Burns outbreaks - ‘the UHB experience’

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Overview

- Infection control in burns
- Introduction to UHB
- Problem organisms & local outbreak experience
  - Carbapenemase Producing *Enterobacteriaceae*
  - MDR *Acinetobacter baumannii*
  - *Pseudomonas aeruginosa*
- Thoughts and reflections

Infection Control in Burns

- Primary modes of cross contamination of pathogens between burns patients direct or indirect contact from:
  - Staff
  - Hospital equipment
  - Hospital environment
- Burns patients high risk as no skin
- Environmental shedding massive
- Outbreaks common lasting for long periods

Bache K *et al.*, Burns. 2015

BURNS 41 (2015) 39–48

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns

Airborne bacterial dispersal during and after dressing and bed changes on burns patients

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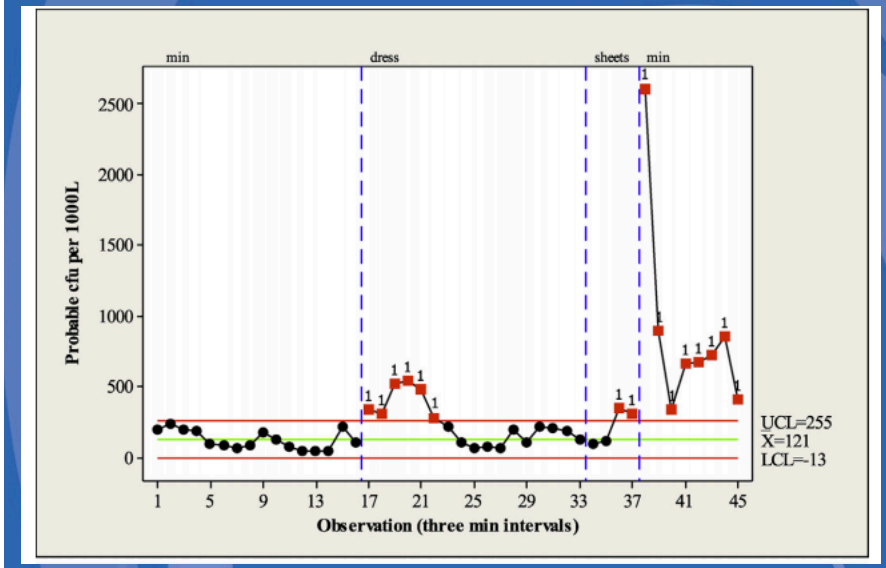
ABSTRACT

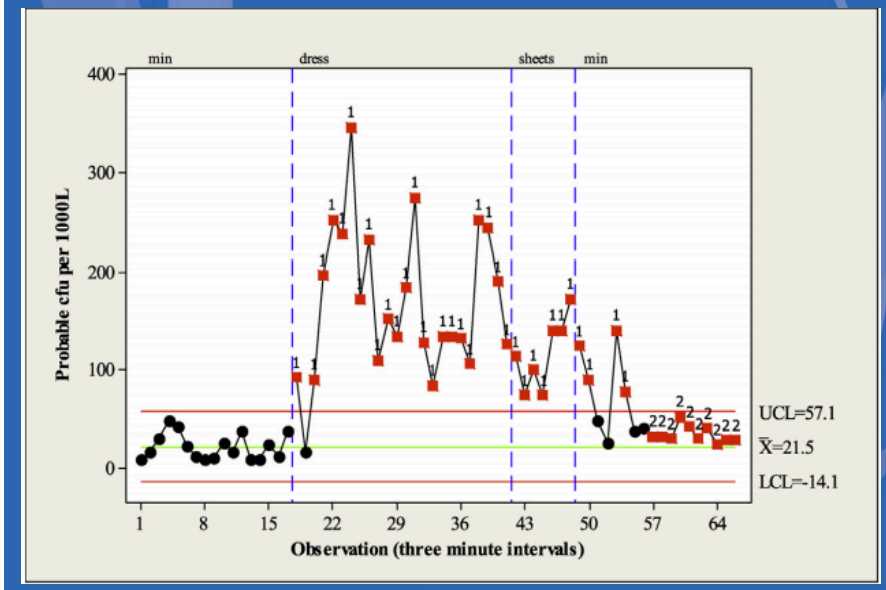
Background: It is acknowledged that activities such as dressing changes and bed sheet changes are high-risk events; creating surges in levels of airborne bacteria. Burns patients are particularly high dispersers of pathogens; due to their large, often contaminated, wound areas. Prevention of nosocomial cross-contamination is therefore one of the major challenges faced by the burns team. In order to assess the contribution of airborne spread of bacteria, air samples were taken repeatedly throughout and following these events, to quantify levels of airborne bacteria.

Methods: Air samples were taken at 3-min intervals before, during and after a dressing and bed change on a burns patient using a sieve impaction method. Following incubation, bacterial colonies were enumerated to calculate bacterial colony forming units per m^3 (cfu/m^3) at each time point. Statistical analysis was performed, whereby the period before the high-risk event took place acted as a control period. The periods during and after the dressing and bed sheet changes were examined for significant differences in airborne bacterial levels relative to the control period. The study was carried out four times, on three patients with burns between 35% total burn surface area (TBSA) and 51% TBSA.

Results: There were significant increases in airborne bacteria levels, regardless of whether the dressing change or bed sheet change took place first. Of particular note, is the finding that significantly high levels (up to 2614 cfu/m^3) of airborne bacteria were shown to persist for up to approximately 1 h after these activities ended.

Discussion: This is the most accurate picture to date of the rapidly changing levels of airborne bacteria within the room of a burns patient undergoing a dressing change and bed change. The novel demonstration of a significant increase in the airborne bacterial load during these events has implications for infection control on burns units. Furthermore, as these increased levels remained for approximately 1 h afterwards, persons entering the room both during and after such events may act as vectors of transmission of infection. It is suggested that appropriate personal protective equipment should be worn by anyone entering the room, and that rooms should be quarantined for a period of time following these events.





Bache K *et al.*, Burns. 2015

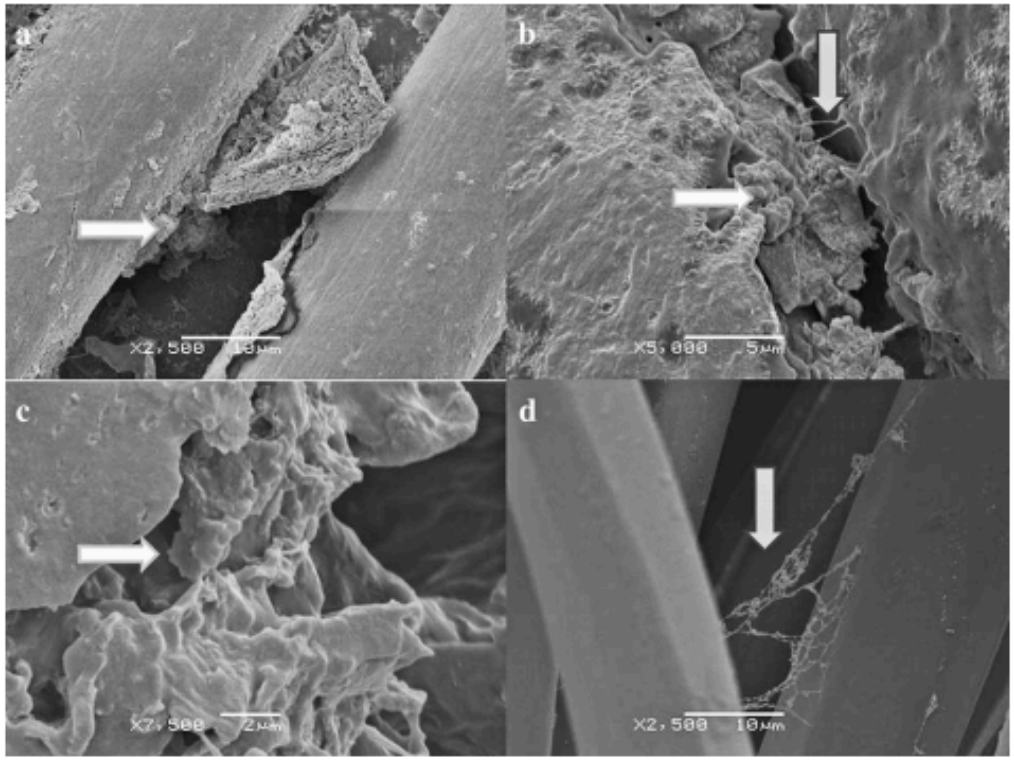


Figure 1. Scanning electron micrographs of: (a) blind cord (original magnification ×2500); (b) see-through ward door (original magnification ×5000); (c) red reagent box (original magnification ×7500); (d) curtain (original magnification ×2500). Horizontal arrows indicate coccoid bacteria embedded in exopolymeric substance (EPS). Vertical arrows indicate residual strings of EPS dehydrated during processing.

Vickery K *et al.*, J Hosp Infect 2012
Mitchell B *et al.*, J Hosp Infect 2015
Dancer SJ *et al.* Clin Micro Rev. 2014

Introduction to UHB NHS Trust

- 1400 in-patient beds
- 42 theatres
- 100 bed critical care unit
- Largest solid organ transplant centre in Europe
- Royal Centre for Defence Medicine
- Regional Major Trauma Centre
- Specialist services include:
  - Burns
  - Trauma & Orthopaedic
  - Liver surgery
  - Renal services
  - Cardiac surgery
  - Haematology and oncology
  - Neurosurgery

What are Carbapenem-Resistant Organisms?

C	Carbapenem or carbapenemase
R or P	Resistant or Producing
E or O	Enterobacteriaceae or Organisms

Non-fermenters	*Acinetobacter baumannii*	CPO
	Pseudomonas aeruginosa	
	Stenotrophomonas maltophilia	
Enterobacteriaceae	*Klebsiella pneumoniae*	CPE
	Escherichia coli	
	Enterobacter cloacae	

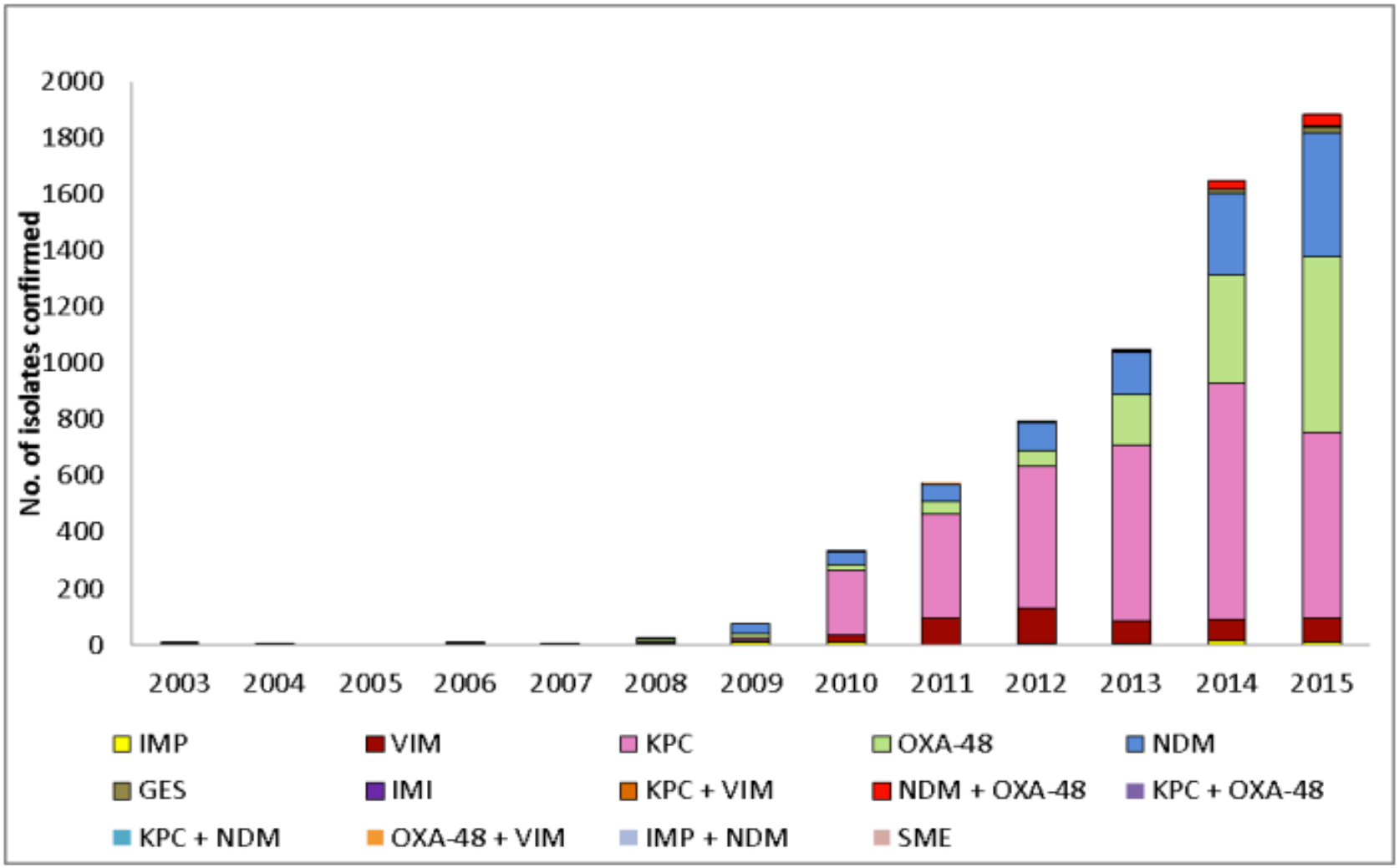
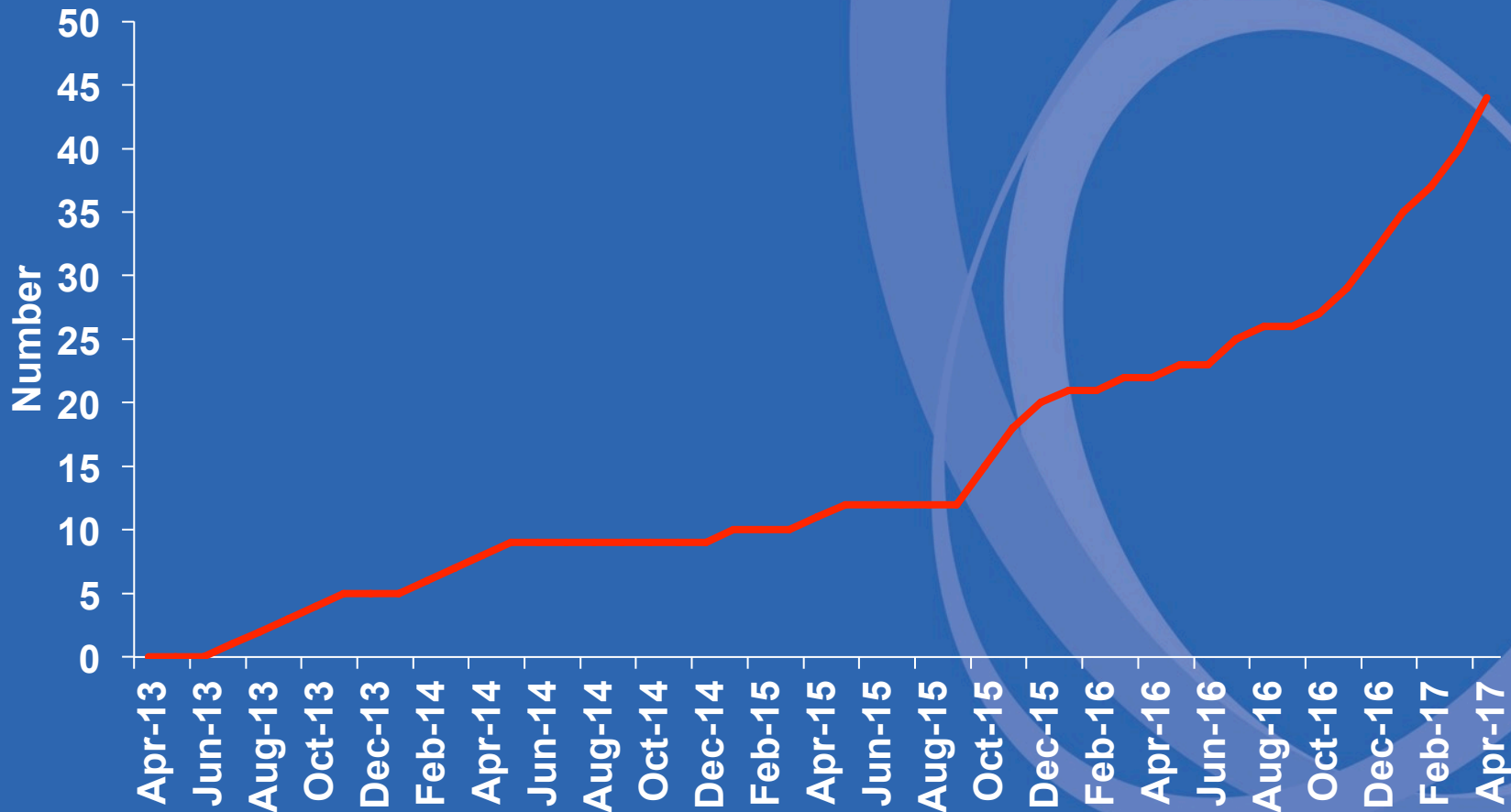


Figure 2.17 Number of isolates referred from UK hospital microbiology laboratories confirmed as carbapenemase-producing Enterobacteriaceae by AMRHAI, 2003-2015

Grundmann H *et al.*, Lancet Infect Dis 2016; ESPAUR 2016

CPEs at UHB


Number
50
45
40
35
30
25
20
15
10
5
0
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Oct-14
Dec-14
Feb-15
Apr-15
Jun-15
Aug-15
Oct-15
Dec-15
Feb-16
Apr-16
Jun-16
Aug-16
Oct-16
Dec-16
Feb-17
Apr-17

CPE cases at UHB since 2010

We have had representatives of all the common CPE enzymes

- KPC 26
- OXA-48 11
- NDM 22
- IMP 2
- VIM & GES 7 *(Pseudomonas aeruginosa)*

- Sporadic strains and clusters

59 CPEs; majority 32 Klebsiella, 12 Enterobacter, 11 *E. coli*

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journal homepage: www.elsevierhealth.com/journals/jhin

Short report

Environmental decontamination following occupancy of a burns patient with multiple carbapenemase-producing organisms

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Burns

SUMMARY

Over the last decade, carbapenemase-producing organisms (CPOs) have spread worldwide, becoming a major public health concern. This article reports the authors' experience in dealing with a burns patient infected with CPOs, and the decontamination methods employed to render a burns shock room safe for re-use. The shock room was cleaned after being vacated, but environmental sampling cultured multiple CPOs. A second decontamination was undertaken comprising a detergent, steam and hypochlorite clean followed by hydrogen peroxide misting, and no CPOs were cultured after subsequent environmental sampling. A burns patient harbouring CPOs contaminates the surroundings heavily, so standard cleaning is insufficient to reduce the environmental bioburden.

Garvey MI *et al.*, J Hosp Infect 2016

Cleans at UHB

- *Routine terminal clean*
  - Cleaning and disinfection with hypochlorite solution/ detergent (1,000ppm; Chlor Clean)
  - Hydrogen peroxide vapour (HPV; Oxyfarm) 6% concentration
- *Full environmental decontamination following CPO case*
  - Detergent/ disinfectant (Chlor Clean)
  - Steam-cleaning
  - Double-strength hypochlorite solution (2,000ppm; Chlor Clean)
  - HPV 12% concentration

Garvey MI *et al.*, J Hosp Infect 2016

Table I
Detail of 15 surfaces tested during environmental sampling using Polywipe sponges (surface area approximately 30 cm^2)

Surface tested	Terminal clean	Enhanced clean
Surface areas in vicinity of patient		
Bed frame	No MDRO	
Ventilator	KLE PNE (CPE), PSE AE	
Drip stand x1	PSE AE (CPO), ACI BAU	
Drip stand x2	PSE AE (CPO)	
Extract vent	ACI BAU (CPO)	
Ventilator monitor	KLE PNE (CPE), PSE AE ACI BAU (CPO)	
Floor	KLE PNE (CPE), PSE AE ACI BAU (CPO)	
Communal area surfaces tested		
Notes trolley	No MDRO	
Sink tap handles	PSE AE (CPO)	
Sink	PSE AE (CPO)	
Shower trolley	No MDRO	
Window sill	PSE AE (CPO), ACI BAU	
Door handle of room	No MDRO	
Handwash sink	No MDRO	
Door handle of ante-room	No MDRO	

MDRO, multi-drug-resistant organisms; KLE PNE, *Klebsiella pneumoniae*; PSE AE, *Pseudomonas aeruginosa*; ACI BAU, *Acinetobacter baumannii*; CPE, carbapenemase-producing Enterobactericeae; CPO, carbapenemase-producing organisms.

Figure 1. Critical care burns shock room with locations of equipment.

Garvey MI *et al.*, *J*HI 2016

CPE s ations

- Public Health Engla vent the spread of CPE, which include or based screening of all admissions.

An inpatient in a hospital abroad

Previous positive case

Also consi n-risk units such verseas.

Public Health England. CPE Toolkit. 2013.

J Antimicrob Chemother 2016; **71**: 3556–3561
doi:10.1093/jac/dkw309 Advance Access publication 11 August 2016

Journal of Antimicrobial Chemotherapy

Universal hospital admission screening for carbapenemase-producing

Table 3. Risk factors for CPE

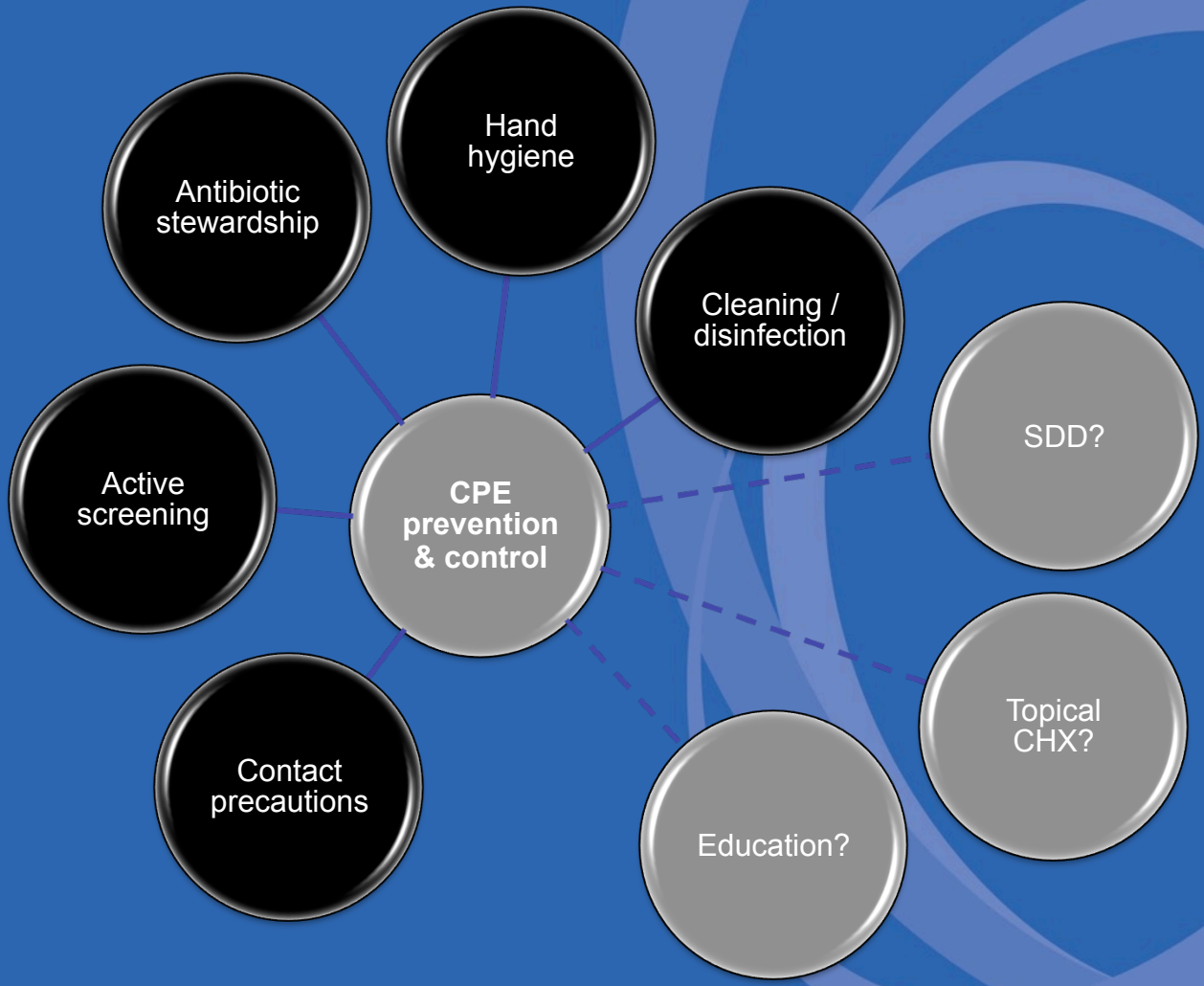
Risk factors	CPE− with risk factor	CPE− without risk factor	CPE+ with risk factor	CPE+ without risk factor	%CPE− with risk factor	%CPE+ with risk factor	*P* value[a]	OR	95% CI
Overnight hospital stay in the past 12 months									
overseas hospital (any country)	40	3966	2	3	1.0	40.0	**<0.001**	64.3	7.3–488.5
overseas hospital (CPE risk countries[b])	13	3993	1	4	0.4	20.0	**0.002**	57.5	2.3–594.6
any UK hospital (including London)	1704	2302	4	1	47.1	80.0	0.306	—	—
within M25	1496	2510	1	4	42.4	20.0	0.574	—	—
GSTT	1253	2753	1	4	36.3	20.0	0.769	—	—
North-West	6	4000	0	5	0.2	0.0	1.000	—	—
Overseas travel in the past 12 months	1311	2695	2	3	32.5	40.0	1.000	—	—
Non-UK residents	48	3958	0	5	1.2	0.0	1.000	—	—
Antibiotics in the past 6 months									
any	2205	1801	5	0	56.2	100.0	0.128	—	—
one course	1192	2814	2	3	29.9	40.0	0.998	—	—
more than one course	1012	2994	3	2	26.2	60.0	0.228	—	—
Risk factors excluding antibiotics	2630	1376	5	0	67.7	100.0	0.287	—	—
Any risk factor	3295	711	5	0	83.1	100.0	0.683	—	—

[a]*P* values ≤0.05 are shown in bold text.
[b]As defined by the PHE Toolkit.[8]

grew a carbapenem-resistant organism despite enrichment culture and only two were positive when retested several months later by Check-Direct and a second PCR assay (Cepheid GeneXpert® Carba-R). A modified Ct cut-off of <35 would have resolved these apparent false-positives. 40% of patients had a risk factor that should prompt screening and pre-emptive isolation as defined by UK CPE guidelines but only 8.1% and 20.2% of these patients had been screened and pre-emptively isolated by clinical teams, respectively. Overseas hospitalization was the only significant risk factor for CPE carriage ($P < 0.001$, OR 64.3, 95% CI 7.3–488.5).

Conclusions: This study highlights a very low carriage rate of CPE. Hospitalization abroad is the most important risk factor to guide admission screening in this low-prevalence setting.

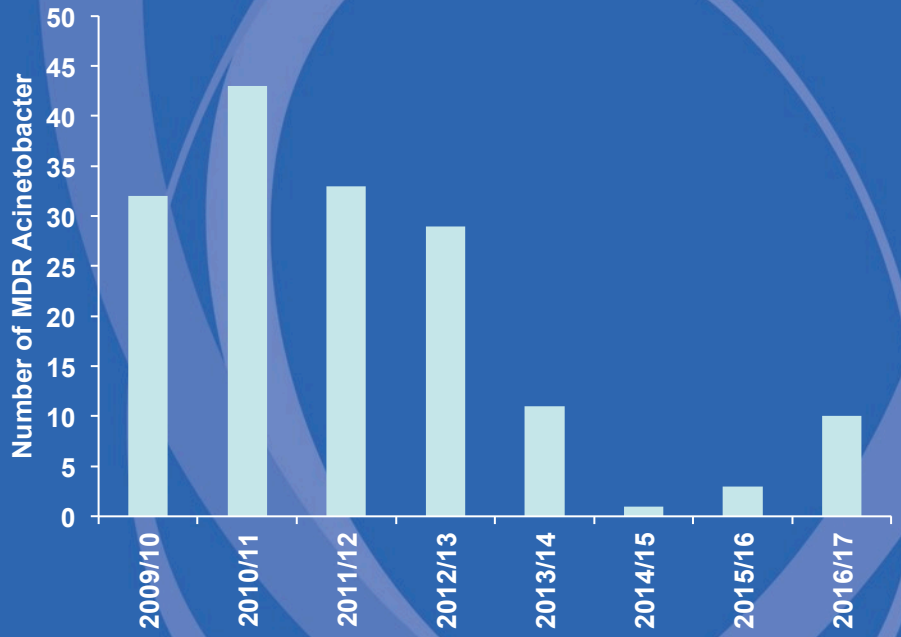
Otter JA *et al.*, J Antimicrob Chem 2016



Otter *et al.* Clin Microbiol Infect 2016.

MDR Acinetobacter at UHB

- Annually up to >250 patients transferred from abroad – risk of CPOs
- MDR *Acinetobacter sp.* endemic in the Trust for over 10 years
- Associated with battlefield trauma from Iraq and Afghanistan
- More recently associated with civilian patients



Outbreak

- Index case (July 2011):
  – Aeromedical evacuee from Afghanistan – Major trauma
  – Prolonged critical care
  – Multiple theatre trips
- 49 cases across 7 wards, mostly burns patients
- Protracted outbreak – last case January 2013

Halachev MR *et al.,* Genome Med 2014.

RESEARCH Open Access

Genomic epidemiology of a protracted hospital outbreak caused by multidrug-resistant *Acinetobacter baumannii* in Birmingham, England

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Abstract

Background: Multidrug-resistant *Acinetobacter baumannii* commonly causes hospital outbreaks. However, within an outbreak, it can be difficult to identify the routes of cross-infection rapidly and accurately enough to inform infection control. Here, we describe a protracted hospital outbreak of multidrug-resistant *A. baumannii*, in which whole-genome sequencing (WGS) was used to obtain a high-resolution view of the relationships between isolates.

Methods: To delineate and investigate the outbreak, we attempted to genome-sequence 114 isolates that had been assigned to the *A. baumannii* complex by the Vitek2 system and obtained informative draft genome sequences from 102 of them. Genomes were mapped against an outbreak reference sequence to identify single nucleotide variants (SNVs).

Results: We found that the pulsotype 27 outbreak strain was distinct from all other genome-sequenced strains. Seventy-four isolates from 49 patients could be assigned to the pulsotype 27 outbreak on the basis of genomic similarity, while WGS allowed 18 isolates to be ruled out of the outbreak. Among the pulsotype 27 outbreak isolates, we identified 31 SNVs and seven major genotypic clusters. In two patients, we documented within-host diversity, including mixtures of unrelated strains and within-strain clouds of SNV diversity. By combining WGS and epidemiological data, we reconstructed potential transmission events that linked all but 10 of the patients and confirmed links between clinical and environmental isolates. Identification of a contaminated bed and a burns theatre as sources of transmission led to enhanced environmental decontamination procedures.

Conclusions: WGS is now poised to make an impact on hospital infection prevention and control, delivering cost-effective identification of routes of infection within a clinically relevant timeframe and allowing infection control teams to track, and even prevent, the spread of drug-resistant hospital pathogens.

Halachev MR *et al.*, Genome Med 2014.

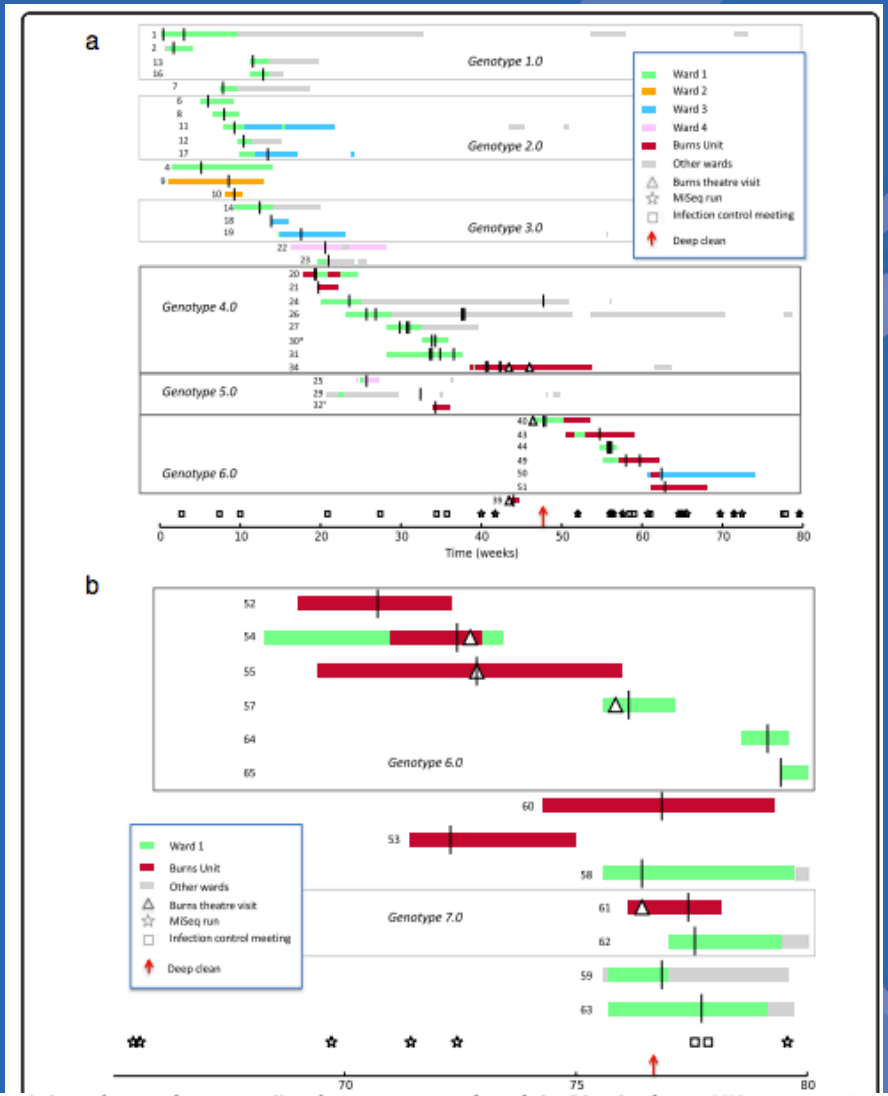


Figure 1 Chronology of the *Acinetobacter baumannii* pulsotype 27 outbreak in Birmingham, UK, 2011 to 2013, showing ward occupancy and other events for 52 patients. (a) The first phase of the outbreak, up to week 70. **(b)** A detailed view of the second phase of the outbreak, after week 70. Vertical bars indicate samples positive for MDR-Aci. The coloured horizontal bars indicate ward occupancy by patients carrying MDR-Aci. Patients are ordered by the SNV genotype of their MDR-Aci isolates, with major genotypes delineated by rectangles. Ward 1 cares mainly for burns and trauma patients; Ward 2 cares mainly for cardiac surgery patients, Ward 3 cares mainly for trauma patients; Ward 4 for plastic, ear-nose-and-throat, maxillofacial, trauma patients. * The first of three isolates obtained from patient 30 was not genome-sequenced. ° Patient 32 visited Ward 1 for 12 hours.

Practical control measures

Infection Control

- Isolation of cases
- Reinforcement of PPE protocols
- Daily hand hygiene audits validated by IPN
- Contact screening
- Focused education

Management

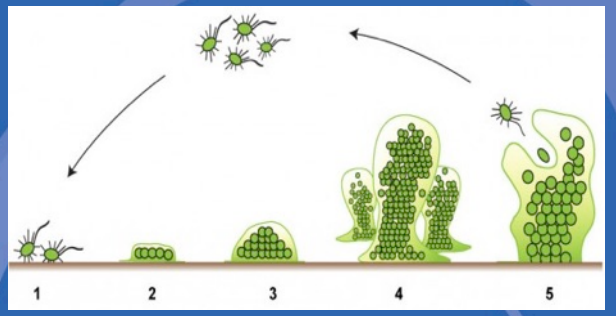
- Root cause analysis with whole journey review
- Regular outbreak meetings

Cleaning control measures

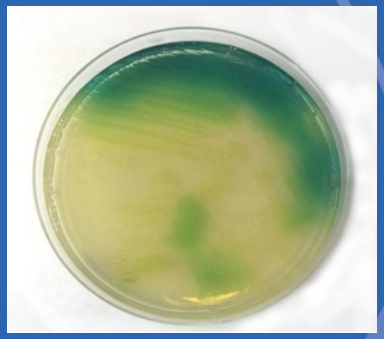
Cleaning

- Environmental screening
- Enhanced cleaning
- Decant and deep clean
- Use of hydrogen peroxide
- Implement Rapid Cleaning Team
- Commence inter-theatre trip terminal cleaning
- Embed an assurance framework for cleaning in theatres

Pseudomonas aeruginosa



- *P. aeruginosa* is widespread in the environment:
  - Soil, water & moist environments
- Usually colonises hospital and domestic sink traps, taps and drains
- Humans may be colonised at moist sites
- Highly opportunistic pathogen
- Outbreaks in burns are frequently reported from water sources
- Water transmission has become a matter of urgent concern



https://www.gov.uk/government/publications/addendum-to-guidance-for-healthcare-providers-on-managing-pseudomonas-published

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Short report

Continued transmission of *Pseudomonas aeruginosa* from a wash hand basin tap in a critical care unit

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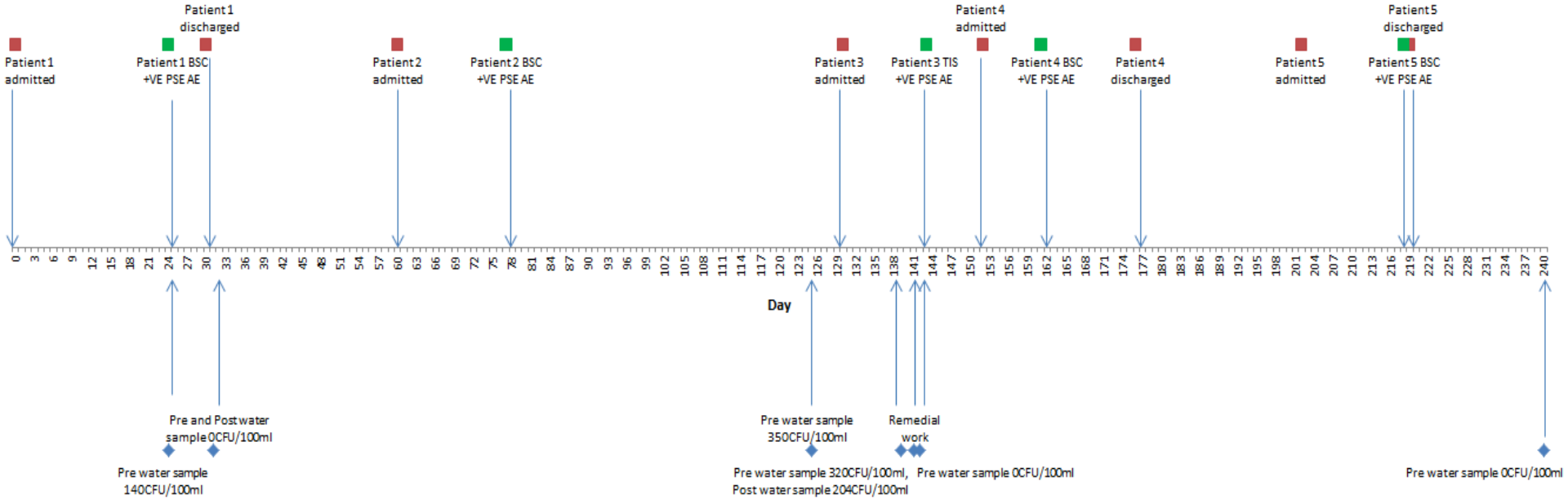
Water
Critical care
Water outlets
Outbreak
Nosocomial

SUMMARY

Pseudomonas aeruginosa is an important nosocomial pathogen, colonizing hospital water supplies including taps and sinks. We report a cluster of *P. aeruginosa* acquisitions during a period of five months from tap water to patients occupying the same burns single room in a critical care unit. *Pseudomonas aeruginosa* cultured from clinical isolates from four different patients was indistinguishable from water strains by pulsed-field gel electrophoresis. Water outlets in critical care may be a source of *P. aeruginosa* despite following the national guidance, and updated guidance and improved control measures are needed to reduce the risks of transmission to patients.

Garvey MI *et al.*, J Hosp Infect. 2016

- Found some patient water transmission events from routine surveillance



Garvey MI *et al.*, J Hosp Infect 2016.

Open Access Research

BMJ Open

Seeking the source of *Pseudomonas aeruginosa* infections in a recently opened hospital: an observational study using whole-genome sequencing

Joshua Quick,[1,2] Nicola Cumley,[2] Christopher M Wearn,[2,3] Marc Niebel,[2] Chrystala Constantinidou,[4] Chris M Thomas,[1] Mark J Pallen,[4] Naiem S Moiemen,[2,3] Amy Bamford,[2,3] Beryl Oppenheim,[2] Nicholas J Loman[1]

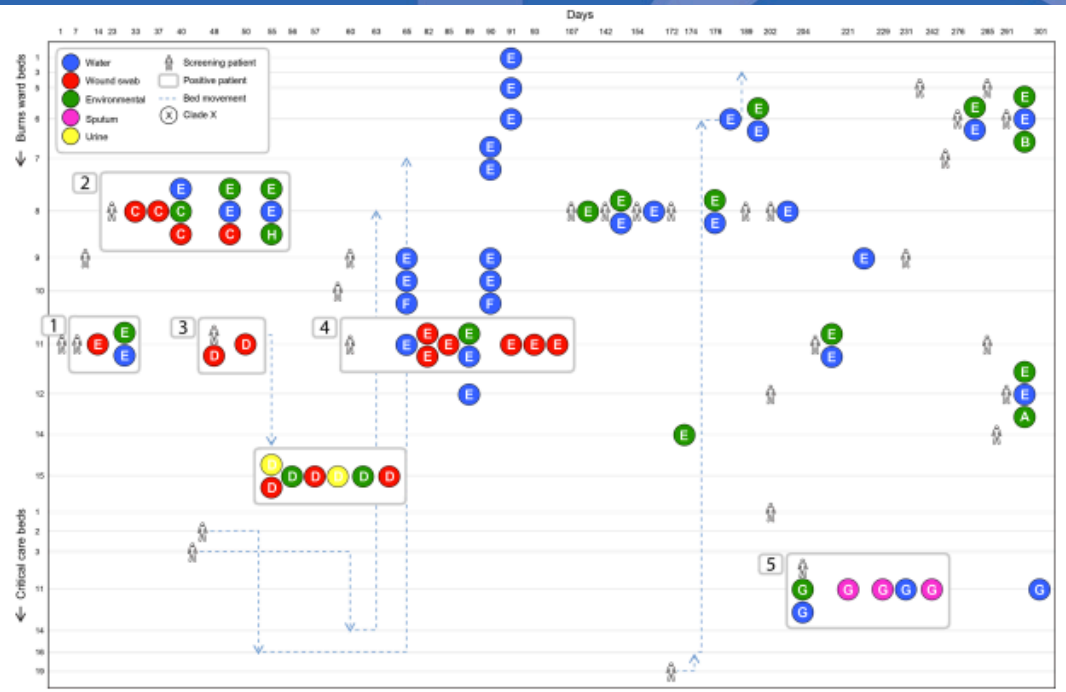


Figure 2 A schematic view of the 300-day study of *Pseudomonas aeruginosa* in a burns centre and critical care unit. Time in days is shown along the x axis with bed numbers in the critical care unit and burns unit along the y axis. Each circular icon indicates a positive isolate of *P. aeruginosa*. The icon's logotype indicates which environment it originated from (wound, urine/sputum, environment or water). The filled colour of the icon indicates the clade it belongs to. Patient icons represent the enrolment of a screening patient into the study and their location. Patient movements around the hospital are noted by dotted lines. The five patients infected with *P. aeruginosa* are denoted by rounded boxes. Boxes are coloured according to the patient number. In the event two or more isolates of the same source and clade were collected on the same day, these have been collapsed into a single circular icon.

Quick J *et al.*, BMJ. 2014

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/ijheh

Engineering waterborne *Pseudomonas aeruginosa* out of a critical care unit

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Transmission
Engineering
Holistic factors

ABSTRACT

Objective: To describe engineering and holistic interventions on water outlets contaminated with *Pseudomonas aeruginosa* and the observed impact on clinical *P. aeruginosa* patient isolates in a large Intensive Care Unit (ICU).
Design: Descriptive study.
Setting: Queen Elizabeth Hospital Birmingham (QEHB), part of University Hospitals Birmingham (UHB) NHS Foundation Trust is a tertiary referral teaching hospital in Birmingham, UK and provides clinical services to nearly 1 million patients every year.
Methods: Breakpoint models were used to detect any significant changes in the cumulative yearly rates of clinical *P. aeruginosa* patient isolates from August 2013–December 2016 across QEHB.
Results: Water sampling undertaken on the ICU indicated 30% of the outlets were positive for *P. aeruginosa* at any one time. Molecular typing of patient and water isolates via Pulsed Field Gel Electrophoresis suggested there was a 30% transmission rate of *P. aeruginosa* from the water to patients on the ICU. From, February 2014, QEHB implemented engineering interventions, consisting of new tap outlets and PALL point-of-use filters; as well as holistic measures, from February 2016 including a revised tap cleaning method and appropriate disposal of patient waste water. Breakpoint models indicated the engineering and holistic interventions resulted in a significant ($p < 0.001$) 50% reduction in the number of *P. aeruginosa* clinical patient isolates over a year.
Conclusion: Here we demonstrate that the role of waterborne transmission of *P. aeruginosa* in an ICU cannot be overlooked. We suggest both holistic and environmental factors are important in reducing transmission.

Garvey MI *et al.*, Int J Hyg Environ Health. 2017

Service improvement

Garvey MI *et al.,* Int J Hyg Environ Health. 2017; Garvey MI *et al.,* J Hosp Infect. 2016

Conclusions

- Strict adherence to infection prevention and control procedures essential to interrupt spread of microorganisms in burns patients
- Environmental cleaning key in controlling spread ? lack of assurance
- Outbreaks can be devastating lasting several months
- Appropriate facilities important
- ? Burns guidance – need for a positive pressure theatre, ventilation of side rooms
- Procedures undertaken on critical care are high risk
- Priority during an outbreak is to protect major burns patients


Chief Nurse

Thank you

Questions?