Outbreak investigations related to construction and renovation

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Factoring Work flows into design

“I’m seeing my 3rd case in 2 weeks of an organism I have never heard of!”

Case 1

- 31 year old male
- PmHx: HBsAg+
- Admitted from community to MICU on 18/07/12 with pneumonia and septic shock
- Transferred to Wd20Rm10 on 31/07 for ECMO
- Antibiotic summary:
  - Bactrim 06-17/08/2012; Meropenem 15-23/08/2012; Amikacin 15/08/2012; Imipenem 03/09-present; Bactrim 23-30/08/2012
- Tracheostomy 27/08/12
- Cultures:
  - *E. meningoseptica* -
    - sputum 19/08, 22/08, 23/08
    - Blood 29/08/12

Case 2

- 63 yr old man
- PmHx:
  - Stage 3A adenoCa lung – CxT and RxT
    - Cavitating lesion in lung
  - MDR-*P. aeruginosa* pneumonia
- Admitted to CTICU Rm 7 on 03/07/12
- OT: lobectomy 03/08/12
- Antibiotic summary:
  - Clindamycin 13-16/08/2012; Vancomycin 13-16/08/2012; Colistin 13-19/08/2012; Ciprofloxacin 17-24/08/2012; Colistin 22-31/08/2012; Aztreonam 24-27/08/2012; Levofloxacin 29-31/08/2012; Vancomycin 29-30/08/2012; Pip-tazo 31/08 - present; fluconazole 02-05/09/2012; Caspofungin commenced 05/09; Metronidazole commenced 05/09
- Tracheostomy
- Cultures:
  - *E. meningoseptica* – blood (line) 26/08/12
    - line removed
  - Sputum & thoracotomy wound:
    - MDR-*P. aeruginosa, S. maltophilia* (panR)

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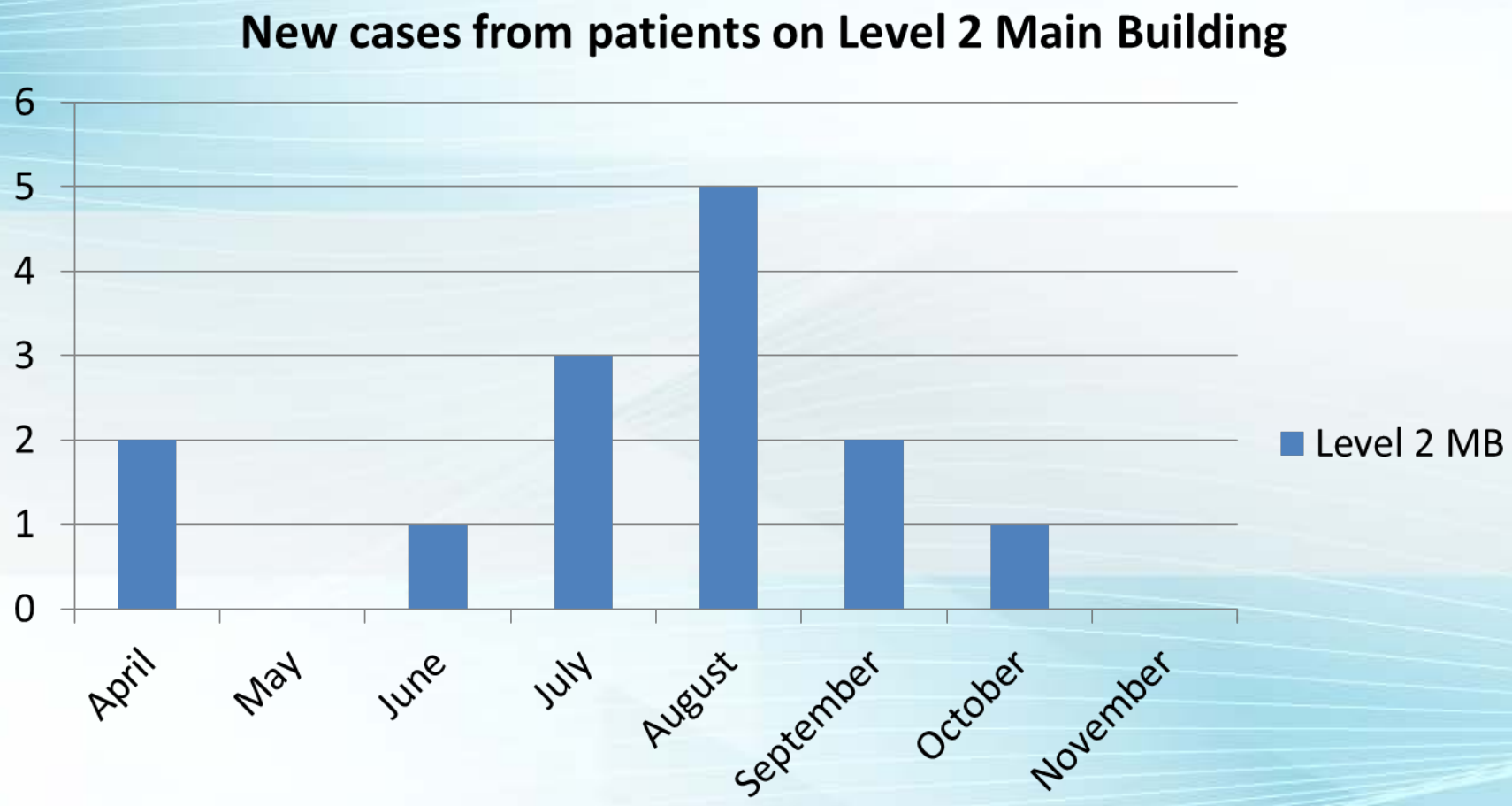
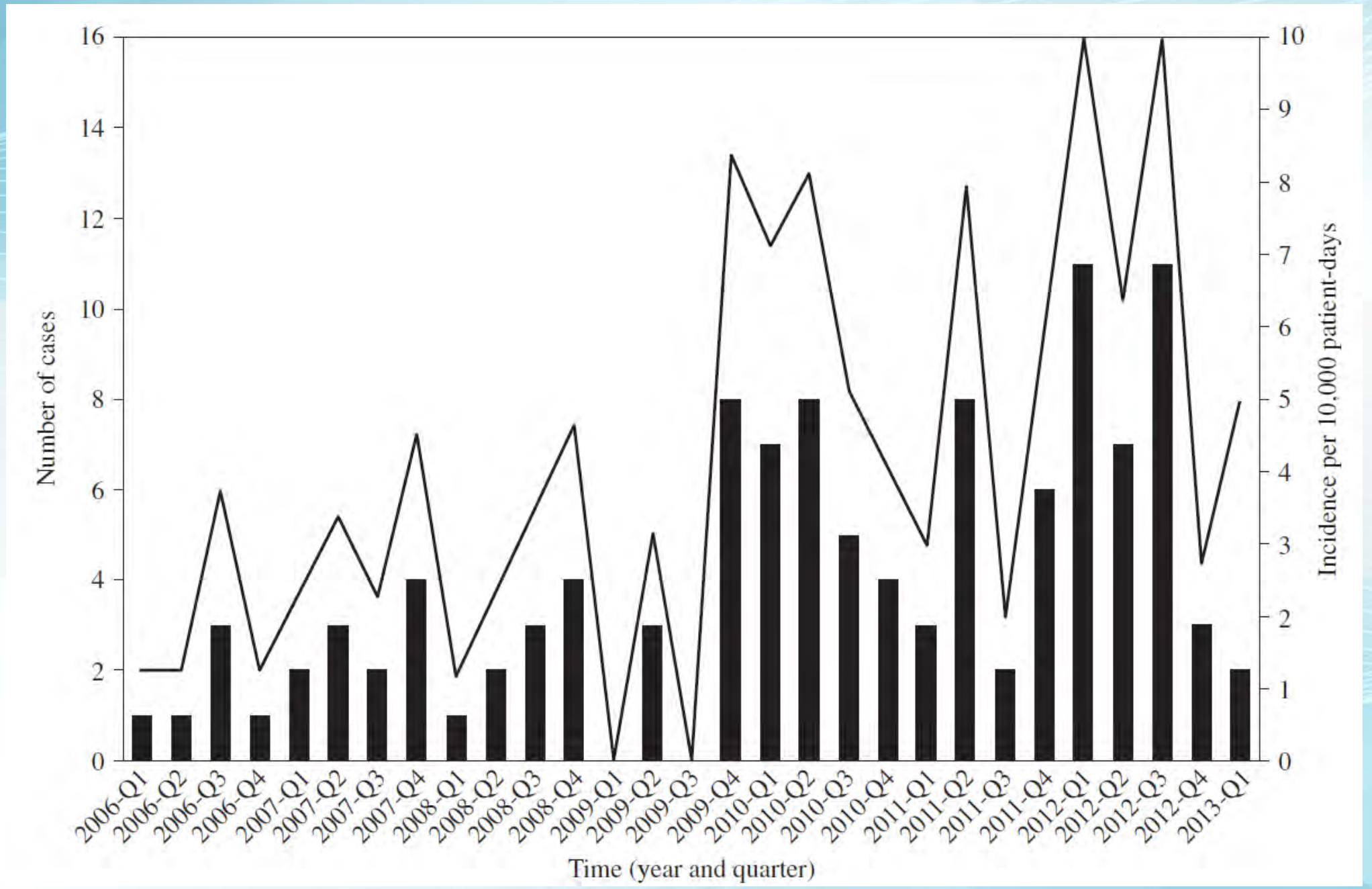
Case 3

- 79 yr old woman
- PmHx:
  - adenoCa lung ->LN
  - DM, HTN
  - MS s/p valvotomy
- Admitted to CTICU Rm8 on 28/07/12 but long admission – MICU, ward 28, ward 44
- OT: VATS -> open thoracotomy and left upper lobectomy 04/07/12
  - Complicated by pulm aa tear
- Antibiotic summary:
  - Meropenem 20/07/2012; Ciprofloxacin 26-29/07/2012; Ceftazidime 29/07-03/08/2012; Imipenem 03/08-05/08/2012; Metronidazole 18-27/08/2012; Meropenem 19-28/08/2012;
- Tracheostomy
- Cultures:
  - *E. meningoseptica* – sputum 31/08/12


New cases from patients on Level 2 Main Building
6
5
4
3
2
1
0
April
May
June
July
August
September
October
November
Level 2 MB

Elizabethkingia meningoseptica

- Gram negative non-fermenter
  - Previously classified:
    - Flavobacterium
    - Then Chryseobacterium
- Environmental organism:
  - Freshwater, salt water, soil, fish and frogs
- Well-adapted to hospital environment, esp ICUs
  - Can survive in chlorinated water
  - Intrinsically resistant to carbapenems, cephalosporins, colistin
    - Usually resistant to aminoglycosides, tetracycline, vancomycin
    - Best treatment options – co-trimoxazole, levofloxacin, piperacillin-tazobactam
- Opportunistic pathogen:
  - Neonatal meningitis (1st identified in 1958)
  - Primary or line related bacteraemia
  - Pneumonia
  - Skin and soft tissue infection
  - Case reports – endocarditis, necrotising fasciitis, peritonitis
- 270 isolates (incl duplicates) since 2009
  - 80% respiratory or blood cultures


Number of cases
Incidence per 10,000 patient-days
Time (year and quarter)
0
2
4
6
8
10
12
14
16
0
1
2
3
4
5
6
7
8
9
10
2006-Q1
2006-Q2
2006-Q3
2006-Q4
2007-Q1
2007-Q2
2007-Q3
2007-Q4
2008-Q1
2008-Q2
2008-Q3
2008-Q4
2009-Q1
2009-Q2
2009-Q3
2009-Q4
2010-Q1
2010-Q2
2010-Q3
2010-Q4
2011-Q1
2011-Q2
2011-Q3
2011-Q4
2012-Q1
2012-Q2
2012-Q3
2012-Q4
2013-Q1

Environmental sampling

- Swab cultures taken from faucets in:
  - CTICU (Ward 20):
    - Room 7, 8, 10, 11, Drs room - *E. m* found (not found in Rm6)
    - Pantry, staff room, clean utility sinks - *No E. m* found
    - Chlorhexidine from dispensers in Room 7,8,10 – *E. m* not found
  - SICU (Ward 21):
    - Central area sinks - *No E. m found (A. bau, Serratia)*
    - Room 2,5,7,13 - *E. m found in* ¾ sinks
  - NICU (ward 24)
    - Sinks (three) - *E. m found in 2/3* sinks (communal area)
    - Breast feeding room -*No E. m* identified
    - Milk rooms 1&2 - no *E. m* identified
  - Ward 41 (control ward – no cases)
    - Sinks at bed 4, 7, 8, 24, 30, 36, 42
      - *E. m* found in all sinks in patient rooms

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E. meningoseptica was cultured from 44% (35/79) of taps, but not from other sources. Hand hygiene sinks were used for disposal of patient secretions and rinsing re-usable patient care items.

Case control study

Table I
Association between sink misuse and colonization with *Elizabethkingia meningoseptica* ($N = 79$)

Frequency of sink misuse	Number of culture-negative aerators ($N = 44$)	Number of culture-positive aerators ($N = 35$)	OR (95% CI)	*P*-value
No misuse	28	10	1.0	–
Any misuse	16	25	4.38 (1.68–11.39)	0.004
Sometimes	8	6	1.75 (0.46–6.61)	0.63
Frequent	8	19	6.65 (2.22–19.92)	0.001

OR, odds ratio; CI, confidence interval.
P-value compared with no misuse of sinks.
Test of homogeneity (equal odds): $P = 0.002$.
Test for trend of odds: $P = 0.047$.

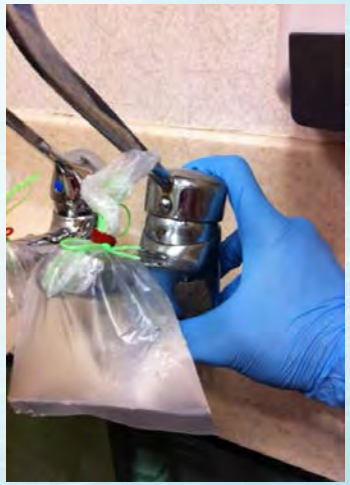
- Laboratory data revealed increasing incidence of E. meningoseptica colonization or infection in ICU patients compared with preceding years ICUs renovated
- E. meningoseptica was cultured from 44% (35/79) of taps, but not from other sources.
- Hand hygiene sinks were used for disposal of patient secretions and rinsing re-usable patient care items.
- Molecular typing revealed that patient isolates had identical patterns to several isolates from hand hygiene taps.
- An urgent education programme was instituted to change these practices. Taps were cleaned systematically and aerators were changed. A temporary reduction in case numbers was achieved.

- Recolonization of taps was demonstrated on follow-up environmental screening, and cases recurred after two months. A survey revealed that 77.3% (163/213) of nursing staff still misused sinks due to time constraints or other problems adhering to the interventions.

- Conclusion: Introduction of non-sanctioned practices due to suboptimal unit design may have unintentional consequences for ICU patients. Room design and staff workflows must be optimized for patient safety as lapses in procedure can inadvertently put patients at risk.

Initial Infection control interventions

- Education/ explanation given to all ICUs:
- Hand Hygiene
  - If hands need to be washed (due to soiling, post contact with blood/body fluids) please ensure staff performs alcohol handrub after that
  - Rooms terminally cleaned
  - Faucets were systematically cleaned and aerators were changed



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Frequently Asked Questions (FAQs):

Elizabethkingia meningoseptica

What is Elizabethkingia meningoseptica?

Elizabethkingia meningoseptica is an environmental bacteria. It rarely causes infections in healthy people but may cause problems in neonates and ICU patients, and has been known to cause outbreaks in these settings. This is because it is able to survive on surfaces, especially water sources like taps and liquid solutions, and because it is intrinsically resistant to most antibiotics used to treat Gram negative bacteria (carbapenems, cephalosporins, aminoglycosides and colistin). Patients who develop infections have usually spent a long time in hospital, often with broad spectrum antibiotic exposure.

What is currently happening in NUH?

Elizabethkingia meningoseptica has become more frequent over the past few years and clusters of patients in the same ward occur from time to time. We noticed that three patients in one ICU all had *E. meningoseptica* infections within a two week period. None of the patients were seriously ill because of this infection. We found that many of the taps at hand hygiene sinks have become contaminated with *E. meningoseptica*, probably due to use of these sinks for rinsing patient equipment. The water itself is not contaminated.

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Initial Infection control interventions

- Patient
  - Use sterile water for any performance of nursing care which requires water usage (E.g. Oral toilet)
  - For sponging of patient, use water from the pantry water dispenser on ward 20

- Washing of items
  - No washing/rinsing of ANY items at the Hand hygiene Sink
  - For kidney dishes/injection trays, wiping down with alcohol wipes is sufficient if not visibly soiled
  - Do not place any patient care items at the Hand hygiene sink in view of possible splashes

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Bad design, bad practices, bad bugs: frustrations in controlling an outbreak of *Elizabethkingia meningoseptica* in intensive care units

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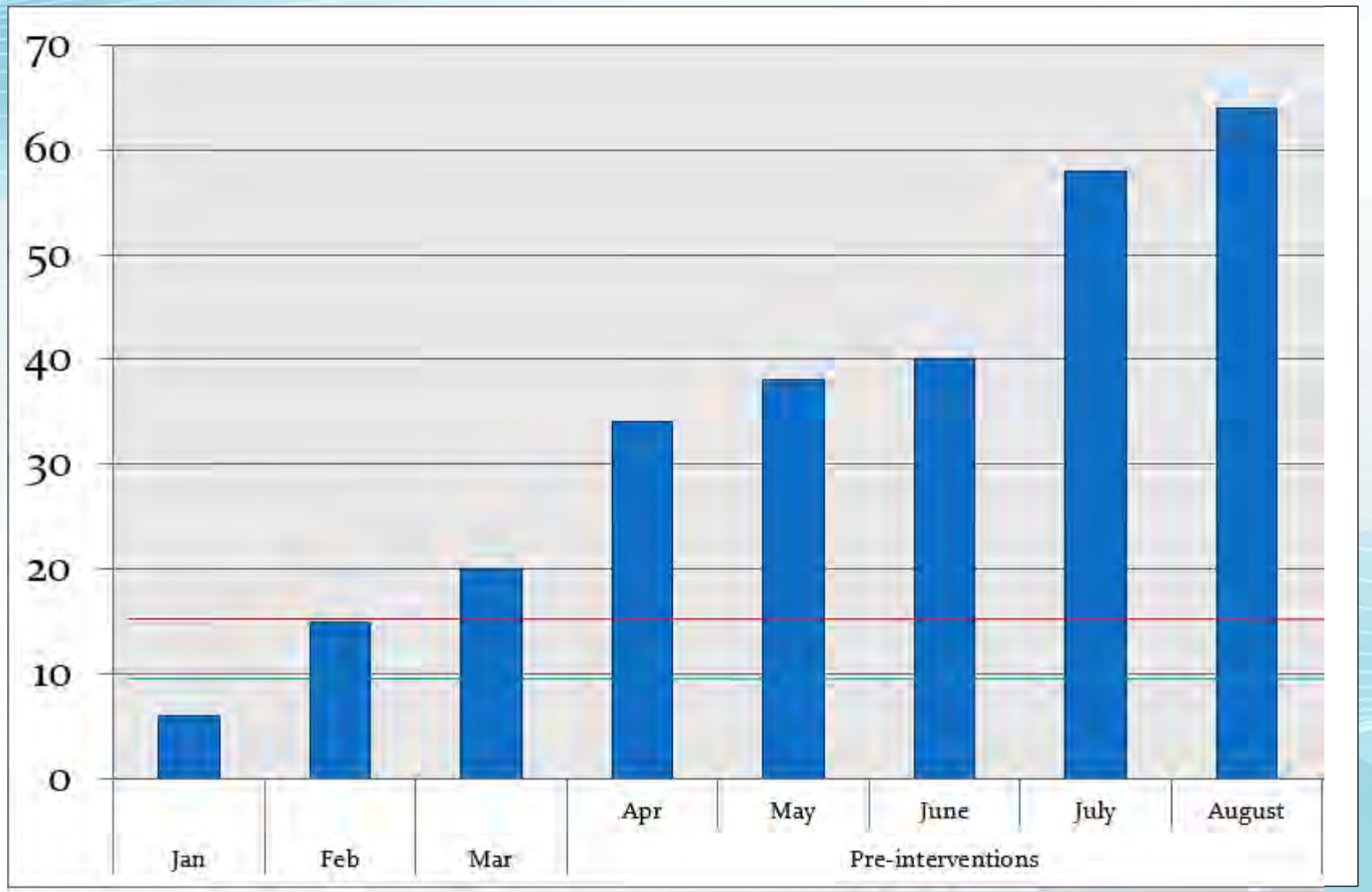
A Paediatric Oncologist noted excess *Bacillus cereus* in June / July 2010

Epidemic curve showing separate patient episodes (duplicate isolates from same episode excluded)

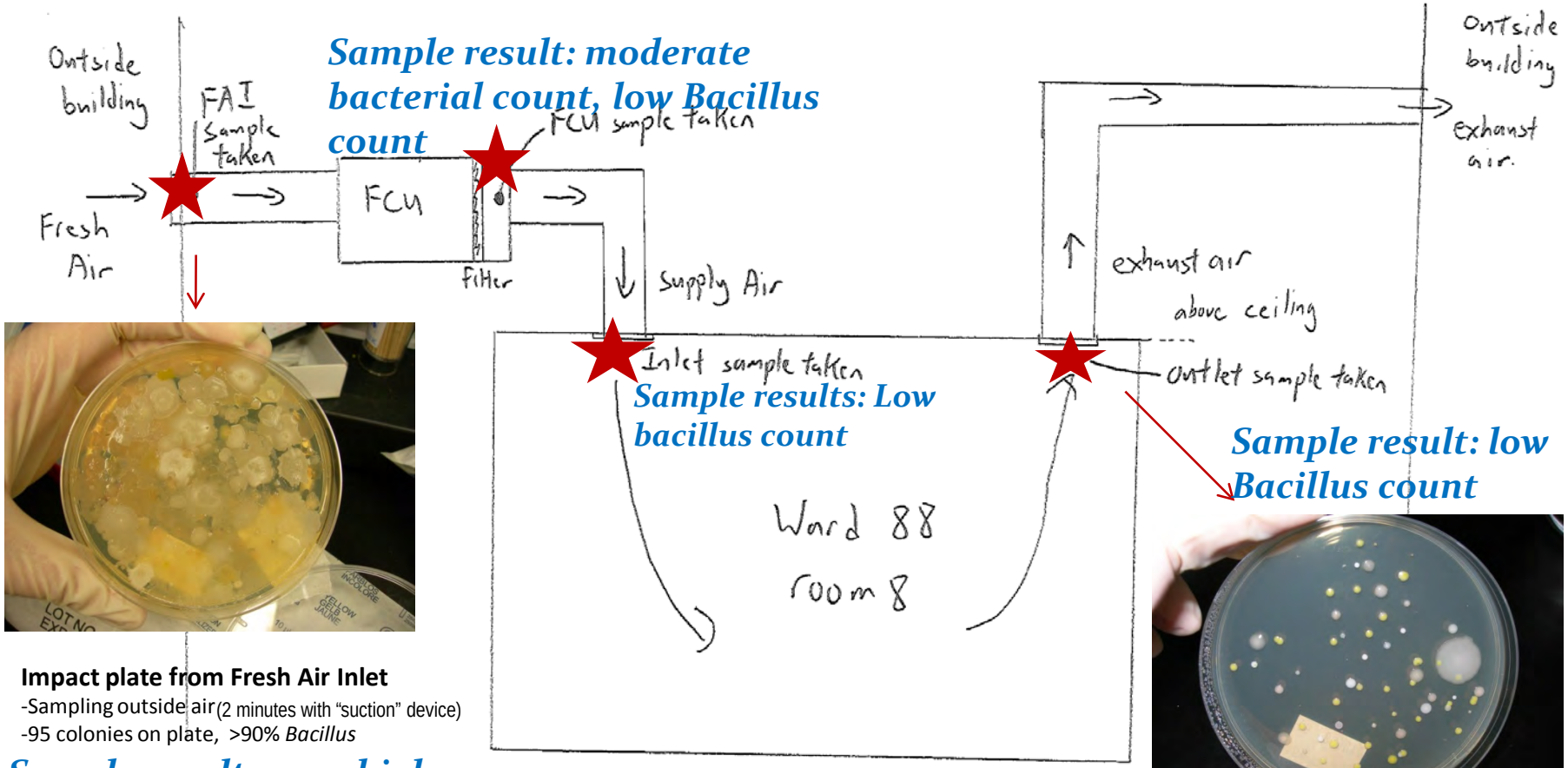


Red line: monthly average 2008/9 Green line: monthly average 2006/7

Bacillus

- Environmental organism
  - Spore forming
    - Difficult to eradicate
    - Removed by heat, chlorine-containing disinfectants
- Opportunistic pathogen
    - Immunocompromised
    - Device associated (iv lines, indwelling devices)
    - Trauma – skin, soft tissue infections, eye
- Associated with nosocomial outbreaks
  - Multitude of different sources implicated
    - Association becoming recognised between linen contamination and with hospital construction

Air sampling studies in ventilation system



Sample result: moderate bacterial count, low Bacillus count

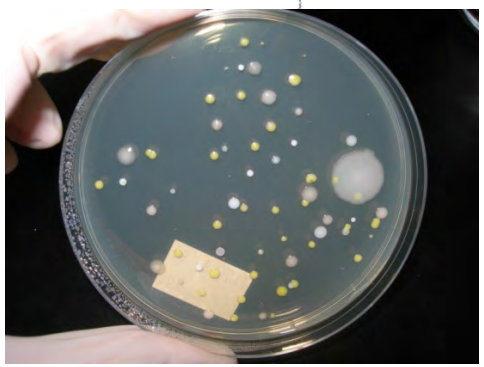
Sample results: Low bacillus count

Sample result: low Bacillus count

Impact plate from Fresh Air Inlet
-Sampling outside air (2 minutes with "suction" device)
-95 colonies on plate, >90% *Bacillus*

Sample result: very high Bacillus count

FAI = Fresh air intake
FCU = Fan coil unit



Impact plate from Outlet unit
-Sampling air before being extracted from room
- 59 colonies on plate, 1 of which was *Bacillus*

Initial sampling showed dense contamination

Worst in patient rooms and air conditioned wards….

and in linen trolleys….

70 settle plates on 7 wards
Left open 1 hour (1m from floor and wall where possible)


16/08/2010


16/08/2010

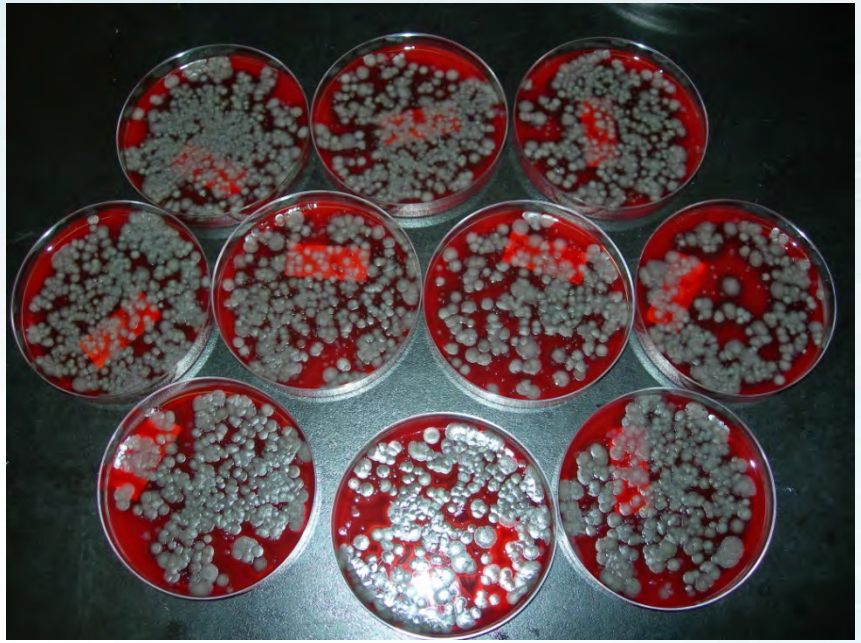

16/08/2010

Results of ventilation review

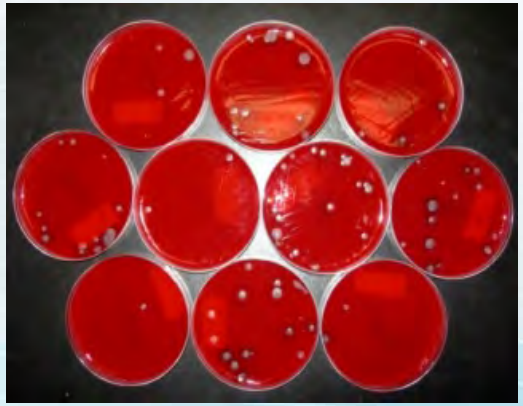
- Filtration system working to design
- Design of ventilation systems allows “trapping” of spores in rooms
  - Denser than air -> fall to floor -> not able to be extracted
  - Confirmed by smoke test

Heavy contamination of linen

Towels most densely contaminated
- 7403 (±1054.3) spores per cm² fabric



Other linen less affected



Patient gowns:
585 (±356.4) spores/cm²

Flat cotton sheets:
80 (± 36.4) spores/cm²

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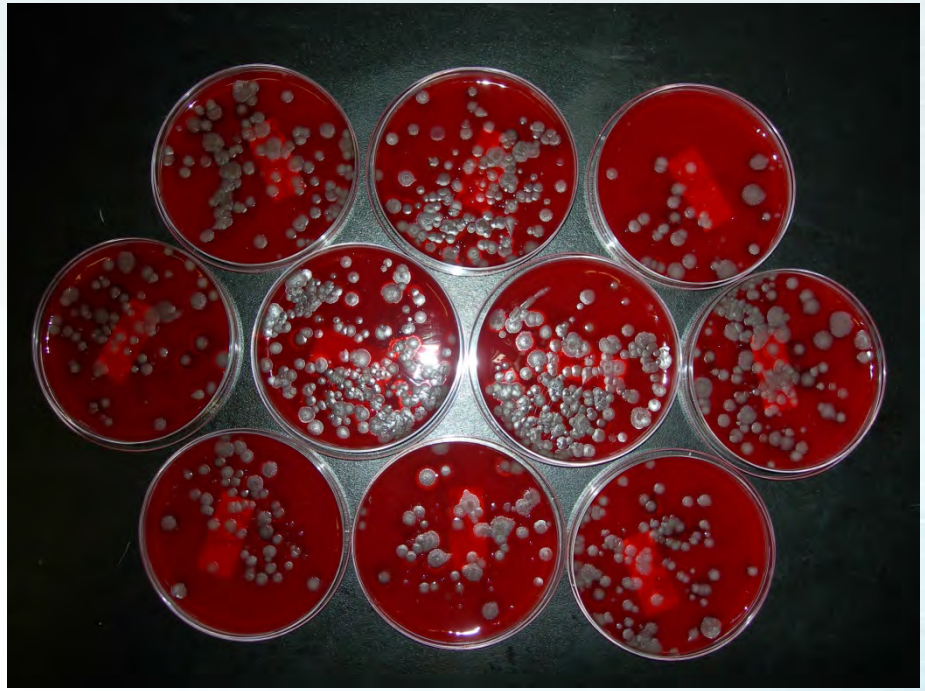
15/09/2010


15/09/2010

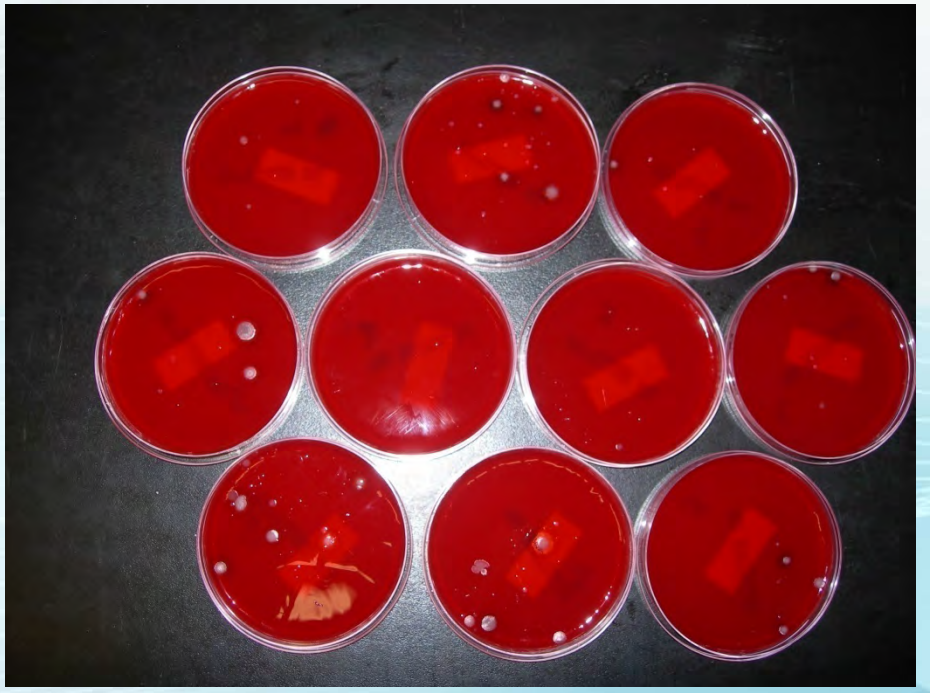

15/09/2010

Amplification cycle in linen

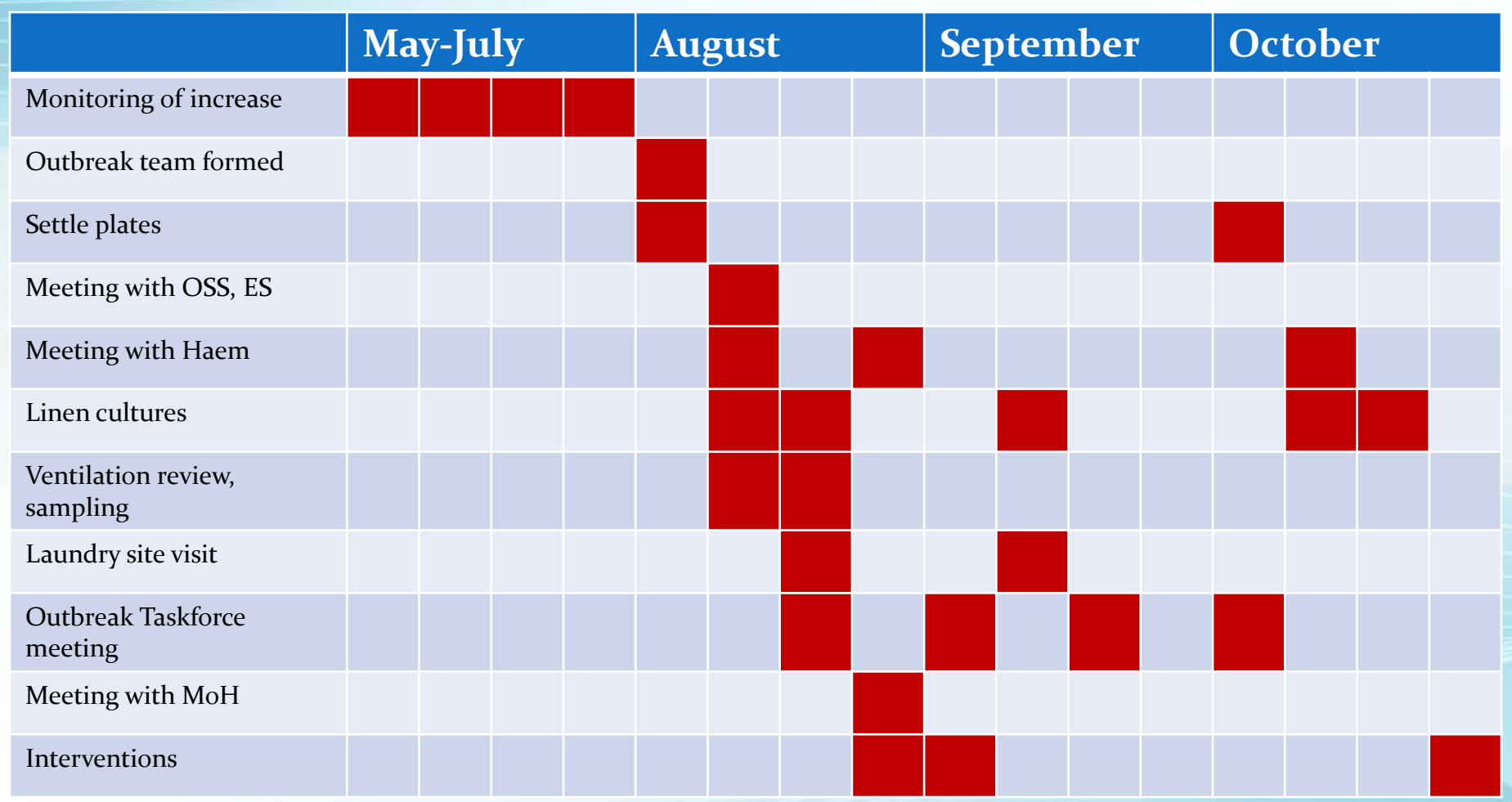
Towels stored in plastic bags: 4437 (±1228.8) spores per cm² fabric



Towels stored in porous material: 165.8 (±84.2) spores per cm² fabric (p<0.001)



Summary of investigation



Interventions

- Ventilation system:
  - Additional filters to those ducts
  - Cleaning of non-disposable filters monthly
- Cleaning:
  - Thorough cleaning of Haem/Onc wards with bleach
  - Change to 0.5% bleach for terminal cleaning in entire hospital
    - All rooms in wd 88, 86, 58, 57 undergo terminal cleaning prior to re-occupation

Interventions (2)

- Linen:
  - Linen to have bleach in wash protocol
  - Autoclave towels on Haem/Onc wards and PICU
  - Recommend to stop use of storing clean linen in plastic bags

Response to interventions

- Environmental sampling showed
  - Reduced contamination of rooms
  - Reduced contamination in towels

- October case counts encouraging
  - 21 isolates from 16 separate patient episodes
    - Almost back to baseline for 2009

- Disinfectant for terminal cleaning changed to 0.5% acidified bleach
- Reinforced aseptic line insertions
- Removal of infected lines
- Additional filters in ventilation system and regular cleaning
- Linen in canvas bag and not plastic bags
- Bleach based laundry protocol (previously sodium hypochlorite)

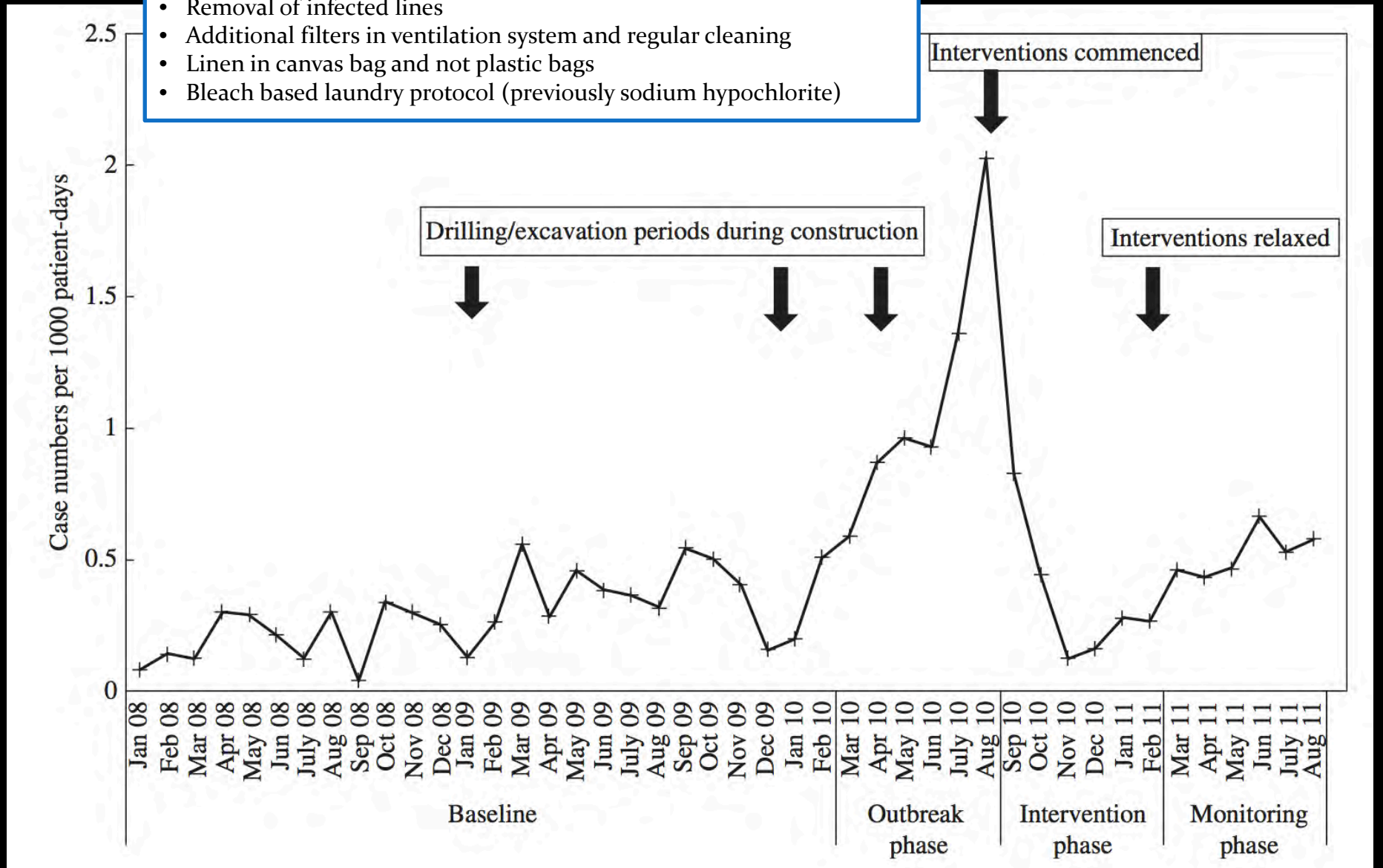


Figure 1. Epidemic curve for new cases of *Bacillus cereus* group per 1000 patient-days, January 2008 to August 2011.

Clinical impact

- From 1st April to 31st October
  - 325 positive cultures from 286 patients
    - 281 positive blood cultures from 253 patients
    - 44 positive cultures from other sites in 33 patients
  - 93 patients received a therapeutic intervention
    - 33 intravascular lines, Hickman lines or Portacaths removed
    - 2 EVD removed
    - 78 patients received treatment course of vancomycin

Sequence of events

- “Private” wing used for high risk patients
  - Rooms had standard ventilation and air filtration
- Then construction started adjacent to the air inlets
- Bacillus, is hardy and was trapped in the rooms
  - Contaminated fluffy towels
  - No sporicidal in cleaning detergents
  - Amplified by storage practices
- Outbreak responded to interventions and ultimately when the construction was over

J Hosp Infect. 2012 Aug;81(4):224-30. doi: 10.1016/j.jhin.2012.04.022. Epub 2012 Jun 15.

Hot and steamy: outbreak of Bacillus cereus in Singapore associated with construction work and laundry practices.

Balm MN[1], Jureen R, Teo C, Yeoh AE, Lin RT, Dancer SJ, Fisher DA.

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