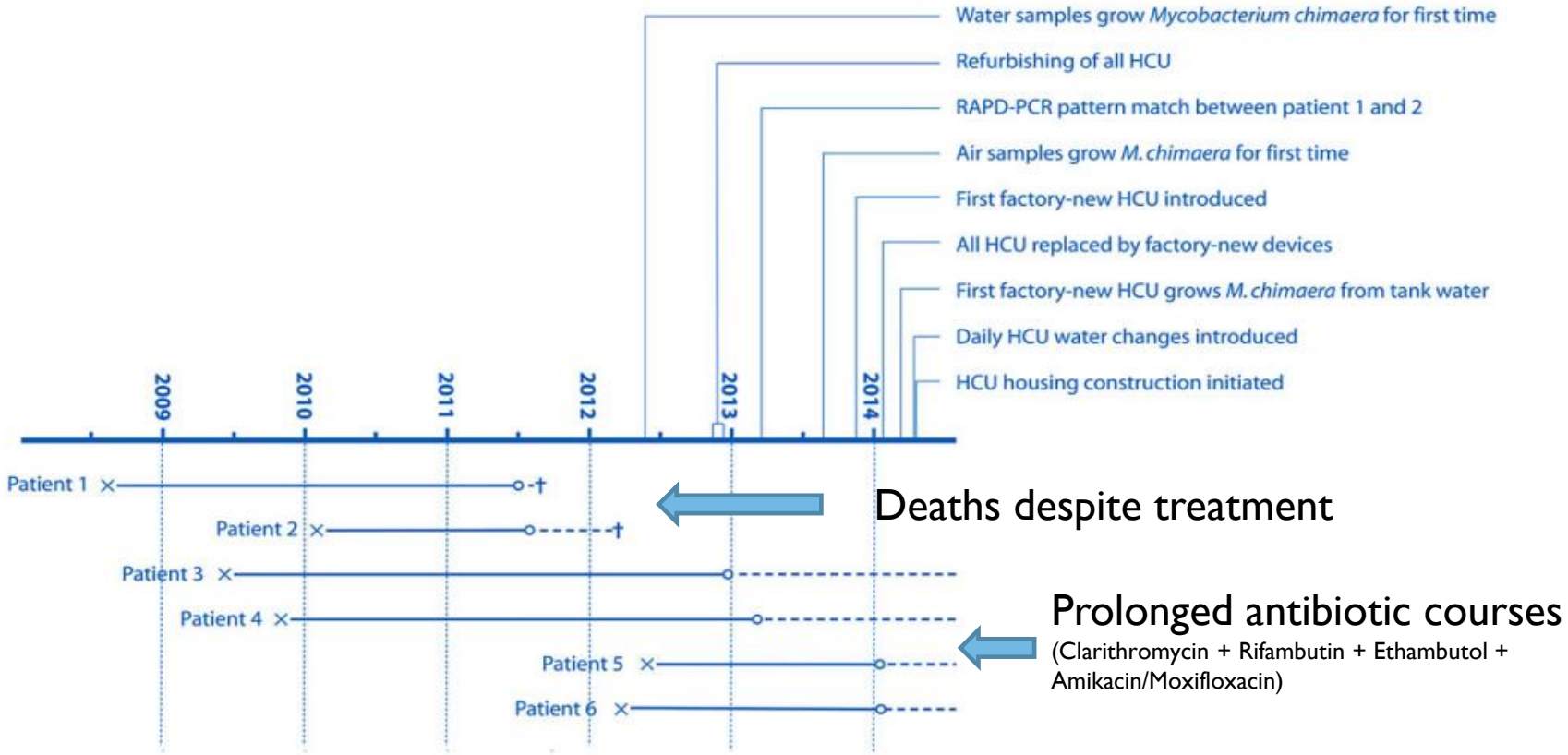
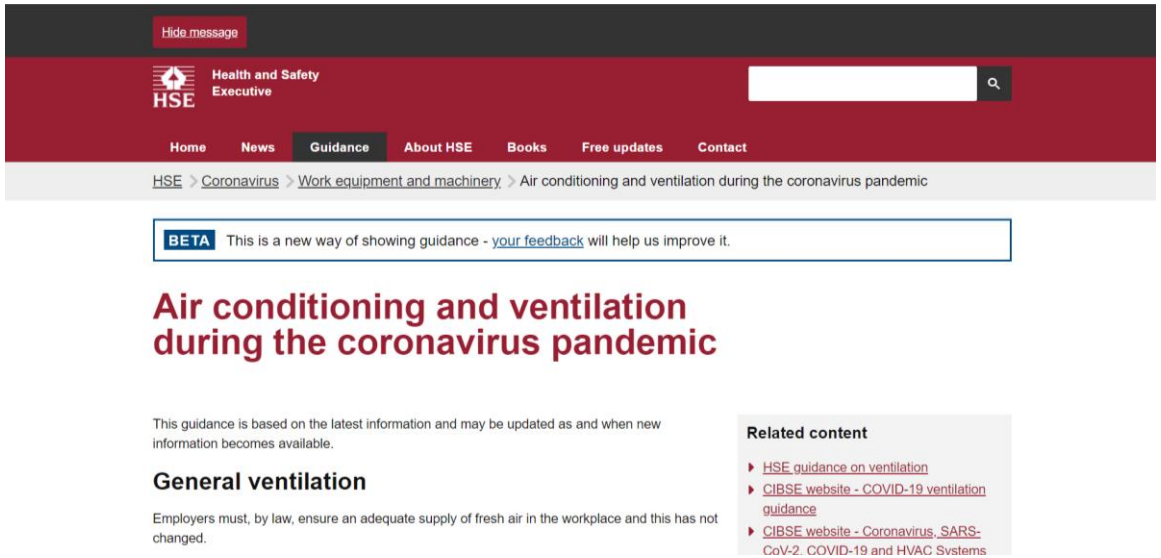
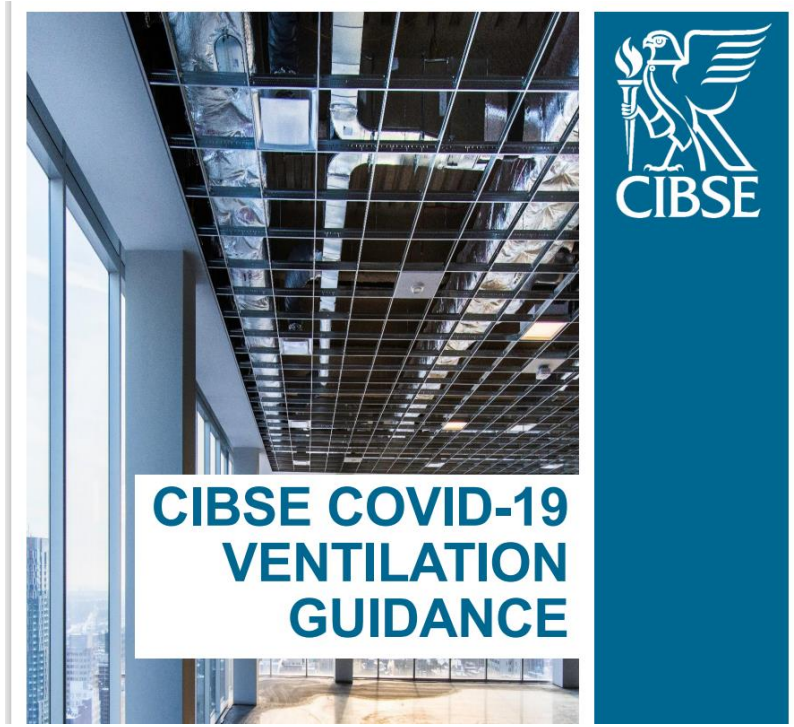


Figure 1. Evolution of the 6 cases of *Mycobacterium chimaera* infection and investigational activity. Abbreviations: x, open-chest heart surgery; o, *M. chimaera* diagnosis; - - -, antibiotic and, in some cases surgical, treatment; +, fatality; HCU, heater-cooler unit; RAPD-PCR, randomly amplified polymorphic DNA polymerase chain reaction.

Clin Infect Dis. 2015 Jul 1;61(1):67-75. Sax et al (2015)





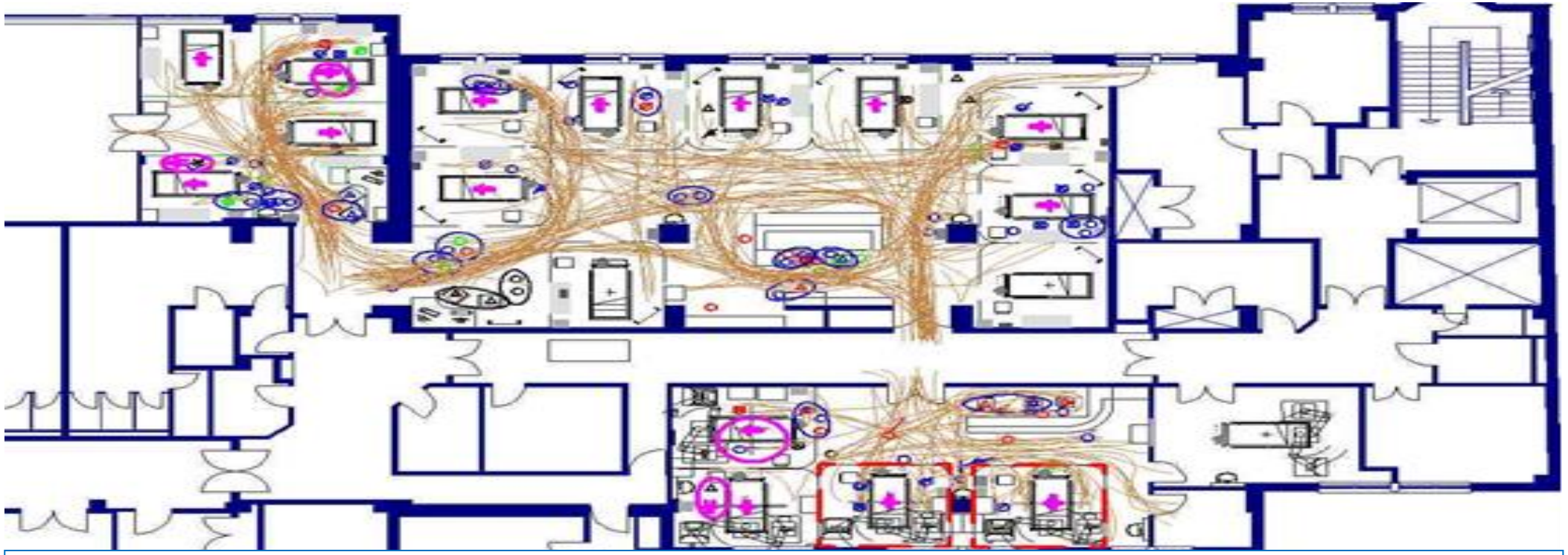
RESPONSIVE GUIDANCE

BEHAVIOUR CHANGE (ADMINISTRATIVE CONTROLS)

RISK ASSESSMENT

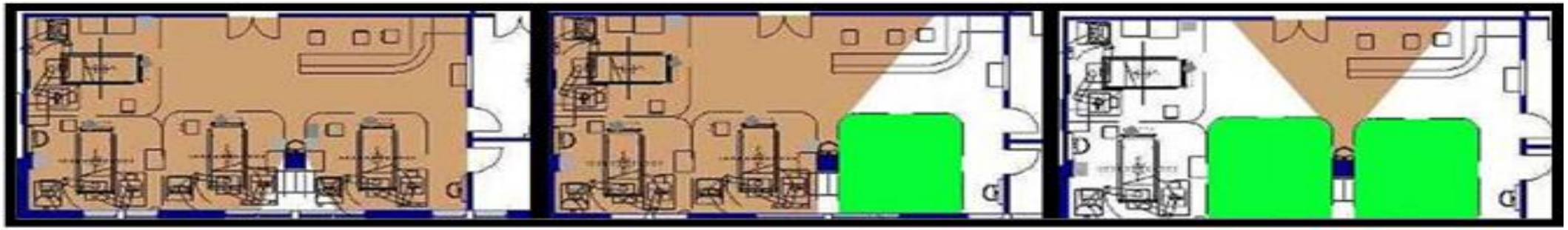
- Routes of transmission
- Patient loads
- Environmental persistence
- Infectious dose
- Colonised/infectious state
- Patient susceptibility
- Timing of infection (community vs hospital acquired)
- Endogenous vs exogenous
- Surveillance
  - Clinical (active vs symptom lead)
  - Environmental

MOVEMENT WITHIN WARD ENVIRONMENTS



The movement of all building users within the units for a period of 10 times 5 minutes of tracing in one day. This means that all movements through the units were traced for the duration of 5 minutes every 30 minutes for a total of 5 hours (10:30-13:00 and 14:30-17:00) on a working day.

EFFECT OF SINK VISIBILITY ON HEALTHCARE WORKER USE



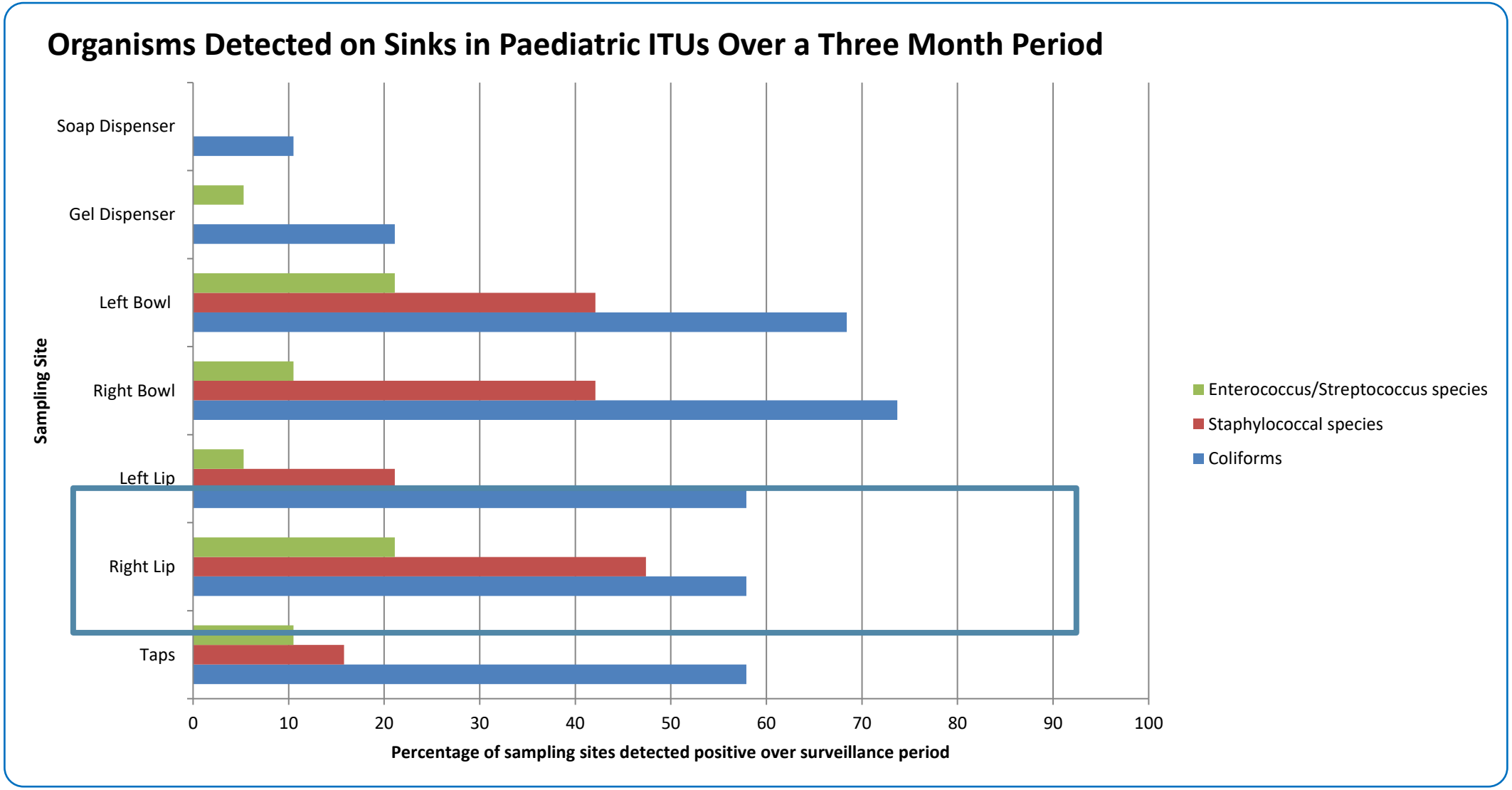
Sink No. in MITU	Number of Times Utilised During a 3 Hour Observation	% Visibility	
		Curtains Opened	Curtains Closed
Sink 4 (left hand sink)	11	89	15
Sink 5 (central sink)	34	97	68
Sink 6 (right hand sink)	1	77	13

Movement From	Movement To	Number of Trips
Sink Bowl	Soap Dispenser	156
Paper Towels	Domestic Waste Bin	151
Soap Dispenser	Paper Towels	151
Clinical Bin	Clinical Bin	136
Bed Rails	Clinical Bin	85
Clinical Bin	Sink Bowl	56
Trolley Surface	Clinical Bin	51
Glove Dispenser	Trolley Surface	50
Clinical Bin	Trolley Surface	39
Clinical Bin	Gel Dispenser	35

The three most common movements made were between objects required for hand washing.

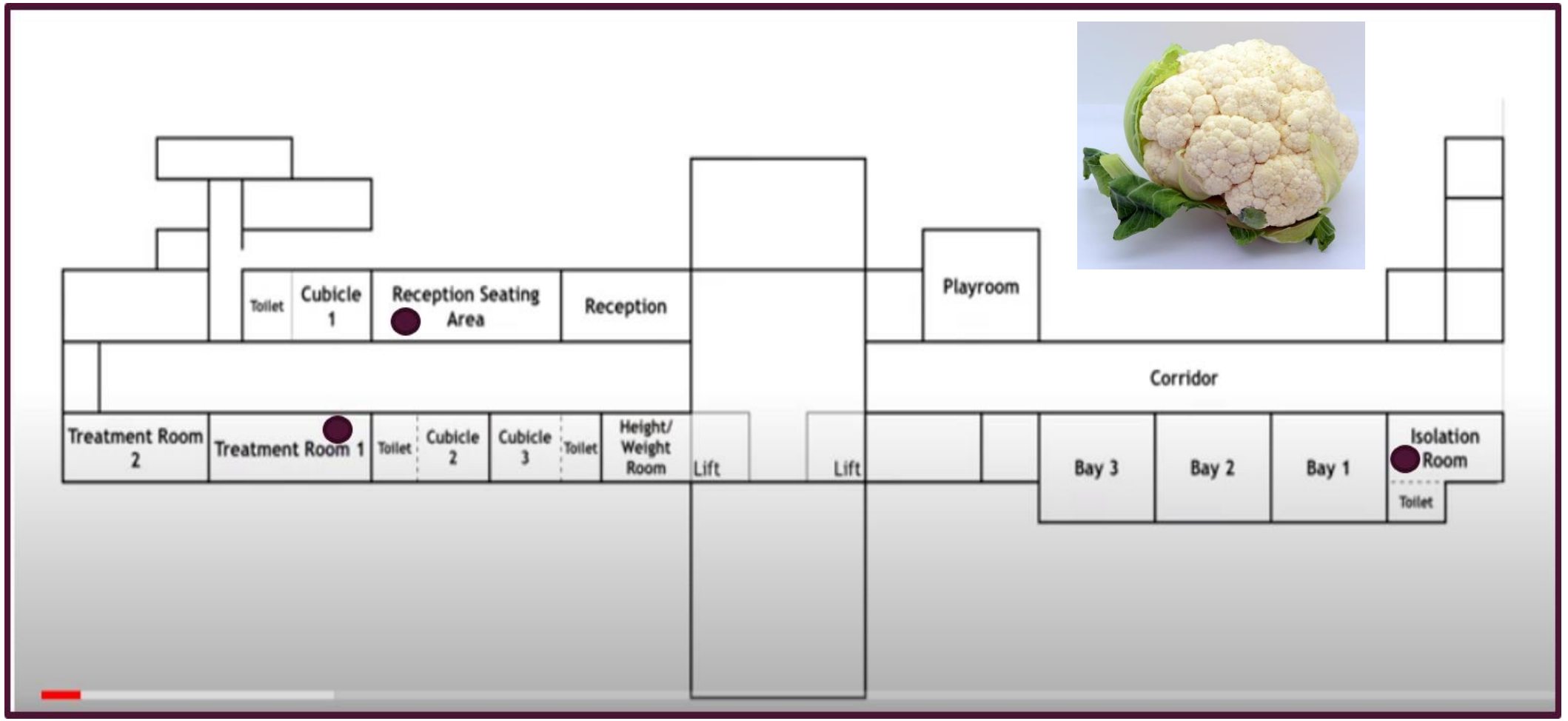
Six of the ten most common movements involve the clinical bin, which is also among the more contaminated objects across bed spaces.

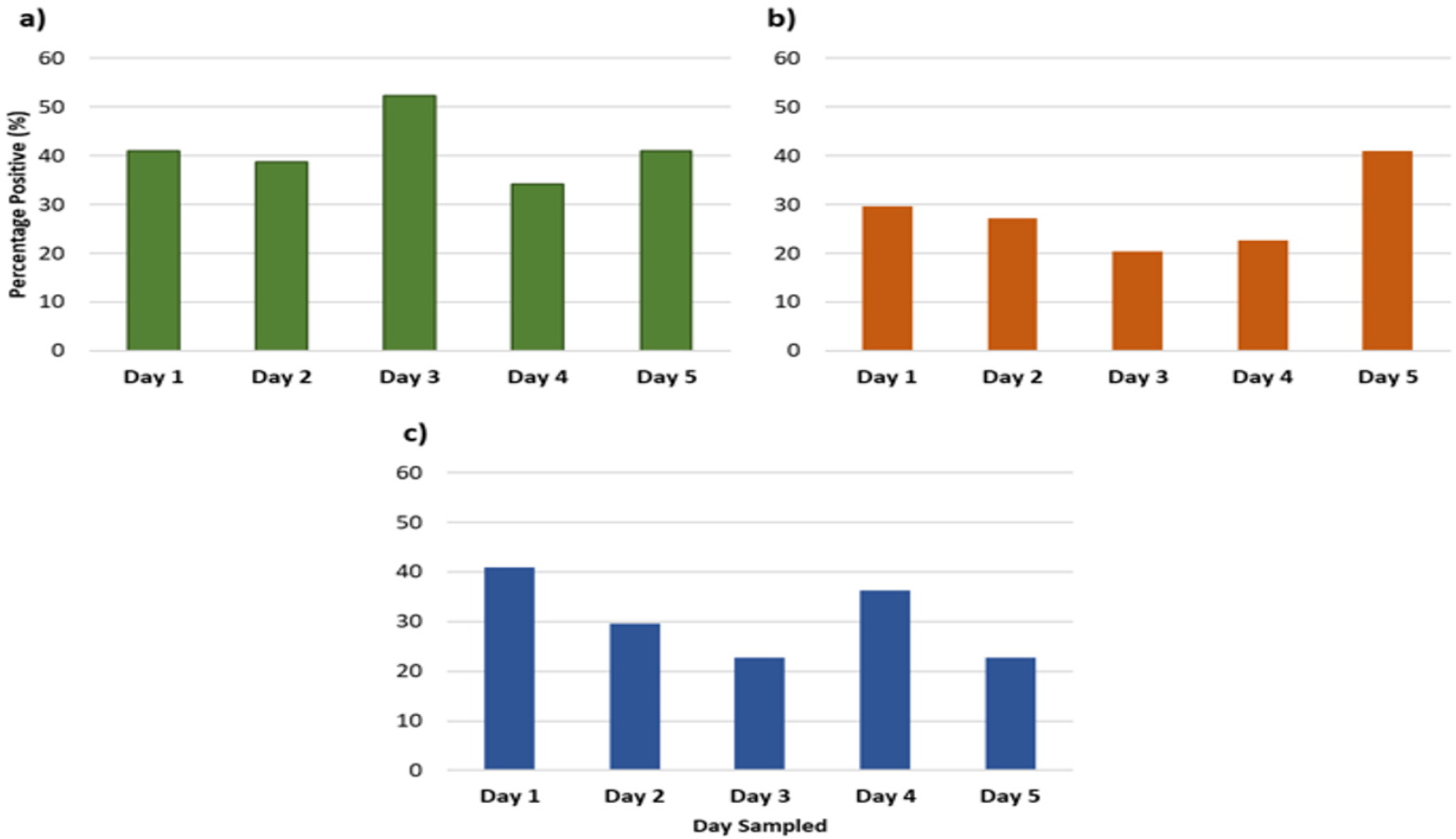
Figure 5-15 Frequency of contact with objects within bed space 6 and bed space 7 on PICU over a three day observation period Circle size and colour indicate frequency of contact.



The important role of sink location in handwashing compliance and microbial sink contamination.Cloutman-Green E, Kalaycioglu O, Wojani H, Hartley JC, Guillas S, Malone D, Gant V, Grey C, Klein N.Am J Infect Control. 2014 May;42(5):554-5

ROUTES OF SPREAD VIA EQUIPMENT AND OTHER SURFACES





Average percentage positive sites for oligonucleotide 1 bed rail in isolation room (a), 2 computer mouse in treatment room (b) and 3 play table in reception (c) across the 5 day sampling period.


RE-AUDIT
SET STANDARDS
MEASURE CURRENT PRACTICE
COMPARE RESULTS v STANDARDS
REFLECT PLAN & CHANGE
AUDIT CYCLE

Name: **Observer** Session no: **1** Sheet no……..

	Before low risk contact	After low risk contact	Before high risk contact	After high risk contact	Before unobserved contact	After unobserved contact
Doctor						
Opp.			1	2		
Soap				2		
Alcohol						
No action			1			
Unknown						
Nurse/HCA						
Opp.	3	4				
Soap						
Alcohol	3					
No action		4				
Unknown						
Other/Unsure						
Opp.					5	6
Soap						
Alcohol					5	
No action						
Unknown						6

Hospital: **Nosuch** Ward: **A** Date: **1.6.07** Start time: **9.00** End time: **9.20**

Patients observed: 6 No. of soap dispensers: 1 No. of alcohol dispensers: 7

YOU MAY NOT SEE IT BUT……

Pre Clean	Cubicle 8	Cubicle 5	Cubicle 4
Floor under sink	Not detected	36	32
Clinical waste bin	36	33	33
Chair arms	33	32	36
Bathroom door handle	35	34	35
Telephone	32	32	35
Bathroom taps	37	Not detected	34
Mattress top (patient)	32	37	37
Bed frame	33	33	37
Trolley	34	37	37
Window sill	39	35	39
Exit door handle	36	34	37
Corridor floor	36	32	Not detected

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THE ENVIRONMENT NETWORK

THE NETWORK FOR PEOPLE INTERESTED IN THE ROLE OF THE ENVIRONMENT WITHIN INFECTION CONTROL