The Year In Infection Control

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DISCLOSURE: NONE
Topics

• Evolving Epidemiology of *Acinetobacter baumannii*

• Environmental cleaning: What is new?

• Epidemiology and Control of HAIs and Multi-Drug Resistant Organisms in Resource-Limited Settings: What do we need?

• Unusual Outbreaks & Outbreak worthy of our attention

• Filling the Gap in Infection Control: Thinking outside the box!
Topics

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Acinetobacter baumannii: Emergence of a Successful Pathogen
Anton Y. Peleg, Harald Seifert, and David L. Paterson

FIG. 2, Countries that have reported an outbreak of carbapenem-resistant Acinetobacter baumannii. Red signifies outbreaks reported before 2006, and yellow signifies outbreaks reported since 2006.
Colistin-Resistant *Acinetobacter baumannii*: Beyond Carbapenem Resistance

Zubair A. Qureshi, Lauren E. Hittle, Jessica A. O'Hara, Jesabel I. Rivera, Alveena Syed, Ryan K. Shields, Anthony W. Pasculle, Robert K. Ernst, and Yohei Doi

- Adequacy of colistin dosing to avoid suboptimal use
- Colistin should not be used to decolonize asymptomatic CRE carriage
- Empirical colistin should be subjected to tight restriction

Genetic relatedness of colistin susceptible and resistant AB

- By MLST, all isolates belong to International Clone 2
- Modification of Lipid A was present in all Colistin-R isolates

Adequacy of colistin dosing to avoid suboptimal use

Colistin should not be used to decolonize asymptomatic CRE carriage

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Severe infections by XDR-AB infections were investigated in an outbreak.

The clone associated with death belong to wide spread IC II and uncommon sequence type 10, closely related to strain from Chez Republic, California and Germany in 1994, 1997, 2003.

The most virulent Clade B was isolated from patients with low co-morbidity score.
Utility of Whole-Genome Sequencing in Characterizing *Acinetobacter* Epidemiology and Analyzing Hospital Outbreaks

Margaret A. Fitzpatrick, a, Egon A. Ozer, a Alan R. Hauser b

Department of Medicine, Division of Infectious Diseases, Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA a; Department of Microbiology and Immunology, Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA b

*Acinetobacter baumannii* frequently causes nosocomial infections and outbreaks. Whole-genome sequencing (WGS) is a promising technique for strain typing and outbreak investigations. We compared the performance of conventional methods with WGS for strain typing clinical *Acinetobacter* isolates and analyzing a carbapenem-resistant *A. baumannii* (CRAB) outbreak. We performed two band-based typing techniques (pulsed-field gel electrophoresis and repetitive extragenic palindromic-PCR), multilocus sequence type (MLST) analysis, and WGS on 148 *Acinetobacter calcoaceticus-A. baumannii* complex bloodstream isolates collected from a single hospital from 2005 to 2012. Phylogenetic trees inferred from core-genome single nucleotide polymorphisms (SNPs) confirmed three *Acinetobacter* species within this collection. Four major *A. baumannii* clonal lineages (as defined by MLST) circulated during the study, three of which are globally distributed and one of which is novel. WGS indicated that a threshold of 2,500 core SNPs accurately distinguished *A. baumannii* isolates from different clonal lineages. The band-based techniques performed poorly in assigning isolates to clonal lineages and exhibited little agreement with sequence-based techniques. After applying WGS to a CRAB outbreak that occurred during the study, we identified a threshold of 2.5 core SNPs that distinguished nonoutbreak from outbreak strains. WGS was more discriminatory than the band-based techniques and was used to construct a more accurate transmission map that resolved many of the plausible transmission routes suggested by epidemiologic links. Our study demonstrates that WGS is superior to conventional techniques for *A. baumannii* strain typing and outbreak analysis. These findings support the incorporation of WGS into health care infection prevention efforts.
<table>
<thead>
<tr>
<th>Typing method</th>
<th>No. of types</th>
<th>Simpson's index (95% CI)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFGE</td>
<td>40</td>
<td>0.892 (0.834–0.950)</td>
<td>90</td>
<td>53</td>
</tr>
<tr>
<td>Rep-PCR</td>
<td>50</td>
<td>0.970 (0.950–0.990)</td>
<td>97</td>
<td>57</td>
</tr>
<tr>
<td>MLST</td>
<td>10</td>
<td>0.758 (0.706–0.810)</td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td>WGS(^d)</td>
<td>75</td>
<td>0.997 (0.995–1.000)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Acinetobacter-positive patients had their ambient air tested for up to 10 consecutive days. The air was Acinetobacter positive for an average of 21% of the days; the rate of contamination was higher among patients colonized in the rectum than in the airways (relative risk [RR], 2.35; \( P = 0.006 \)). Of the 6 air/clinical isolate pairs available, 4 pairs were closely related according to rep-PCR results.
Infrequent air contamination with *Acinetobacter baumannii* of air surrounding known colonized or infected patients.

Rock C, Harris AD, Johnson JK, Bischoff WE, Thom KA.

Using a validated air sampling method we found *Acinetobacter baumannii* in the air surrounding only 1 of 12 patients known to be colonized or infected with *A. baumannii*. Patients' closed-circuit ventilator status, frequent air exchanges in patient rooms, and short sampling time may have contributed to this low burden.

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• Filling the Gap in Infection Control: Thinking outside the box!
Environmental Contamination and Viral Shedding in MERS Patients During MERS-CoV Outbreak in South Korea

Seo Yu Bin,1,2 Jung Yeon Heo,2 Min-Suk Song,3,4 Jacob Lee,1,2 Eun-Ha Kim,3 Su-Jin Park,3,4 Hyeok-il Kwon,3,4 Se mi Kim,3,4 Young-il Kim,3,4 Young-Jae Si,3,4 In-Won Lee,3,4 Yun Hee Baek,3 Won-Suk Choi,3 Jinsoo Min,2 Hye Won Jeong,2 and Young Ki Choi3,4

1Division of Infectious Diseases, Department of Internal Medicine, Hallym University College of Medicine, Chuncheon, 2Departments of Internal Medicine, and 3Microbiology, College of Medicine and Medical Research Institute, and 4Zoonotic Infectious Diseases Research Center, Chungbuk National University, Seowon-Gu, Cheongju, Republic of Korea

Background. Although Middle East Respiratory Syndrome coronavirus (MERS-CoV) is characterized by a risk of nosocomial transmission, the detailed mode of transmission and period of virus shedding from infected patients are poorly understood. The aims of this study were to investigate the potential role of environmental contamination by MERS-CoV in healthcare settings and to define the period of viable virus shedding from MERS patients.

Methods. We investigated environmental contamination from 4 patients in MERS-CoV units of 2 hospitals. MERS-CoV was detected by reverse transcription polymerase chain reaction (PCR) and viable virus was isolated by cultures.

Results. Many environmental surfaces of MERS patient rooms, including points frequently touched by patients or healthcare workers, were contaminated by MERS-CoV. Viral RNA was detected up to five days from environmental surfaces following the last positive PCR from patients’ respiratory specimens. MERS-CoV RNA was detected in samples from anterooms, medical devices, and air-ventilating equipment. In addition, MERS-CoV was isolated from environmental objects such as bed sheets, bedrails, IV fluid hangers, and X-ray devices. During the late clinical phase of MERS, viable virus could be isolated in 3 of the 4 enrolled patients on day 18 to day 25 after symptom onset.

Conclusions. Most of touchable surfaces in MERS units were contaminated by patients and healthcare workers and the viable virus could shed through respiratory secretion from clinically fully recovered patients. These results emphasize the need for strict environmental surface hygiene practices, and sufficient isolation period based on laboratory results rather than solely on clinical symptoms.
### Table 3. Frequency of Environmental Sample Positivity for Middle East Respiratory Syndrome Coronavirus in Reverse Transcription Polymerase Chain Reaction or Viral Culture

<table>
<thead>
<tr>
<th>Swab Site</th>
<th>PCR Results (Positivity Percent, %)</th>
<th>Culture Results (Positivity Percent, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed sheet</td>
<td>3/15 (20.0)</td>
<td>1/15 (6.7)</td>
</tr>
<tr>
<td>Bedrails</td>
<td>4/15 (26.7)</td>
<td>1/15 (6.7)</td>
</tr>
<tr>
<td>Bed tables</td>
<td>2/5 (40.0)</td>
<td>0/5 (0.0)</td>
</tr>
<tr>
<td>Bed controllers</td>
<td>5/15 (33.3)</td>
<td>0/15 (0.0)</td>
</tr>
<tr>
<td>Shelves</td>
<td>0/14 (0.0)</td>
<td>0/14 (0.0)</td>
</tr>
<tr>
<td>Door buttons</td>
<td>1/10 (10.0)</td>
<td>0/10 (0.0)</td>
</tr>
<tr>
<td>Bathroom door knobs</td>
<td>1/10 (10.0)</td>
<td>0/10 (0.0)</td>
</tr>
<tr>
<td>Patient room floor</td>
<td>0/7 (0.0)</td>
<td>0/7 (0.0)</td>
</tr>
<tr>
<td>Patient monitor buttons</td>
<td>0/5 (0.0)</td>
<td>0/5 (0.0)</td>
</tr>
<tr>
<td>Thermometers</td>
<td>1/5 (20.0)</td>
<td>0/5 (0.0)</td>
</tr>
<tr>
<td>IV fluid hangers</td>
<td>5/14 (35.7)</td>
<td>2/14 (14.3)</td>
</tr>
<tr>
<td>Portable X-rays</td>
<td>1/5 (20.0)</td>
<td>0/5 (0.0)</td>
</tr>
<tr>
<td>Computed radiography cassette</td>
<td>1/1 (100.0)</td>
<td>1/1 (100.0)</td>
</tr>
<tr>
<td>Anteroom floors</td>
<td>2/14 (14.3)</td>
<td>0/14 (0.0)</td>
</tr>
<tr>
<td>Anteroom tables</td>
<td>3/7 (42.8)</td>
<td>1/7 (14.3)</td>
</tr>
<tr>
<td>Entrances of air-ventilating equipment</td>
<td>1/6 (16.7)</td>
<td>0/6 (0.0)</td>
</tr>
</tbody>
</table>
What is new!

• MERS-CoV could be isolated from sputum up to 25\textsuperscript{th} day after disease onset.
• Infected pts can shed virus in the respiratory secretions for >25 days.
• Strict ENV cleaning policy should be applied also during the patient is at recovery phase.
• Any isolation and quarantine policy should be considered on laboratory results rather than pts’ clinical symptoms.
• ENV contamination may play a role in nosocomial transmission of MERS-CoV.
Climbing the Evidentiary Hierarchy for Environmental Infection Control

- Demonstrated
  Reduced infections

- Demonstrated + reduced
  Pathogen transmission via
  Admission- discharge active surveillance testing or clinical incidence

- Demonstrated that in-use disburden reduction may be clinically relevant
  1. Terminal- only use: reduction of “same room transmission”
  2. Terminal and daily use: reduction in Hand contamination rates

- Demonstrated in-use
  Bioburden reduction

- Laboratory demonstration of bioburden reduction efficacy (10^3 -10^6 reductions, depending on claim)
Objective and Design

To determine if enhanced methods for terminal room disinfection decrease acquisition and infection due to multidrug-resistant organisms (MDROs)
Methods

28 months – all 4 cleaning strategies

- Each strategy for 7 months
  - Sequence randomized
- First month: “wash in” between phases

Prospective, multicenter, cluster-randomized, crossover trial to evaluate three strategies for enhanced terminal room disinfection

- 9 hospitals
- Randomization at level of hospital
- 2x2 factorial design
Definitions and Inclusion Criteria

Patient in “Seed Room”

Exposed Patient

Terminal Clean

Documented infection or Colonization with MRSA  VRE  C. difficile  MDR-ACINETOBACTER

“TARGET MDROs”

In room > 24 hours

Potential “Incident Case”

Same organism as the patient in the “seed room”

Positive culture while in room

OR

Positive culture after stay in room - 90 days (MRSA, VRE) - 28 days (C. difficile)

Study Phase

Strategy

A + C

Bleach

B +

Bleach/UV

n/exposure days

36/11,385

38/12,509

364

Cumulative rate

31.6

30.4

Average rate ± STD

33.0 ± 46.4

26.6 ± 19.2

RR(95% CI); P-value

ref 1.0 (0.57-1.76)

1.0

Study Phase

Strategy

A

Quat

B

Quat/UV

C

Bleach

D

Bleach/UV

n/exposure days

115/22,426

76/22,389

101/24,261

131/28,757

Cumulative rate ± rate

51 ± .3

33 ± .9

41 ± .6

45 ± .6

Average rate ± STD

46.1 ± 27.9

28.7 ± 20.5

41.1 ± 16.6

39.2 ± 20.9

RR(95% CI); P-value

ref 0.70 (0.50-0.98)

0.036

0.78 (0.58-1.05)

0.11

0.43 (0.19-0.996)

0.049

0.36 (0.18-0.70)

0.003

MRSA Outcome

Study Phase

Strategy

A

Quat

B

Quat/UV

C

Bleach

D

Bleach/UV

n/exposure days

73/14,524

54/14,780

74/15,343

89/18,960

Cumulative rate ± rate

50 ± .3

36 ± .5

48 ± .2

46 ± .9

Average rate ± STD

51.7 ± 31.8

33.9 ± 24.6

47.0 ± 21.6

39.1 ± 33.1

RR(95% CI); P-value

ref 0.78 (0.58-1.05)

0.11

1.00 (0.82-1.21)

0.12

0.97 (0.76-1.09)

0.30

VRE Outcome

Study Phase

Strategy

A

Quat

B

Quat/UV

C

Bleach

D

Bleach/UV

n/exposure days

37/5,838

17/5,780

24/7,522

37/9,488

Cumulative rate ± rate

63 ± .4

29 ± .4

31 ± .9

39 ± 0

Average rate ± STD

22.9

11.4

17.1

11.1

22.7

32.2

24.9

RR(95% CI); P-value

ref 0.41 (0.15-1.13)

0.43 (0.19-0.996)

0.36 (0.18-0.70)

0.41

0.15

0.19

0.18

0.08

0.049

0.003

Rate = n/10,000 exposure days
Conclusions

• Enhanced terminal room disinfection strategies decreased the clinical incidence of target MDROs by 10-30% among exposed patients

• Biggest impact on vegetative bacteria

• Quat + UV for vegetative bacteria

• Compliance with study protocol was high (remarkable 90% compliance >20,000 rooms)

• Do different pathogens have different winner strategy?
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The Burden of Healthcare-Associated Infections in Southeast Asia: A Systematic Literature Review and Meta-analysis

Moi Lin Ling, Anucha Apisarnthanarak, and Gilbert Madriaga

A

PRISMA flowchart

Identification

Records identified through database searching (n = 14,089)

Records screened after removing duplicates (n = 12,285)

Records excluded (n = 11,788)

Eligibility

Additional studies from hand searching (n = 9)

Full-text articles assessed for eligibility (n = 506)

Full-text articles excluded (n = 452)

Included

Studies included in synthesis (n = 41)

B

Full-text review and included studies per country

Legend:

Full-text review
Included for analysis

Thailand
Vietnam
Malaysia
Indonesia
Singapore
Philippines
<table>
<thead>
<tr>
<th>Type of Infection</th>
<th>Microorganisms</th>
<th>Range, %</th>
<th>Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall HAIs</td>
<td><em>Pseudomonas aeruginosa</em></td>
<td>13.4–31.5</td>
<td>Hughes et al, 2005 (Malaysia) [23]; Thu et al, 2011 (Vietnam) [42]; Danchaivijitr et al, 2007 (Thailand) [24]</td>
</tr>
<tr>
<td></td>
<td><em>Klebsiella</em> spp</td>
<td>10–10.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Acinetobacter baumannii</em></td>
<td>10.7–23.3</td>
<td></td>
</tr>
<tr>
<td>ICU</td>
<td><em>Acinetobacter</em> spp</td>
<td>18.42–21.13</td>
<td>Katherason et al, 2008 (Malaysia) [34]; Thongpiyapoom et al, 2004 (Thailand) [26]</td>
</tr>
<tr>
<td></td>
<td><em>Klebsiella</em> spp</td>
<td>14.1–44.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>P. aeruginosa</em></td>
<td>15.8–16.9</td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td><em>Escherichia coli</em></td>
<td>10.3–38.7</td>
<td>Anannamcharoen et al, 2012 (Thailand) [35]; Luksamijarukul et al, 2006 (Thailand) [47]; Yong et al, 2001 (Malaysia) [41]; Syahrinal et al, 2001 (Malaysia) [39]; Thu et al, 2005 (Vietnam) [55]; Young et al, 2011 (Singapore) [43]; Kehachindawat et al, 2007 (Thailand) [38]; Buang et al, 2012 (Malaysia) [44]; Hung et al, 2011 (Vietnam) [40]; Narong et al, 2003 (Thailand) [45]</td>
</tr>
<tr>
<td></td>
<td><em>Pseudomonas</em> spp</td>
<td>12–29.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Staphylococcus aureus</em></td>
<td>11.5–44.4</td>
<td></td>
</tr>
<tr>
<td>CAUTI</td>
<td><em>Candida</em> spp</td>
<td>25–27.8</td>
<td>Thongpiyapoom et al, 2004 (Thailand) [26]; Katherason et al, 2008 (Malaysia) [34]; Navoa-Ng et al, 2011 (Philippines) [28]; Rozaidi et al, 2001 (Malaysia) [29]; Narong et al, 2003 (Thailand) [45]</td>
</tr>
<tr>
<td></td>
<td><em>E. coli</em></td>
<td>11.1–36.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Klebsiella</em> spp</td>
<td>11.1–75</td>
<td></td>
</tr>
<tr>
<td>VAP</td>
<td><em>Acinetobacter</em> spp</td>
<td>13.6–42.8</td>
<td>Katherason et al, 2009 (Malaysia) [27]; Navoa-Ng et al, 2011 (Philippines) [28]; Rozaidi et al, 2001 (Malaysia) [29]; Thongpiyapoom et al, 2004 (Thailand) [26]; Narong et al, 2003 (Thailand) [45]</td>
</tr>
<tr>
<td></td>
<td><em>Pseudomonas</em> spp</td>
<td>14.8–32.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Klebsiella</em> spp</td>
<td>14.3–38.7</td>
<td></td>
</tr>
<tr>
<td>CLBSI</td>
<td><em>Acinetobacter</em> spp</td>
<td>11.1–50</td>
<td>Katherason et al, 2010 (Malaysia) [31]; Tan et al, 2007 (Malaysia) [30]; Navoa-Ng et al, 2011 (Philippines) [28]; Thongpiyapoom et al, 2004 (Thailand) [26]; Rozaidi et al, 2001 (Malaysia) [29]; Narong et al, 2003 (Thailand) [45]</td>
</tr>
<tr>
<td></td>
<td><em>S. aureus</em></td>
<td>9.1–16.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Klebsiella</em> spp</td>
<td>9.1–38.9</td>
<td></td>
</tr>
</tbody>
</table>
During XDR-AB outbreak in RLS, if you can choose one strategy (in additional to HH), what would be your choice?
Expert Opinions

• During outbreak, I would certainly try “universal gloves and gowns”.
  Harris AD, et al. Universal glove and gown use and acquisition of antibiotic resistant bacteria in ICU. JAMA, 2014
  Anthony D. Harris, M.D.

• I certainly will go with horizontal approach and “universal decolonization” is one of the strategy that I might consider.
  Huang SS, et al. Targeted versus universal decolonization to prevent ICU infections. NEJM, 2013
  Susan Huang, M.D.

• I believe that environmental cleaning would be a nice addition to HH, per Thai data.
  Paul Tambyah, M.D.
Essential activities

- Surveillance
- Performance improvement for HAIs
- Acute event response & outbreak investigation
- Education and training HCWs and patients
- National reporting of HAIs

Resource Necessary for IPC/HE Program

- Personal resource (HE/IPC) (1-1.5 FTE vs. 0.5-1 FTE)
- Additional support personnel (administration)
- Information technology and health informatics
- Education, data and report presentation
ESCMID PUBLICATIONS

ESCMID guidelines for the management of the infection control measures to reduce transmission of multidrug-resistant Gram-negative bacteria in hospitalized patients


<table>
<thead>
<tr>
<th>Study design</th>
<th>Initial quality of a body evidence</th>
<th>Decrease quality</th>
<th>Increase quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized trials</td>
<td>High</td>
<td>Risk of bias</td>
<td>Large effect (RRR 50% or RR 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconsistency</td>
<td>Very large effect (RRR 80% or RR 5)</td>
</tr>
<tr>
<td>Observational studies</td>
<td>Low</td>
<td>Indirectness</td>
<td>Dose response</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Imprecision</td>
<td>All plausible residual confounding may be working to reduce the demonstrated effect or increase the effect if no effect was observed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Publication bias</td>
<td></td>
</tr>
</tbody>
</table>

RRR, relative risk reduction; RR, relative risk.
### TABLE 8.
Quality of studies by intervention. Basic and additional measures to reduce the spread of multidrug-resistant (MDR)-Acinetobacter baumannii and MDR-Pseudomonas aeruginosa in hospitalized adult patients: recommended for all acute-care facilities in epidemic setting

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>MDR-A. baumannii Quality of studies</th>
<th>Overall quality of evidence</th>
<th>MDR-P. aeruginosa Quality of studies</th>
<th>Overall quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>Moderate</td>
<td>Conditional</td>
<td>Conduct educational programmes to ensure HCWs understand why P. aeruginosa is important epidemiologically, why prevention of spread is critical for control, and which measures for preventing spread have proven to be effective. Ensure regular multidisciplinary meetings to implement interventions, to review adherence audit, to report local data and feedback to all HCWs and other relevant staff.</td>
<td></td>
</tr>
<tr>
<td>Environmental cleaning (EC)</td>
<td>Moderate</td>
<td>Conditional</td>
<td>Implement regular EC procedures, which include detergents or disinfectants, depending on local practice to reduce the transmission rate. Ensure cleaning of patient care equipment and the environment. When available, dedicate non-critical medical items for use on individual patients colonized or infected with MDR-P. aeruginosa. Shared equipment should be disinfected between use on different patients.</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial stewardship (ABS)</td>
<td>Moderate</td>
<td>Conditional</td>
<td>Implement an ABS programme. Consider interventions that limit the use of specific antimicrobial agents based on patients’ case-mix.</td>
<td></td>
</tr>
<tr>
<td>Infection prevention and control (IPC) infrastructure</td>
<td>NA</td>
<td></td>
<td>There is no evidence available to provide recommendations for, or against, the intervention. However, the authors suggest provision of administrative support, including economic and human resources, to prevent and control MDR-P. aeruginosa transmission within the healthcare facility. Use public health resources to support the initiation of IPC interventions within hospitals. An IPC infrastructure should include environmental personnel such as estates, domestic and janitorial representatives.</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 5.
Quality of studies by intervention. Basic measures to reduce the spread of multidrug-resistant Pseudomonas aeruginosa

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>MDR-P. aeruginosa Quality of studies</th>
<th>Overall quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand hygiene</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

(Continued)
Topics

• Evolving Epidemiology of *Acinetobacter baumannii*

• Environmental cleaning: What is new?

• Epidemiology and Control of HAIs and Multi-Drug Resistant Organisms in Resource Limited Settings: What do we need?

• Unusual Outbreaks & Outbreak worthy of our attention

• Filling the Gap in Infection Control: Thinking outside the box!
Hospital Outbreak of Pulmonary and Cutaneous Zygomycosis due to Contaminated Linen Items From Substandard Laundry

Vincent C. C. Cheng,1,2 Jonathan H. K. Chen,1 Sally C. Y. Wong,1 Sally S. M. Leung,1 Simon Y. C. So,1 David C. Lung,3 Wan-Mui Lee,2 Nigel J. Trendell-Smith,4 Wai-Ming Chan,5 Desmond Ng,6 Liza To,3 Albert K. W. Lie,7 and Kwok-Yung Yuen1

1Department of Microbiology, Queen Mary Hospital, 2Infection Control Unit, Queen Mary Hospital, 3Centre for Health Protection, Department of Health, 4Department of Pathology, Queen Mary Hospital, 5Adult Intensive Care Unit, Queen Mary Hospital, 6Head Office, Hospital Authority, and 7Department of Medicine, Queen Mary Hospital, Hong Kong Special Administrative Region, China

Background. Healthcare laundry-related infection is rare, and pulmonary zygomycosis due to contaminated hospital linens has never been reported.

Methods. We reported an outbreak investigation of zygomycosis in a university-affiliated teaching hospital. Air samplers, sponge swabs and Replicate Organism Detection and Counting (RODAC) contact plates were used for environmental sampling. The fungal isolates from clinical and environmental samples were identified by morphology, MALDI-TOF MS, and ITS1-5.8S-ITS2 rRNA gene cluster sequencing.

Results. From 2 June 2015 to 18 July 2015, 6 immunosuppressed patients developed pulmonary (n = 4) and/or cutaneous (n = 3) infection by a spore-forming mold, Rhizopus microsporus, through direct inhalation and skin contact of contaminated linen items supplied by a designated laundry. Seventy (27.8%) of 252 freshly laundered clothing and 15 (3.4%) of 443 nonclothing laundered linen items (pillow case, bed sheet, draw sheet) were contaminated by R. microsporus, which was significantly higher than those from other hospital laundries (0%, n = 451; P < .001) supplying linen to hospitals with no cases of zygomycosis reported during the same period. The fungal isolates from patients and linens were phylogenetically related. In sum, 61% of environmental samples and 100% of air samples at the designated laundry were also positive for zygomycetes, suggesting heavy environmental contamination. RODAC contact plates revealed mean total viable bacteria counts of freshly laundered items (1028 ± 611 CFU/100 cm²) far exceed the “hygienically clean” standard of 20 CFU/100 cm² set by the US healthcare textile certification requirement.

Conclusions. Suboptimal conditions of washing, drying, and storage contributed to the massive linen contamination and the outbreak of zygomycosis.
Only 12 hospital outbreaks have been linked to the laundered linen items in the past 43 years.

No consensus on standard hygienic practice on how to clean linen items (its important has been overlooked in most hospitals).

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Jun 2015</td>
<td>(Retrospective) First patient with <em>Rhizopus microsporus</em> isolated from respiratory specimen.</td>
</tr>
<tr>
<td>23 Jun 2015</td>
<td>(Retrospective) First patient with <em>Rhizopus microsporus</em> isolated from skin tissue around exit site of thoracotomy tube.</td>
</tr>
<tr>
<td>15 July 2015</td>
<td>(Index case) Post-bone marrow transplant patient with <em>Rhizopus microsporus</em> isolated from tissue debrided from a necrotic area on the neck.</td>
</tr>
<tr>
<td>16 July 2015</td>
<td>Epidemiological investigation and environmental sampling (including air samples) in affected clinical areas.</td>
</tr>
<tr>
<td>18 July 2015</td>
<td>Site visit to central linen storage in the hospital, with environmental sampling (including air samples).</td>
</tr>
<tr>
<td>20 July 2015</td>
<td>Suspension of linen supplied from the designated laundry (SWL). Site visit to SWL for inspection and environmental sampling (including air samples).</td>
</tr>
<tr>
<td>27 July 2015</td>
<td>Second visit to SWL (post-environmental disinfection) for inspection and environmental sampling (including air samples).</td>
</tr>
<tr>
<td>1 August 2015</td>
<td>Prospective clinical and laboratory surveillance for new cases of zygomycosis after replacement of laundry.</td>
</tr>
<tr>
<td>31 October 2015</td>
<td>3488 specimens (from 1324 patients) collected and processed for fungal culture from 1 August to 31 October 2015. No new cases of zygomycosis were identified.</td>
</tr>
</tbody>
</table>
Implications

• This outbreak suggested that suboptimal washing, drying and storage contributed to massive linin contamination and outbreaks.
• To prevent this outbreak, concept of “hygienically cleaned linen items” should be introduced with regular microbiology testing.
• Cleaning, disinfection, de-dusting of facility environment and surface equipment should be enforced and audited.
• Temperature and sensor of washing machine should be checked and calibrated regularly.
• There should be a clear segregation between clean and dirty areas to avoid cross contamination.
Outbreak worthy of our attention!
Outbreak at a tertiary care hospital in IL

39 case patients highly genetically related

Field Investigation (January-July 2013)
9 case patients

Duodenoscope A

Duodenoscope B

Duodenoscope C

Clinical Cases (September 2013)
2 case patients

Duodenoscope A Patient Notification (8/12/2013)
94 notified; 58 screened; 23 cases

Duodenoscope B Patient Notification (11/5/2013)
39 notified; 16 screened; 1 case

Duodenoscope C Patient Notification (10/4/2013)
23 notified; 15 screened; 3 cases

Epstein L. JAMA. 2014;312(14):1447-1455
Duodenoscope and CRE

No breech in manufacturer recommended reprocessing step with positive culture at elevator mechanism after HLD

15 of 116 articles have been published after 2015
Endoscope reprocessing

Humphries RM. J Clin Microbiol 2015;53:3118–3125
What can We do to Prevent Infection?

• IP associated with ERCP and GI scopes is multifaceted (e.g., manufacturer, federal authority, IPCs) and no single available strategy will eliminate this problem.

• This immediate risks can be minimized by a multi-component strategy (e.g., compliance with endoscope reprocessing guideline, HLD followed by ETO, periodic microbiologic sampling).

• Only when we implement new technologies (e.g., equipment redesign, single-use sterile endoscopes, sterilization of GI endoscopes with technology that achieves an SAL of $10^{-6}$) will we eliminate the risk of infection.

Topics

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• Filling the Gap in Infection Control: Thinking outside the box!
A Dilemma

- Much of what we do in healthcare – especially in the hospital – is reflexive
  - If a patient is hypoxemic: we give oxygen
  - Low BP: IV fluids
  - Positive blood cultures: antibiotics
  - Frequency, urgency, and dysuria: dx UTI

- These rote responses are usually helpful
  However, this reflex-like approach can lead to problems
  - Pt sick enough to be admitted from the ED: Foley catheter
  - Asymptomatic catheterized patient has a ”dirty” urine: antibiotics
One Possible Solution: “Medical Mindfulness”

• Being in the moment and considering decisions carefully before jumping to reflexive action
• Daniel Kahneman:
  - Intuition (System 1): fast, automatic, effortless; difficult to alter
  - Reasoning (System 2): slower, effortful, & flexible
Applying Mindful Evidence-Based Practice at the Bedside Using Catheter-Associated Urinary Tract Infection as a Model

Infection Control & Hospital Epidemiology / Volume 34 / Issue 10 / October 2013,
Hiroko Kiyoshi-Teoa\textsuperscript{1a2a3} c1, Sarah L. Kreina\textsuperscript{1a2a3a4} and Sanjay Sainta\textsuperscript{2a3a4}

\textbf{FIGURE 1.} Mindful evidence-based practice model.
Pre-intervention period $p = 0.45$

Post-intervention period $p = 0.04$

- CUSP initiative
- Neurotrauma Critical Care Unit
- Neurocare Intensive Care Unit
- Medical Intensive Care Unit
- Surgical Intensive Care Unit
- Cardiac Critical Care Unit

CAUTI rates (per 1000 catheter days)

Time (months)

- Jul-11
- Sep-11
- Nov-11
- Jan-12
- Mar-12
- May-12
- Jul-12
- Sep-12
- Nov-12
- Jan-13
- Mar-13
- May-13
- Jul-13
- Sep-13
- Nov-13
- Jan-14
- Mar-14

- Reflex urine culture protocol implemented
Behavior-Based Interventions to Improve Hand Hygiene Adherence Among Intensive Care Unit Healthcare Workers in Thailand

Anucha Apisarnthanarak, MD; Thane Eiamsitrakoon, MD; Linda M. Mundy, MD, PhD

OBJECTIVE. To evaluate behavioral-based interventions to improve hand hygiene (HH) among healthcare workers (HCWs) at a Thai tertiary care center.

METHODS. A quasi-experimental study was performed in 6 intensive care units with computer-generated allocation. Baseline demographic characteristics, self-reported stage of HH behavioral commitment, and observed HH adherence were examined from January 1, 2012, through December 31, 2012 (preintervention), and from January 1, 2013, through December 31, 2013 (postintervention). Self-reported HH was categorized by the stages construct from the Transtheoretical Model of Health Behavior Change. The intensive care unit group randomization was to either standard-of-care HH education every 3 months (S1), intensified HH interventions (S2), or intensified HH interventions plus increased availability of alcohol-based handrub throughout the unit (S3).

RESULTS. Among 125 HCWs from 6 intensive care units (42 in S1, 41 in S2, 42 in S3) there were 1,936 total HH observations; most HCWs (100 [80%]) were nurses or nurse assistants. Compared with preintervention, overall postintervention HH adherence improved in HCWs assigned to S2 (65% vs 85%; P = .02) and S3 (66% vs 95%; P = .005) but not S1 (68% vs 71%; P = .84). Improvement in HH adherence was demonstrated among HCWs who reported lower stages of HH commitment in S2 (21% vs 84%; P < .001) and S3 (24% vs 89%; P < .001) and in HCWs who self-reported higher stages of commitment in S3 (78% vs 96%; P < .001).

CONCLUSIONS. HCW HH programs may benefit from stage-based tailored strategies to promote sustained HH adherence.

Infect Control Hosp Epidemiol 2015;36(5):517–521
Methods

• The behavior Theorem

The Transtheoretical Model of Health Behavior Change (TTM)

- Precontemplation: a HCW not intending to change commitment to HH in the next 6 mos
- Contemplation: a HCW who self-reported awareness of potential commitment to HH in the next 6 mos
- Preparation: a HCW who intended to practice 5MHH within the next month
- Action: a HCW who had committed to 5MHH within the past 6 months
- Maintenance: a HCW who continued to commit to 5MHH in at least 6 mos.
- Termination: a HCW who

• Ajzen I. The theory of planned behavior. Organizational Behavior and Human Decision Processes. 1991
<table>
<thead>
<tr>
<th>Observed HH Adherence</th>
<th>Preintervention (n = 968 opportunities)</th>
<th>Postintervention (n = 968 opportunities)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assigned HH adherence group, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>68.0</td>
<td>71.0</td>
<td>.84</td>
</tr>
<tr>
<td>S2</td>
<td>65.0</td>
<td>85.0</td>
<td>.02</td>
</tr>
<tr>
<td>S3</td>
<td>66.0</td>
<td>95.0</td>
<td>.005</td>
</tr>
<tr>
<td>Observed 5MHH adherence, %</td>
<td></td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td>Before touching the patient (moment 1)</td>
<td>53.1</td>
<td>71.0</td>
<td></td>
</tr>
<tr>
<td>Before a clean or aseptic procedure (moment 2)</td>
<td>39.9</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>After body fluid exposure risk (moment 3)</td>
<td>34.6</td>
<td>79.4</td>
<td></td>
</tr>
<tr>
<td>After touching the patient (moment 4)</td>
<td>86.4</td>
<td>96.9</td>
<td></td>
</tr>
<tr>
<td>After touching the patient’s surroundings (moment 5)</td>
<td>80.2</td>
<td>90.1</td>
<td></td>
</tr>
<tr>
<td>Self-reported TTM stage of commitment to HH</td>
<td></td>
<td></td>
<td>.02</td>
</tr>
<tr>
<td>Contemplation (n = 8)</td>
<td>21.0</td>
<td>54.5</td>
<td></td>
</tr>
<tr>
<td>Preparation (n = 21)</td>
<td>25</td>
<td>75.1</td>
<td></td>
</tr>
<tr>
<td>Action (n = 26)</td>
<td>79.9</td>
<td>91.9</td>
<td></td>
</tr>
<tr>
<td>Maintenance (n = 70)</td>
<td>86.5</td>
<td>96.9</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- MDROs are evolving non-stop!
- Need good quality evidence on effective IPC strategy!
- Application of IPC evidence in RLS remains challenging!
- Outbreaks is a good opportunity to explore new IPC strategy!
- We should think outside the box to enhance the science in the filed!
Thank you very much for your attention

“Kob-Koon-Krubb”
ขอบคุณครับ
Why data are not consistent?

Factors that impact study findings:

- Baseline prevalence of *A. baumannii* rectal carrier,
- Use of concurrent antibiotics that have activity toward *A. baumannii*,
- Use of close ventilator-circuit,
- Type of unit (closed vs. open air unit)
- Frequency of air exchange in the studied unit.

AB may be aerosolized in suitable environment
Endoscope reprocessing

Stage 1
Cleaning

Stage 2
HLD

Stage 3
Alcohol rinse/dry

If stage 3 is skipped, waterborne microorganisms (e.g., *Pseudomonas*) may proliferate during storage.

Dirty instruments

3 log reduction

6 log reduction

Number of microorganisms

10^9

10^6

1
Disrupting the lifecycle of the Urinary Catheter

1. Preventing unnecessary and improper placement

2. Maintaining awareness and proper care of catheters

3. Prompting catheter removal

4. Preventing catheter replacement
## Table 4. Process and Outcome Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Frequency of Data Collection and Reporting</th>
<th>Data Collection System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary Catheter Use</td>
<td>Number of urinary catheter-days divided by the total number of resident-days</td>
<td>Daily collection, monthly reporting</td>
<td>HRET Comprehensive Data System</td>
</tr>
<tr>
<td>NHSN LTC CAUTI rate</td>
<td>Number of NHSN defined CAUTIs divided by the number of urinary catheter-days multiplied by 1000</td>
<td>Monthly</td>
<td>HRET Comprehensive Data System or CDC NHSN</td>
</tr>
<tr>
<td>Population based CAUTI rate</td>
<td>Number of NHSN defined CAUTIs divided by the total number of resident-days multiplied by 1000</td>
<td>Monthly</td>
<td>HRET Comprehensive Data System</td>
</tr>
</tbody>
</table>
| Staff Skills Questionnaire     | 1. Response accuracy by item and category: Team building  
2. CAUTI definition  
3. Epidemiology, surveillance and reporting  
4. Resident safety culture  
5. Hand hygiene  
6. Equipment and environment  
7. Standard & transmission-based precautions  
8. Antimicrobial stewardship | Collected three times throughout cohort participation during project in-person events | Online survey system (Cvent)            |
| AHRQ – Nursing Home Survey on Patient Safety Culture | 1. Response frequencies for each of the 42 items and 12 dimensions, including their composite scores: Teamwork (4 items)  
2. Staffing (4 items)  
3. Compliance With Procedures (3 items)  
4. Training and Skills (3 items)  
5. Nonpunitive Response to Mistakes (4 items)  
6. Handoffs (4 items)  
7. Feedback and Communication About Incidents (4 items)  
8. Communication Openness (3 items)  
9. Supervisor Expectations and Actions PROMOTING Resident Safety (3 items)  
10. Overall Perceptions of Resident Safety (3 items)  
11. Management Support for Resident Safety (3 items)  
12. Organizational Learning (4 items) | Twice: once at the beginning and end of cohort participation | Online survey system (Cvent)            |
Review of Fungal Outbreaks and Infection Prevention in Healthcare Settings During Construction and Renovation

Hajime Kanamori,1,2 William A. Rutala,1,2 Emily E. Sickbert-Bennett,1,2 and David J. Weber1,2

1Hospital Epidemiology, University of North Carolina Health Care, and 2Division of Infectious Diseases, University of North Carolina School of Medicine, Chapel Hill

Hospital construction and renovation activities are an ever-constant phenomenon in healthcare facilities, causing dust contamination and possible dispersal of fungal spores. We reviewed fungal outbreaks that occurred during construction and renovation over the last 4 decades as well as current infection prevention strategies and control measures. Fungal outbreaks still occur in healthcare settings, especially among patients with hematological malignancies and those who are immunocompromised. The causative pathogens of these outbreaks were usually Aspergillus species, but Zygomycetes and other fungi were occasionally reported. Aspergillus most commonly caused pulmonary infection. The overall mortality of construction/renovation-associated fungal infection was approximately 50%. The minimal concentration of fungal spores by air sampling for acquisition of fungal infections remains to be determined. Performing infection control risk assessments and implementing the recommended control measures is essential to prevent healthcare-associated fungal outbreaks during construction and renovation.
Table 2. Fungal Infections and Associated Mortality by Each Underlying Disease During Construction, Renovation, or Demolition

<table>
<thead>
<tr>
<th>Underlying Diseases</th>
<th>No. of Articles Published</th>
<th>No. of Patients Infected</th>
<th>No. of Patients Died</th>
<th>Mortality, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematologic malignancies or bone marrow transplant</td>
<td>26</td>
<td>414</td>
<td>148</td>
<td>131/288 (45.5)</td>
</tr>
<tr>
<td>Other malignancies, transplant, and/or immunosuppressed</td>
<td>13</td>
<td>105</td>
<td>38</td>
<td>38/60 (63.3)</td>
</tr>
<tr>
<td>patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients in intensive care unit</td>
<td>3</td>
<td>8</td>
<td>2</td>
<td>2/4 (50)</td>
</tr>
<tr>
<td>Rheumatology patients</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>4/6 (66.7)</td>
</tr>
<tr>
<td>After surgery</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>1/8 (12.5)</td>
</tr>
<tr>
<td>Premature infants</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2/3 (66.7)</td>
</tr>
<tr>
<td>Nephrology and dialysis patients</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2/3 (66.7)</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>547</td>
<td>197</td>
<td>180/372 (48.4)</td>
</tr>
</tbody>
</table>

Table 3. Bundle of Key Methods for Preventing Filamentous Fungal Infections Associated With Renovation/Construction Activities

1. Hospital epidemiology (infection control) should be notified by plant engineering prior to any renovation/construction activities in the healthcare facility.

2. Conduct an ICRA for all renovation/construction activities: implement recommended prevention strategies as guided by the ICRA.

3. Focus prevention efforts on control of airborne dissemination of fungal spores (e.g., barriers, containment, air handling, portable HEPA filters).

4. Consider impact of renovation/construction on the involved hospital unit plus adjacent units on the same floor, and hospital units on floors above and below the renovation/construction activities.

5. Maintain surveillance for healthcare-associated filamentous fungal infections during renovation/construction. Investigate any cases to see if they are related to renovation/construction and determine if prevention efforts need to be revised.

6. Visit renovation/construction sites regularly to assure compliance with recommended prevention activities.
Evolving Epidemiology of Acinetobacter baumannii (AB)
Environment Cleaning: What is new?
Epidemiology and Control of HAIs and Multi-Drug Resistant Organisms in Resource-Limited Settings: What do we need?
Unusual Outbreaks
Filling the Gap in Infection Control: Thinking outside the box!