Healthcare Associated Infections After Major Flooding... Expect the Unexpected

Anucha Apisarnthanarak, M.D.
Division of Infectious Diseases
Thammasat University Hospital

Hosted by Jane Barnett
jane@webbertraining.com
Disasters are Increasing

All disasters can have an impact on infection transmission

Impact of Flood
Objectives

- Healthcare Associated Infections After Flooding
- Fungal Infections
- Bacterial Infections
- Mycobacterial Infections
- Infection Control After Flooding

Emergence of Pseudo-outbreak due to *Penicillium* spp.

<table>
<thead>
<tr>
<th>No. of Cases</th>
<th>Dec 2011</th>
<th>Jan 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Obtaining Outbreak Data

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/Gender</th>
<th>Location (ICU)</th>
<th>Underlying Disease</th>
<th>Final Diagnosis</th>
<th>Length of Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65F</td>
<td>ED (1)</td>
<td>HTN</td>
<td>Aspergillosis</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>65M</td>
<td>ED (1)</td>
<td>None</td>
<td>CAI</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>65M</td>
<td>ED (1)</td>
<td>None</td>
<td>CAI</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>75F</td>
<td>ED (1)</td>
<td>HTN, CM</td>
<td>VTE &amp; Pneumonia</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>65F</td>
<td>ED (1)</td>
<td>EOM</td>
<td>VTE</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>75M</td>
<td>ED (1)</td>
<td>HTN, CVA</td>
<td>VTE</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>65F</td>
<td>ED (1)</td>
<td>None</td>
<td>Pneumonia</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>65F</td>
<td>ED (1)</td>
<td>None</td>
<td>E. coli</td>
<td>1</td>
</tr>
</tbody>
</table>

Postflood Pseudomonalgia Due to *Penicillium* Species
Pseudo-outbreak may seem benign, but it is a big deal for some patient populations. It also impact physicians’ decision.

What will you do in patients who will receive hardware after surgery or CVT surgery?
It will impact doctors’ decision to treat immunocompromised hosts (e.g., febrile neutropenia)

Fungal infections is also in differential diagnosis for NI in units with high fungal burden in the air.

Interventions

- Area decontamination start with manual clean
- Hydrogen peroxide vaporizer
- Implement air filtration at the site
- Observed IC compliance to withdrawn B/C

New Approach to Room Decontamination

When to Use these Special Approaches for Room Decontamination?

- Special high risk areas (lab, OR, vaccine lab, etc)
- Adjunct measure to control outbreak of MDROs
- Terminal care in private patient room preoccupied with MDRO patients particularly in high risk units (HIV)
- In special situations (e.g., room decontamination for bioterrorism such as anthrax) and if quarantine room, flood
- Sensitive equipment that may be difficult to disinfect after cleaning
  - Paunched patients for inpatient exposure to people and damage to surfaces or equipment, chemical elements should be used in the benefit check exceeds the risk

AHA Position Paper

Effectiveness of UV Irradiation

<table>
<thead>
<tr>
<th>Organism</th>
<th>Location</th>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N. of samples</td>
<td>Decontamination, log reduction, mean (95% CI)</td>
<td>N. of samples</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VRE</td>
<td>40</td>
<td>1.00 (1.00-1.00)</td>
<td>0.25 (0.25-0.25)</td>
</tr>
<tr>
<td>MRSA</td>
<td>40</td>
<td>1.00 (1.00-1.00)</td>
<td>0.25 (0.25-0.25)</td>
</tr>
<tr>
<td>MRK &amp; bewarent</td>
<td>40</td>
<td>1.00 (1.00-1.00)</td>
<td>0.25 (0.25-0.25)</td>
</tr>
<tr>
<td>C. diff spores</td>
<td>40</td>
<td>1.00 (1.00-1.00)</td>
<td>0.25 (0.25-0.25)</td>
</tr>
</tbody>
</table>

William A. Rutala, MD, MPH, Maria E. Gryczynski, MT (ASCP), David J. Weber, MD, MPH

Infection Control and Medical Epidemiology - October 2014
Efficacy of UV Light for Moulds

- At certain wave length, UV light breaks molecule bond in DNA destroying an organism
- UV-C has characteristic wave length of 200-270 nm which lies a germicidal activity portion of UV spectrum 200-320nm

More to Less Susceptible
- S. aureus
- Strep Gr A
- E. coli
- Ps. Aeruginosa
- Mycobacterium spp
- Bacillus spp
- Aspergilus spp
- Penicillium spp

Martin, et al. 2008

HP activity for Fungus

Figure 1. Comparison of Aspergilus spp contamination in a hospital laboratory before and after decontamination with dry-mist hydrogen peroxide. (P<0.00)

Conclusions: The authors concluded that the dry-mist hydrogen peroxide decontamination system should provide facilities with an effective method for controlling the spread of infectious diseases, noting that the method can be used both preventatively during routine decontamination and as a treatment during infectious disease outbreaks.


Decontamination of room air and adjoining wall surfaces by nebulizing hydrogen peroxide

Results: In a massive mold infestation resulting from water damage (worst case), an approximately 5-fold decrease in the mold content and an approximately 13-fold decrease in the number of colony-forming units (sum of the bacteria + fungi) could be detected in the room air immediately after the nebulizing was finished. Even in samples of wall and joint plaster, the molds were reduced, although to a distinctly lesser extent.

By indoor nebulization of 5–6% H2O2, A. brasiliensis was reduced >4 log on vertical and horizontal surfaces.

Introduction of HP
Interpret Results with Cautions

- Settle plate is a non-standard culture method (no standard cut off)
- Detection of moulds depends on air currents
- Air cultures for mould do not always accurately indicate the spore load
- Don't get consistent reliable information
- Several experts suggest against use of settle plate culture
This finding is not surprising

Lessons Learned

- Air decontamination using vapor/aerosolize is only a part of room decontamination and cannot be used as stand-alone intervention

- Other interventions that might help include through cleaning, use of filter/HEPA filter/UV light

Table 1. Serial Air Bioburden Measurements of Bacteria and Fungi in the Patient Rooms and Nursing Station of a Hospital’s Negative-Pressure Unit After Fumigation With a Quaternary Ammonium Salt-Based Solution Combined With 2 Alcohols

<table>
<thead>
<tr>
<th>Duration After Fumigation</th>
<th>Bacterial Air Bioburden (CFU/m³)</th>
<th>Fungal Air Bioburden (CFU/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>PR 1</td>
<td>NS 1</td>
</tr>
<tr>
<td></td>
<td>PR 2</td>
<td>NS 2</td>
</tr>
<tr>
<td></td>
<td>PR 3</td>
<td>NS 3</td>
</tr>
<tr>
<td></td>
<td>PR 4</td>
<td>NS 4</td>
</tr>
<tr>
<td></td>
<td>NS 5</td>
<td>NS 5</td>
</tr>
<tr>
<td></td>
<td>NS 6</td>
<td>NS 6</td>
</tr>
</tbody>
</table>

Abbreviations: CFU, colony-forming unit; NS, nursing station; PR, patient room.

What happen 6-mo after Flood
Pseudo-outbreak/infection lead to unnecessary work up and antifungal exposure

Six Outbreak Investigations for Moulds

Detection of Fungal in the Air by Non-standard Method

Predominant Fungus
- *Aspergillus* spp.
- *Penicillium* spp.
- *Microspora* spp.
- *Paecilomyces* spp.

Initial Air Quality Check After Flood

<table>
<thead>
<tr>
<th>Air quality characteristics</th>
<th>All rooms</th>
<th>Open ventilation</th>
<th>Closed ventilation</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative humidity (%) median, range</td>
<td>46.9 (30.2-68.2)</td>
<td>61.4 (47.7-72.5)</td>
<td>61.8 (56.7-72.5)</td>
<td>0.24</td>
</tr>
<tr>
<td>Temperature (°C median, range)</td>
<td>20.6 (16.0-25.0)</td>
<td>27.3 (22.5-28.0)</td>
<td>25.0 (20.0-25.0)</td>
<td>0.001</td>
</tr>
<tr>
<td>Carbon dioxide (ppm median, range)</td>
<td>487 (400-575)</td>
<td>646 (586-696)</td>
<td>596 (462-770)</td>
<td>0.00</td>
</tr>
<tr>
<td>Total bacterial biovolume (CFU/m³ median, range)</td>
<td>48.0 (22.4-360)</td>
<td>180 (140-360)</td>
<td>125 (100-200)</td>
<td>0.84</td>
</tr>
<tr>
<td>Total fungal biovolume (CFU/m³ median, range)</td>
<td>50.0 (18.4-200)</td>
<td>75.5 (43.4-200)</td>
<td>45.0 (10.0-200)</td>
<td>0.85</td>
</tr>
</tbody>
</table>

By multivariate analysis, initial fungal bioburden >500 CFU/m³ was associated with pseudo-outbreak due to moulds (aOR = 4.71; P = 0.02)
Initial Air Quality Check After Flood

<table>
<thead>
<tr>
<th>Air quality characteristics</th>
<th>All resin (N=8)</th>
<th>Open resins (N=3)</th>
<th>Outside resins (N=1)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High bacterial and fungal bioburden &gt;500 CFU/mm³ were detected only in units with excess humidity (100% vs. 0%; P&lt;0.001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to All areas with fungal pseudo-outbreak had excess humidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>By multivariate analysis, first floor units were associated with excess fungal and bacterial bioburden (aOR = 1.16; P&lt;0.001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total fungal colonies (CFU/cm²)</td>
<td>50 (30-100)</td>
<td>75 (30-100)</td>
<td>50 (10-200)</td>
<td>4.45</td>
</tr>
</tbody>
</table>

Stem Cell Transplant Units and Aspergillus Outbreaks

- **Causes**
  - No HEPA filtration
  - Poor maintenance of air filters
  - Poorly sealed windows and walls
  - Positive pressure not maintained
  - No patient precautions when outside of unit
  - Construction in or near hospital
  - Disturbance of normally closed spaces
  - Often unknown

Invasive Infections: Aspergillus

- **Ubiquitous fungi**
  - Aspergillus fumigatus (90% of disease)
- **High risk patients**
  - Hematopoietic stem cell transplant recipients
  - Solid organ transplant patients
  - Prolonged neutropenia
  - Preterm neonates

Surgical site infections and Aspergillus spp.

- **Examples in literature**
  - Endocarditis or endocarditis following cardiac surgery
  - Burn wound infections
  - Prosthetic joint replacement
  - Vascular grafts
- **Source of aspergillus not always known**
  - Heavy contamination of OR air intake
  - Contamination of irrigation or air filters
  - Contaminated irrigating fluids or wound dressings

Healthcare Associated Infections After Flooding

**Bacterial Infections**

Termination of XDR-Acinetobacter: Lessons Learned

- Implementation of infection control measures
- Education and training programs
- Improved adherence to infection control guidelines
Control of *Acinetobacter* outbreak after floods

All except three belong to the same clone

Courtesy of Dr. Hsu Li Yang

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This is Not a Local Issues: A Survey Was Made to 101 Hospitals in 15 Provinces

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Surveillance After Flood

**Traditional diseases:**

- Leptospirosis
- Hepatitis A
- Dengue hemorrhagic fever
- Pneumonia (e.g., Legionella)
- Measle
- TB
- Infected conjunctivitis
- Viral diarrhea

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Always monitors for possible diseases after flood

- We identified 5 cases of melioidosis occurred in a month after flood (melioidosis never thought to be related to diseases after flood)

- Unique feature of these patients: No traditional underlying diseases, quick presentation (within 5 days), high melioid titer and had fulminant clinical course

---

Table 1

<table>
<thead>
<tr>
<th>Case</th>
<th>Underlying condition/diagnosis</th>
<th>Blood culture positive</th>
<th>Days from presentation to antibiotic median</th>
<th>Days from admission to receipt of appropriate antibiotic median</th>
<th>Treatment</th>
<th>Survived</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CPT, ENP/NP</td>
<td>12/18</td>
<td>2</td>
<td>2</td>
<td>Imipenem</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>VAP/AC</td>
<td>14/36</td>
<td>5</td>
<td>2</td>
<td>CCl+TPN-BOC</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>VAP/pneumonia</td>
<td>18/18</td>
<td>5</td>
<td>2</td>
<td>CCl+TPN-BOC</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>VAP/pneumonia</td>
<td>14/36</td>
<td>5</td>
<td>2</td>
<td>CCl+TPN-BOC</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>VAP/pneumonia and soft tissue effusion</td>
<td>12/18</td>
<td>7</td>
<td>4</td>
<td>CCl+TPN-BOC</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*All select benzylpenicillin except CPT, chronic obstructive pulmonary disease, HPA, hepatitis, ENP, community-acquired pneumonia, CAS, chloramphenicol, TPN-BOC, chloramphenicol-valproate exchange.

*Positive f = 10% for person residing in non-endemic regions.
Outbreak of *Mycobacterium porcinum* linked to water supply

- *M. porcinum* is a rapid-growing mycobacterium
- UTMB found 26 patients between 2005-2010
  - Most cases before hospital flooding
  - 11 patients considered infected (4 community and 7 hospital-acquired)
  - Hospital water and ice samples collected immediately after flooding
    - 86 (62.5%) of 139 water samples grew rapid-growing mycobacterium
    - 40% of those tested 80% were *M. porcinum*
  - *M. porcinum* detected in tap water from 80% of homes tested in same city as hospital
  - The majority of patient isolates were closely related to hospital and residential water isolates by PFGE


Medical issues related to mold exposure

- Exposure to inhaled spores, fungal fragments, and mycotoxins
- Diseases
  - Allergic reactions
  - Toxic effects
  - Invasive infections (immunocompromised)
- Reactions more likely to occur with either high fungal load or chronic exposure

Mold exposure – Allergies and asthma

- 10% of general US population have IgE antibodies to common inhaled molds
- Sensitization to fungi, especially *Alternaria alternata*, linked to the presence and severity of asthma
- No clear data for mold causing allergic rhinitis


Mold exposure – Rare lung diseases

- Allergic bronchopulmonary aspergillosis
  - IgE-mediated disease in asthma and cystic fibrosis patients
  - Wheezing, eosinophilia, pulmonary infiltrates, chronic cough with mucus plugs
- Hypersensitivity pneumonitis
  - High-dose and/or prolonged exposure
  - Fever, chills, malaise, nausea, cough, chest tightness, and dyspnea without wheezing

Chronic asbestos exposure

Mesothelioma

Asbestosis

Need to monitor HCWs

Table 1: Organisms resulting in healthcare-associated infections after extensive flooding, risk factors and preventive measures

<table>
<thead>
<tr>
<th>Organism &amp; Pathogen</th>
<th>Risk Factors</th>
<th>Preventive Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>Water quality, dermal exposure</td>
<td>Water quality monitoring, hand hygiene</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>Ventilation, environmental controls</td>
<td>Environmental controls, disinfection</td>
</tr>
<tr>
<td>Enterococcus faecalis</td>
<td>Contact with patients, contaminated water</td>
<td>Hand hygiene, infection control procedures</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Disinfection failures, contaminated water</td>
<td>Disinfection, water quality monitoring</td>
</tr>
</tbody>
</table>

Healthcare-associated infections and their prevention after extensive flooding

Anucha Apsanthanarai*, David K. Wearne†, and G. Glen Mayhall‡

Purpose of review
This review will focus on the epidemiology of healthcare-associated infections (HAIs) after extensive flooding in healthcare facilities. There is evidence suggesting an increased incidence of HAIs and pseudo-outbreaks due to flood-related extensive flooding in healthcare facilities. However, there is no strong evidence of an increased incidence of healthcare-associated infections (HAIs) and pseudo-outbreaks (i.e., sentinel event alerts) following extensive flooding. Although some studies have indicated evidence of increased transmission of healthcare-associated, gastrointestinal, or respiratory illness, the overall incidence of healthcare-associated infections (HAIs) and pseudo-outbreaks following extensive flooding has been variable. However, evidence has been presented of an increased incidence of healthcare-associated infections (HAIs) following extensive flooding in healthcare facilities.

Recent findings
There is evidence suggesting an increased incidence of HAIs and pseudo-outbreaks due to flood-related extensive flooding in healthcare facilities. There is no strong evidence of an increased incidence of healthcare-associated infections (HAIs) and pseudo-outbreaks following extensive flooding. Although some studies have indicated evidence of increased transmission of healthcare-associated, gastrointestinal, or respiratory illness, the overall incidence of healthcare-associated infections (HAIs) and pseudo-outbreaks following extensive flooding has been variable. However, evidence has been presented of an increased incidence of healthcare-associated infections (HAIs) following extensive flooding in healthcare facilities.

Summary
Additional studies are needed to evaluate the epidemiology of flood-related HAIs and the optimal surveillance and control methods following extensive flooding.

Recovering Hospital Units After Flooding

HAIs and Air Sampling
Active and Laboratory-Based Point-of-Care Surveillance
Detection of Key Pathogens
Prompt Investigations
Implementation of Infection Control Measures

Thank you very much for your attention!
8 July  (British Teleclass)
CONTROLLING THE SPREAD OF MULTIDRUG-RESISTANT ORGANISMS IN HEALTHCARE SETTINGS: IS IT REALLY POSSIBLE?
Prof. Pierre Peraziaux, Centre de Coordination de Lutte Contre les Infections Nosocomiales, Bordeaux, France

10 July  (FREE Teleclass)
CHEMOTHERAPY – HEALTH, SAFETY, AND WASTE MANAGEMENT ISSUES
Ed Krasunas, WMMN International, Connecticut

17 July  (FREE Teleclass)
USING SOCIAL MARKETING TO IMPROVE HEALTHCARE QUALITY
Jason Athan, M-SQU Consulting and Communications, Canada

24 July  (FREE Teleclass)
HAND HYGIENE TECHNOLOGIES 2005-2014: ARE THESE INTERVENTIONS THE MISSING LINK IN HAND HYGIENE COMPLIANCE?
Dr. Marjorie McGucken and Mr. John Governik, McGuicken Methods International, USA

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