Breaking Valley Fever

On the search for Coccidioides immitis in Washington

Amy Salamone
Mycotics Technician
Zoonotic Disease Program
amy.salamone@doh.wa.gov
**Coccidioidomycosis**

- “Valley Fever” is caused by the soil-dwelling fungi *Coccidioides immitis* & *C. posadasii*
- 60% of people who are exposed do not develop symptoms
  - 40% may experience flu-like illness, 8% may develop pneumonia
- People who become sick can be ill for weeks to months
  - Treatment can be costly and usually takes 3-6 months
  - Not a contagious illness

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### Asymptomatic

60%

### Primary

- 40% ‘Flu-like Syndrome’
- 32% Pneumonia
- 8% Cavitation Pericarditis

### Chronic

- Chronic Thoracic Involvement 1 - 3.5%
- Disseminated, Miliary, Meningeal 0.5 - 1%

### Progressive

40 OF EVERY 100 infected people become sick with symptoms such as cough, fever, fatigue, rash, and night sweats.

5 will have severe pneumonia and need treatment

In less than 1 in 100, the disease spreads outside the lungs and can cause serious symptoms

www.life-worldwide.org/fungaldiseases/coccidioidomycosis

www.valleyfeverarizona.org
Coccidioides

- Cocci is dimorphic, growing as two phases depending on the environment
- People generally become sick by inhaling fungal arthroconidia when soil is disrupted
  - construction, farming, recreational activity, wind, landslides
Three unrelated cases of locally-acquired Cocci infection in Washington reported during 2010-2011\textsuperscript{1}

As of August 2017, 12 cases of Cocci infection have been reported as locally-acquired\textsuperscript{2}

\textsuperscript{2} epiTRENDS. 2017. Fungal Disease Awareness. Washington State Department of Health. v22(8)
Surveillance in Washington

- Pathogen surveillance supports the One Health initiative by helping to understand this emerging disease in Washington
- Field surveillance for Cocci in Washington can help inform physicians and veterinarians of associated environmental risks to patients

There are two main types of surveillance in Washington

1) Tracking Exposure
   - Epidemiological investigations identify sampling locations where human cases were likely exposed
   - Serology surveys, in cooperation with veterinarians, help to identify locations where animals were likely exposed

2) Environmental Investigation
   - Sampling locations are based on soil characteristics that match the ecological niche models for Cocci
Tracking Exposure

- Coccidioidomycosis became a reportable condition state-wide in 2014
- Epidemiology of human illness
  - Person becomes ill → diagnosed with Cocci → care provider/diagnostic lab reports to DOH → epidemiologist interviews patient → exposure location identified
  - Surveillance team is dispatched to location to sample for Cocci
Tracking Exposure

- Serological surveys
  - DOH partners with veterinary clinics to obtain small blood samples from canines that are already having blood drawn
  - Veterinarian takes sample → DOH sends for testing → Animal tests positive → Learn prevalence in canine population
  - Start to understand geographic distribution of Cocci

<table>
<thead>
<tr>
<th>County</th>
<th>Positive</th>
<th>Indeterminate</th>
<th>Negative</th>
<th>Total Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams</td>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Benton</td>
<td>6 (1.6%)</td>
<td>15</td>
<td>349</td>
<td>370</td>
</tr>
<tr>
<td>Clark</td>
<td></td>
<td>5</td>
<td>5</td>
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<tr>
<td>Columbia</td>
<td></td>
<td>2</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Franklin</td>
<td>5 (2.2%)</td>
<td>12</td>
<td>207</td>
<td>224</td>
</tr>
<tr>
<td>Grant</td>
<td>4 (8.7%)</td>
<td>2</td>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>King</td>
<td>2*</td>
<td>1</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Lincoln</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pierce</td>
<td>3*</td>
<td>2</td>
<td>64</td>
<td>69</td>
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<tr>
<td>Skagit</td>
<td></td>
<td>3</td>
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<td></td>
</tr>
<tr>
<td>Snohomish</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Walla Walla</td>
<td>1 (1.2%)</td>
<td>2</td>
<td>78</td>
<td>81</td>
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<tr>
<td>Whatcom</td>
<td></td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Yakima</td>
<td>5 (2.7%)</td>
<td>8</td>
<td>172</td>
<td>185</td>
</tr>
<tr>
<td><strong>Total Results</strong></td>
<td><strong>26 (2.5%)</strong></td>
<td><strong>44</strong></td>
<td><strong>961</strong></td>
<td><strong>1031</strong></td>
</tr>
</tbody>
</table>

*Likely travel-acquired infections
Counties in red are recognized as endemic for *Coccidioides*
Percentages are of the total number tested for each county.
Environmental Investigation

- Based on the known ecology of Cocci (can be problematic!)
- Since early 1900’s, scientists have tried to understand Cocci distribution in the environment
  - Potential associations with rodents, animal burrows, sandy soil, soil salinity, soil pH, creosote bushes, prickly pear cacti, Native American middens
  - None of these associations, alone, fully explain Cocci distribution
- Generally accepted that Cocci is associated with sandy soil that has alkaline pH and increased electrical conductivity (relating to salinity)
- Research is ongoing to understand what drives the spotty distribution of Cocci
A “Habitat Similarity Index” is one predictive model that has been developed. The model shows similarity of a given site to optimal Cocci habitat based on soil characteristics in endemic areas of the southwest.
Using fine resolution data from positive locations in Washington, we are developing a predictive niche model for Cocci in our area.

**Soil and Environmental Variables**
- Soil pH
- Soil Salinity
- Soil Texture
- Soil conductivity
- Temperature extremes
- Precipitation
- Frost free days
- Drainage class
- Slope of land
- Depth to water table
- Hydrologic soil groups
2017 Field Sampling Sites

- Sampling sites chosen based on soil type to feed the predictive niche model for Cocci in Washington
  - 5 soil types represent 75% of the soil in Benton County
  - Systematic sampling at DNR managed land in Benton County
  - SURRGO data available from USGS

Benton
Environmental Surveillance 2014-2017
Practice Safe Surveillance

- We have developed comprehensive field protocols to protect against exposure to Cocci arthroconidia
  - Respiratory protection is provided by a half-face mask or Powered Air Purifying Respirator (PAPR) equipped with P100 filters
  - Full coveralls and nitrile gloves limit the risk of transporting infective spores on clothing or skin
    - Tyvek suits and boot covers are suggested, but with discretion in public settings
After sampling, field clothing is soaked in a dish detergent solution.
Non-porous field equipment are surface disinfested with a 70% alcohol spray before transportation from field site.
As a biosecurity measure, the pathogen is neutralized in the field using a hybrid field/lab DNA extraction method.
   This method allows for processing soil samples without the need for a biosecurity level 3 facility.
Field Sampling Methods

- Within a site, 10-meter diameter plots are established 50-100 meters apart.

Map of a field site with plots identified

Field plot with the center marked and flags around the perimeter

- Three types of samples are taken:
  1. Surface samples at 0-3” depth
  2. Sub-surface samples at 3-6” depth
  3. Rodent burrows within the plot

Soil sampling

Rodent burrow within a plot
At every site, we set up a mobile lab station to analyze soil samples:

- Measure electrical conductivity, soil pH, and estimated % sand/silt
  - Data to feed the predictive model for WA
- Start DNA extraction in the field

Once the pathogen is neutralized, the sample can be brought into our lab for detection of Cocci DNA.
Air Sampling

- Detection of Cocci arthroconidia in air samples can help us identify times when there may be a higher risk for exposure
  - Identify seasonality factors such as precipitation and temperature
  - Determine physical factors like wind events

- Passive Air Deposition Sampler (PADS)
  - Relies on wind to deposit sample onto collection filter

- High Volume Air Sampler
  - Requires power to draw air through a collection filter
Molecular Testing

- The most reliable method to find Cocci in the environment is through molecular detection of Cocci DNA
- DNA Extraction from Soil (hybrid field/lab)
  - Cell lysis (in the field)
    - Break open cells to release DNA
  - Debris removal (in the lab)
    - Cellular and soil debris are removed
  - DNA purification (in the lab)
    - All non-DNA molecules are removed
- PCR with specific primers\(^1\) to detect Cocci DNA

\(^1\) Chow et al. 2016. Molecular detection of airborne Coccidioides in Tucson, Arizona. v55
Molecular Testing

- The ZD Program now has in-house molecular testing!
- With help from our CDC colleagues, quantitative PCR techniques are being validated for use in detecting Cocci and other zoonotic diseases in Washington
  - Faster turn around time from sample collection to results
  - We can make real-time decisions about surveillance efforts
Raise Awareness

- We work with local health jurisdictions to raise awareness about the presence of Cocci in Washington.
- Informed medical professionals are more likely to consider testing for and diagnosis of Valley Fever.
- People aware of Valley Fever are more likely to request testing and are more likely to receive earlier diagnosis.
- WA DOH recently participated in the first “Fungal Disease Awareness Week” organized by the CDC.
  - See DOH’s EpiTrends vol. 22 no. 8.
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