Burns outbreaks - ‘the UHB experience’

Dr Mark Garvey
Principal Clinical Scientist in Microbiology
Director of the Hospital Infection Research Laboratory
Associate Director of Infection Prevention and Control
mark.garvey@uhb.nhs.uk
@drmarkgarvey

Mr Craig Bradley
Lead Nurse Infection Prevention and Control
IPS Board Member
craig.bradley@uhb.nhs.uk
@craigbradleyF1 @uhbipc
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
Airborne bacterial dispersal during and after dressing and bed changes on burns patients

Sarah E. Bache, Michelle Maclean, George Gettinby, John G. Anderson, Scott J. MacGregor, Ian Taggart

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 dispensers 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 m³ (cfu/m³) 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 2014 cfu/m³) 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.
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.

Figure 2. Risk of MRSA, meticillin-resistant *Escherichia coli* separate Klebsiella or possible to...
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?

<table>
<thead>
<tr>
<th>C</th>
<th>Carbapenem or carbapenemase</th>
</tr>
</thead>
<tbody>
<tr>
<td>R or P</td>
<td>Resistant or Producing</td>
</tr>
<tr>
<td>E or O</td>
<td>Enterobacteriaceae or Organisms</td>
</tr>
</tbody>
</table>

Non-fermenters:  
- *Acinetobacter baumannii*
- *Pseudomonas aeruginosa*
- *Stenotrophomonas maltophilia*

Enterobacteriaceae:  
- *Klebsiella pneumoniae*
- *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
We have had representatives of all the common CPE enzymes

- KPC 28
- OXA-48 13
- NDM 26
- IMP 2
- VIM & GES 8 (*Pseudomonas aeruginosa*)

- Sporadic strains and clusters

66 CPEs; majority 34 Klebsiella, 15 *E. coli*, 12 Enterobacter
Strict adherence to infection prevention and control procedures is essential to interrupt the spread of antibiotic resistant organisms and preserve the usefulness of antibiotics.

Cleaning is key to prevent the spread of CPE.

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 misting (HPM; Oxyfarm) 6% concentration

- **Full environmental decontamination following CPO case**
  - Detergent/disinfectant (Chlor Clean)
  - Steam-cleaning
  - Double-strength hypochlorite solution (2,000ppm; Chlor Clean)
  - HPM 12% concentration

Garvey MI et al., J Hosp Infect 2016
Table 1
Detail of 15 surfaces tested during environmental sampling using Polywipe sponges (surface area approximately 30 cm²)

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

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

Figure 1. Critical care burns shock room with locations of equipment.
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.
Genomic epidemiology of a protracted hospital outbreak caused by multidrug-resistant *Acinetobacter baumannii* in Birmingham, England

Mihail R Halachev,1† Jacqueline Z-M Chan,2† Chrystala I Constantinidou,2 Nicola Cumley,3 Craig Bradley,3 Matthew Smith-Banks,3 Beryl Oppenheim3 and Mark J Pallen2†

**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.
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

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

M.I. Garvey*, C.W. Bradley, J. Tracey, B. Oppenheim

*University Hospitals Birmingham NHS Foundation Trust, Queen Elizabeth Hospital Birmingham, Edgbaston, Birmingham, UK*

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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.

© 2016 Published by Elsevier Ltd on behalf of the Healthcare Infection Society.
• Found some patient water transmission events from routine surveillance

Garvey MI et al., J Hosp Infect 2016.
Seeking the source of *Pseudomonas aeruginosa* infections in a recently opened hospital: an observational study using whole-genome sequencing

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

Mark I. Garvey\(^a,b,*,\) Craig W. Bradley\(^a\), Martyn A.C. Wilkinson\(^b\), Christina Bradley\(^b\), Elisabeth Holden\(^a\)

\(^a\) University Hospitals Birmingham NHS Foundation Trust, Queen Elizabeth Hospital Birmingham, Edgbaston, Birmingham B15 2WR, United Kingdom
\(^b\) Hospital Infection Research Laboratory, University Hospitals Birmingham NHS Foundation Trust, Queen Elizabeth Hospital Birmingham, Edgbaston, Birmingham B15 2WB, United Kingdom

**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 (QEH), 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 QEH.

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, QEH 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.

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Service improvement

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

Delivering the best in care
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
• Procedures undertaken on critical care are high risk
• Priority during an outbreak is to protect major burns patients
Thank you

Questions?