Legionella and Health-care Associated Infection Outbreaks

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Overview

- *Legionella* background information
- Recently investigated Legionnaires’ disease cases
- Review of health-care associated infectious disease outbreaks reported to the New Mexico Department of Health, 2011–2015
Legionnaires’ Disease Background

• First described in an outbreak that occurred at the 1976 American Legion Convention

Photo Credit WHY Y/ Paige Pfleger

Dr. Bachman, PA Secretary of Health
AP Photo Credit/ Paul Vathis
Epidemiology from National Surveillance

- Greater number of people at risk, increased testing and reporting, true increased in disease, aging plumbing infrastructure
Risk Factors

• Clinical
  ▪ Chronic lung disease
  ▪ Systemic malignancy
  ▪ Smoking (current or historical)
  ▪ Renal or hepatic failure
  ▪ Diabetes
  ▪ Immune system disorders
  ▪ Age ≥50 years

• Environmental
  ▪ Overnight stay outside of the home
    ▪ Hotels
    ▪ Health-care facility
  ▪ Exposure to hot tubs
  ▪ Recent repairs or maintenance work on domestic plumbing
## Clinical Presentation

<table>
<thead>
<tr>
<th></th>
<th>Legionnaires' disease</th>
<th>Pontiac fever</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical features</td>
<td>Pneumonia, cough, fever</td>
<td>Flu-like illness (fever, chills, malaise) without pneumonia</td>
</tr>
<tr>
<td>Pathogenesis</td>
<td>Replication of organism</td>
<td>Inflammatory response to endotoxin</td>
</tr>
<tr>
<td>Radiographic pneumonia</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Incubation period</td>
<td>2 to 10* days after exposure</td>
<td>24 to 72 hours after exposure</td>
</tr>
<tr>
<td>% of persons who become ill, when exposed to the source of an outbreak</td>
<td>Less than 5%</td>
<td>Greater than 90%</td>
</tr>
<tr>
<td>Isolation of organism</td>
<td>Possible</td>
<td>Not possible</td>
</tr>
<tr>
<td>Outcome</td>
<td>Hospitalization common</td>
<td>Hospitalization uncommon</td>
</tr>
<tr>
<td></td>
<td>Case-fatality rate: 10%, approximately 30% for healthcare-associated cases</td>
<td>Case-fatality rate: 0%</td>
</tr>
</tbody>
</table>
Indications for Testing

- **Patients with pneumonia who:**
  - Did not respond to outpatient antibiotic therapy for community-acquired pneumonia (CAP)
  - Have severe illness
  - Are also immunocompromised
  - In the setting of an outbreak
  - Have a travel history

- **Health-care associated pneumonia**
  - Especially with increased risk or any of the above indications
  - When there is positive environmental tests for *Legionella*
  - Changes in water quality that may lead to *Legionella* growth
Diagnosis

“Best practice is to obtain lower respiratory specimens for culture at the time urinary antigen testing is ordered, preferably before the administration of antibiotics.”

Centers for Disease Control and Prevention
(https://www.cdc.gov/legionella/clinicians/diagnostic-testing.html)
## Diagnostic Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture</td>
<td>• Clinical and environmental isolates can be compared</td>
<td>• Technically difficult</td>
</tr>
<tr>
<td></td>
<td>• Detects all species and serogroups</td>
<td>• Slow (&gt;5 days to grow)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• May be affected by antibiotic treatment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Requires special media</td>
</tr>
<tr>
<td>Urine Antigen</td>
<td>• Can be done rapidly</td>
<td>• Designed to identify <em>L. pneumophila</em> serogroup 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Documentation of cross reactivity with other species and serogroups</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No molecular comparison</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture</td>
<td>20–80 (dependent on technical skills)</td>
<td>100</td>
</tr>
<tr>
<td>Urine Antigen</td>
<td>70–100</td>
<td>100</td>
</tr>
</tbody>
</table>
RECENT INVESTIGATION OF LEGIONNAIRES’ DISEASE
Legionnaires’ Disease Outbreaks

- Most common U.S. cause of water-associated outbreaks
  - Usually involving environmental reservoirs or complex water systems
- Identified in 4% of Legionnaires’ disease
  - Likely under identified
  - Need environmental exposure history
  - Health-care associated can involve high cases counts
- Other sources included cooling towers, hot tubs, industrial equipment, decorative fountains
Cluster Recognition

- At the end of November 2016, 3 cases of pneumonia, confirmed as Legionnaires' disease by UAT, were reported in Chaves County
- Surveillance review at the time for Chaves County
  - An additional 2 confirmed cases were reported in October, 2016
  - A total of 3 cases in 2015
Case Definition

- **Suspected Case:** Legionnaires’ disease or Pontiac fever without lab confirmation in a resident of Chaves County or someone who has spent time working or visiting Chaves County from Oct 1, 2016 until present.

- **Confirmed Case:** A suspect case who has lab confirmation by culture OR by detection of *Legionella pneumophila* serogroup 1 antigen in urine using validated reagents.
Epidemiologic Investigation

- Median age 69 years old (range 33–92)
- Majority with other severe medical illnesses
- Majority visited central area of Roswell
- No common building or water system exposure
Environmental Assessment

- Surveyed the area where the majority of cases visited
- Interviewed building managers where possible external aerosol sources were identified
- Sampled possible external aerosol sources in the area and internal sources in health facilities where ≥2 cases visited
Laboratory Investigation

• Clinical testing
  ▪ Duplicate UAT was preformed for 4 cases
  ▪ Sputum samples cultured and tested by PCR
  ▪ All additional testing was negative

• Environmental testing
  ▪ Low chlorine levels and warm temperatures found in buildings
  ▪ No *Legionella pneumophila* identified in environmental samples
Conclusions

• Possible outbreak
  ▪ No common source identified
  ▪ Not as large as first suspected
    • Unable to confirm testing in 4 cases
• Importance of confirming the diagnosis and maintaining clinical suspicion
• Maintaining building water management programs
Guidance—ASHRAE 188

- Updated in 2015, targeted at preventing *Legionella*
- Care of building water systems
  - Water management programs minimum components, reassessments, and updates
  - Devices (e.g., hot tubs, cooling towers)
- Does not address emergency remediation or specifics on what to do when there is a Legionnaires' disease case associated with a facility

Guidance—Health-care Infection Control Practices Advisory Committee (HICPAC)

• Guidelines for environmental infection control in health-care facilities
  ▪ Wide ranging infection control issues
  ▪ Included different environments (e.g. air, water, surfaces, linens, etc.) as well as multiple pathogens
  ▪ Discusses evidence using a rating category system

HICPAC documents: https://www.cdc.gov/hicpac/pubs.html

Guidelines for Environmental Infection Control in Health-Care Facilities: https://www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf
Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings

**Identifying Buildings at Increased Risk**

Survey your building (or property) to determine if you need a water management program to reduce the risk of *Legionella* growth and spread.

If you answer **YES** to any of questions 1 through 4, you should have a water management program for *that building’s* hot and cold water distribution system.

### Healthcare Facilities

Yes ____ No ____  1. Is your building a healthcare facility where patients stay overnight or does your building house or treat people who have chronic and acute medical problems† or weakened immune systems?

Yes ____ No ____  2. Does your building primarily house people older than 65 years (like a retirement home or assisted-living facility)?

Yes ____ No ____  3. Does your building have a centralized hot water system (like a hotel or high-rise apartment complex)?

Yes ____ No ____  4. Does your building have more than 10 stories (including basement levels)?

Devices in buildings that can spread contaminated water droplets should have a water management program even if the building itself does not. If you answer **NO** to all of questions 1 through 4 but **YES** to any of questions 5 through 8, you should have a water management program for *that device*.

CDC toolkit: [https://www.cdc.gov/legionella/maintenance/wmp-toolkit.html](https://www.cdc.gov/legionella/maintenance/wmp-toolkit.html)
HEALTH-CARE ASSOCIATED INFECTION OUTBREAKS
Health-care Associated Infections (HAIs)

- HAIs are a major public health threat
  - 1 in 25 patients hospitalized in acute care facilities
  - Transmission of antimicrobial resistance
  - Worsen patient outcomes

- HAIs difficult to detect

- Control when causing an outbreak
  - Prevent rapid spread
  - Identify possible underlying infection control issues
  - Protect patients, health-care personnel (HCP), and visitors
  - Maintain health facility operations
Highlights of Previous Study of HAI Outbreaks

- Bacterial and blood borne outbreaks most common in the published literature (Gastmeier 2005)
- Gastrointestinal illness
  - Most frequently reported to German public health authorities (Haller 2014)
  - Most common cause of HAI outbreaks investigated by U.S. infection preventionists (Rhinehart 2012)
- Need for more common understanding and coordinated response
  - Systems for detection
  - Standard definitions
  - Streamlined response tools
Project Goals

- Current: Evaluate the types and effects of HAI outbreaks reported New Mexico Department of Health (NMDOH)

- Long-term: Contribute to common practice guidelines for HAI outbreak detection and response
Specific Indicators

- The majority, >50%, of the HAI outbreaks reported to NMDOH will have one of the following characteristics:
  - Unusual pathogen (pathogen other than norovirus, *C. difficile*, *Staphylococcus aureus*, or influenza)
  - Occur in a short time period (≤14 days)
  - Any case deaths attributed to the outbreak
  - Involving HCP (≥ 1 HCP case)
Methods

- Retrospective review of HAI outbreaks reported to NMDOH
  - Reported to NMDOH 2011–2015
  - Outbreak defined as ≥2 epidemiologically linked HAIs at a health-care facility

- Pre-defined, piloted data abstraction tool used to capture:
  - Health facility characteristics
  - Outbreak type, size, length, and case counts

- Data directly abstracted into an electronic database
Outbreak Characteristics (n 135)

- **Setting**
  - Outbreaks reported from 69 health facilities
    - Median 2 outbreak/facility in 5 years (range: 1-6)
  - Long term care health facilities (93.1%)
  - Bernalillo county (48.1%)

- **Median length of time***
  - Outbreak duration 11 days (range: 1–72 days)*
  - Time from first case to reporting 4 days (range: 0–61 days)+

*Excludes 3 outbreaks (MRSA, *P. aeruginosa*, *B. cepacia*) that lasted >1 year
+Excludes 3 outbreaks (*P. aeruginosa*, *B. cepacia*, unknown) that lasted >1 year
# HAI Outbreaks by Syndrome and Pathogen (n 135), 2011 –2015

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>n  (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrointestinal (GI)</td>
<td>99 (73.9%)</td>
</tr>
<tr>
<td>Norovirus</td>
<td>70* (51.9%)</td>
</tr>
<tr>
<td>*Includes two norovirus outbreaks with reported <em>C. difficile</em> cases</td>
<td></td>
</tr>
<tr>
<td><em>C. difficile</em></td>
<td>4 (3.0%)</td>
</tr>
<tr>
<td>Respiratory and Influenza like Illness</td>
<td>28 (20.7%)</td>
</tr>
<tr>
<td><em>Influenza</em></td>
<td>20 (14.8%)</td>
</tr>
<tr>
<td><em>Other HAI Outbreaks</em></td>
<td>8 (5.9%)</td>
</tr>
<tr>
<td>*Other syndromes: bacteremia, SSTI, UTI, mixed GI and respiratory. Other pathogens: MRSA, pertussis, CRE, <em>P. aeruginosa</em>, <em>B. cepacia</em>, GAS</td>
<td></td>
</tr>
</tbody>
</table>

*HAI* = healthcare-associated infection; *GI* = gastrointestinal; *SSTI* = skin and soft tissue infection; *UTI* = urinary tract infection; *MRSA* = methicillin-resistant *Staphylococcus aureus*; *CRE* = carbapenem-resistant *Enterobacteriaceae*. *GAS* = group A streptococci.
### Mean Case Counts by Pathogen

#### Mean Case Counts (Standard Deviation)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Total</th>
<th>Confirmed</th>
<th>Patient</th>
<th>HCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norovirus*</td>
<td>48.9 (42.0)</td>
<td>3.4 (1.8)</td>
<td>31.0 (23.6)</td>
<td>19.7 (30.3)</td>
</tr>
<tr>
<td><em>C. difficile</em></td>
<td>10.3 (3.8)</td>
<td>8.0 (5.5)</td>
<td>7.8 (5.9)</td>
<td>2.7 (4.6)</td>
</tr>
<tr>
<td>Influenza</td>
<td>16.9 (14.3)</td>
<td>3.9 (2.9)</td>
<td>13.4 (12.0)</td>
<td>4.6 (5.5)</td>
</tr>
</tbody>
</table>

*Includes two norovirus outbreaks with reported *C. difficile* cases
Mean Case Hospitalizations and Deaths by Pathogens

<table>
<thead>
<tr>
<th></th>
<th>Hospitalizations</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norovirus*</td>
<td>2.6 (10.7)</td>
<td>0.1 (0.3)</td>
</tr>
<tr>
<td>C. difficile</td>
<td>1.7 (2.9)</td>
<td>2.7 (4.6)</td>
</tr>
<tr>
<td>Influenza</td>
<td>2.1 (1.8)</td>
<td>0.7 (1.1)</td>
</tr>
</tbody>
</table>

*Includes two norovirus outbreaks with reported C. difficile cases
Reported Outbreak Effects

- **Unit closed in 44.6% (58/130) of outbreaks**
  - 87.9% (51/58) were facility closures

- **Changes in equipment**
  - Disposable dishes 37.7% (49/130)
  - Personal protective equipment 37.5% (48/128)
  - Changes in equipment cleaning specific to the outbreak
Hypothesis: >50% of HAI Outbreaks

<table>
<thead>
<tr>
<th>Outbreak Characteristics</th>
<th>n/N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unusual pathogen+</td>
<td>5/135 (4%)</td>
</tr>
<tr>
<td>HCP cases</td>
<td>80/95 (84%)</td>
</tr>
<tr>
<td>Occur in short time period (≤14 days)</td>
<td>69/112 (62%)</td>
</tr>
<tr>
<td>Case deaths</td>
<td>11/90 (12%)</td>
</tr>
</tbody>
</table>

+Pathogen other than norovirus, *C. difficile*, *Staphylococcus aureus*, or influenza
Conclusions

- The majority of reported HAI outbreaks have a similar profile
  - Gastrointestinal illness, specifically norovirus, in long term care facilities, affecting HCPs, lasting a relatively short period of time
- Not as common as expected were outbreaks caused by unusual pathogen or ones with case deaths
Speculation

- Focusing response on the common profile factors might lead to improved prevention and control
- Looking for outbreaks that don’t fit this profile may lead to better detection
- Standardization HAI outbreak definitions, detection, reporting, and response measures could lead to further insights about prevention and control
Future Directions

- **Assess the potential size of the problem**
  - Describe HAI outbreak methods at the facility level
  - Estimating potential outbreaks by applying different, but commonly used, definitions to surveillance data
    - Compare reported *C. difficile* outbreaks to ones detected in surveillance data
- **Evaluate current HAI outbreak detection methods and control practices at health facilities**
Thank you!

Questions?