Laboratory Perspective in the Response to the 2012 Yosemite Hantavirus Infection Outbreak

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Dongxiang Xia: Nothing to disclose
Presentation: Laboratory Perspective in the Response to the 2012 Yosemite Hantavirus Infection Outbreak

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Acknowledgments

- **California Department of Public Health (CDPH)**
  - Viral and Rickettsial Disease Laboratory Branch (VRDL)
  - Infectious Diseases Branch (IDB)
  - Occupational Health Branch (OHB)

- **U.S. Centers for Disease Control and Prevention**
  - Viral Special Pathogens Branch (VSPB)

- **National Park Service (NPS)**
  - Yosemite National Park (YNP)
  - Office of Public Health (OPH)
  - Delaware North Corporation

- **Local health departments**

- **Reporting clinicians and laboratories**
Hantavirus - Sin Nombre Virus (SNV)

- **A Genera in Family Bunyaviridae**
  - Genome of 3 single-stranded, negative sense RNA segments (L, M, S)
  - Spectrum of illness
    - Old World, hemorrhagic fever with renal syndrome (HFRS), caused by Hantaan, Dobrava, Saaremaa, Seoul, and Puumala viruses
    - New World, hantavirus pulmonary syndrome (HPS) or hantavirus cardiopulmonary syndrome (HCPS), caused by SNV
    - HPS is a nationally notifiable disease

- **Transmission**
  - In California, Deer mice (*Peromyscus maniculatus*) are the primary reservoir of SNV
  - Infected mice shed virus in feces, urine, saliva
  - Inhalation of aerosolized excreta
  - Ingestion of contaminated food

- **Incubation period (SNV)**
  - 14 – 17 days (range 9 to 33 days)

- **1st recognized in 1993 in Four Corners outbreak**
Distribution of 44 Reported Cases of Hantavirus Cardiopulmonary Syndrome (HCPS) in California Residents by Most Likely County of Exposure, Through June 2012*

Total 58 cases reported Feb 1980 - June 2012 in CA residents

*Most likely county of exposure was determined based on patient history, epidemiologic investigation, and environmental evaluation. Of 58 total HCPS cases reported February 1980 through June 2012, most likely county of exposure could not be determined for 10, and 4 were likely exposed outside California. Deer mice (Peromyscus maniculatus), the principal reservoir and vector for the causative agent of HCPS, can be found throughout California. Individuals should always take appropriate precautions anywhere mice and other rodents are present to reduce the risk of exposure to HCPS and other rodent-borne diseases.
HPS Cases by Year,
California, 2001-2010

Maximum 4 cases/year between 2001-2010
Hantavirus Testing at VRDL

- **VRDL provides:**
  - Diagnostic testing for SNV by serology (CDC ELISA)
    - IgG and IgM for human specimens
  - Lab testing for rodent surveillance studies (support Vector Born Disease Section, VBDS)
    - IgG for animal specimens
    - RT-PCR for genotyping studies
  - Consultation and liaison to epidemiology
  - Reporting and interpretation of laboratory results

- **VRDL is the only lab in CA performing confirmatory testing**
  - Local health department-referred suspect human cases
  - Provisionally-positive samples referred by commercial labs
  - Rodents trapped by VBDS
## First Two HPS Cases Triggering Investigation in 2012

<table>
<thead>
<tr>
<th></th>
<th>First Case</th>
<th>Second case</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDPH/VRDL was alerted</td>
<td>July 9</td>
<td>July 31</td>
</tr>
<tr>
<td>Status when alerted</td>
<td>Hospitalized</td>
<td>Fatal</td>
</tr>
<tr>
<td>VRDL confirmed</td>
<td>July 11</td>
<td>Aug 7</td>
</tr>
<tr>
<td>Residence</td>
<td>Southern CA</td>
<td>San Francisco Bay area</td>
</tr>
<tr>
<td>Resident rodents</td>
<td>No or only urban rodents</td>
<td>No or only urban rodents</td>
</tr>
<tr>
<td>Yosemite visit</td>
<td>June</td>
<td>June</td>
</tr>
<tr>
<td>Lodge</td>
<td>Signature Tent Cabin, Curry Village (CV)</td>
<td></td>
</tr>
</tbody>
</table>

Concurrence of otherwise two unrelated HPS cases, both with travel to and lodging in the CV area of Yosemite National Park (YNP) in June, suggested a possible outbreak associated with YNP.
Yosemite National Park

- **Park statistics:**
  - Roughly the size of Rhode Island
  - Nearly 4 million visitors in 2012
  - About 3,000 employees

- **Tuolumne Meadows**
  - Two previous cases (2000, 2010)

- **Yosemite Valley:**
  - Major tourist attractions: Half Dome and El Capitan
  - Majority of visitors
  - Includes Curry Village campground and cabin area where first two cases in 2012 outbreak stayed
  - An area not previously associated with disease
  - Concerns for investigation
Outbreak Investigation

- **Initiated:** 14 August 2012

- **Participating agencies**
  - CDPH: IDB, VRDL, OHB
  - CDC: Viral Special Pathogens Branch
  - NPS: Office of Public Health

- **Teams and tasks:**
  - Laboratory
  - Epidemiology
  - Environmental
  - Occupational Health

*Peromyscus maniculatus* (Deer mouse)
Sequence of Outbreak Activities

Aug 14: Investigation initiated

Aug 16: CDPH Press Release: Notified public of HPS Cases

Aug 26: Health Alert Network/Epi-X: Medical community alerted of HPS

Aug 27, 28: Previous overnight visitors of Curry Village notified of HPS

The CDPH-led epidemiological investigation prompted a surge in laboratory testing
Hantavirus Clinical Samples Received per Week

July 2010
Dec 2010
May 2011
Oct 2011
Jan 2011
May 2012
Sept 2012
Jan 2013
May 2013
Hantavirus Samples Received per Week

- **Week 35**: 95 Rodents
- **Week 37**: 58 Rodents
- **Week 39**: 95 Occupational Health Samples
- **Week 42**: 294 Occupational Health Samples
- **Week 43**: 180 Occupational Health Samples

**July 2012**

**December 2012**

![Sample chart showing weeks 27 to 48 with corresponding samples received per week.]
Positive Cases (10/67) including 3 Deaths

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>State</th>
<th>Date of Onset</th>
<th>Status*</th>
<th>Result</th>
<th>Lab</th>
<th>Yosemite</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>CA</td>
<td>Jul 2012</td>
<td>R</td>
<td>IgM + / IgG + SNV</td>
<td>VRDL</td>
<td>Jun 2012</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>CA</td>
<td>Jul 2012</td>
<td>D</td>
<td>IgM + / IgG +/- SNV</td>
<td>VRDL</td>
<td>Jun 2012</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>PA</td>
<td>Jul 2012</td>
<td>D</td>
<td>Lung tissue IHC</td>
<td>CDC</td>
<td>Jun 2012</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>CA</td>
<td>Jul 2012</td>
<td>R</td>
<td>IgM + / IgG + SNV</td>
<td>VRDL</td>
<td>Jun 2012</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>CA</td>
<td>Aug 2012</td>
<td>R</td>
<td>IgM + / IgG + SNV</td>
<td>VRDL</td>
<td>Jul 2012</td>
<td>Signature Cabin, rodent nest</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>CA</td>
<td>Aug 2012</td>
<td>R</td>
<td>IgM + / IgG - SNV</td>
<td>VRDL</td>
<td>Jul 2012</td>
<td>Tuolumne Meadows</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>WV</td>
<td>Jul 2012</td>
<td>D</td>
<td>Lung tissue IHC</td>
<td>CDC</td>
<td>?</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>CA</td>
<td>Jul 2012</td>
<td>R</td>
<td>IgM + / IgG + SNV</td>
<td>VRDL</td>
<td>Jun 2012</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>CA</td>
<td>Aug 2012</td>
<td>R</td>
<td>IgM + / IgG + SNV; Focus = IgM screen +</td>
<td>VRDL</td>
<td>Jun 2012; Jul 2012</td>
<td>Signature Cabin</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>CA</td>
<td>Jul 2012</td>
<td>R</td>
<td>IgM + / IgG + SNV</td>
<td>VRDL</td>
<td>Jun 2012</td>
<td>Signature Cabin</td>
</tr>
</tbody>
</table>

*R = Recovered
*D = Death

VRDL confirmed all cases from California
CDC tested and confirmed all non-California cases
## 2012 Rodent Surveillance Results

<table>
<thead>
<tr>
<th></th>
<th>Aug</th>
<th>Sept</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Curry Village</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall trap success</td>
<td>95/185 (51%)</td>
<td>19/133 (14%)</td>
</tr>
<tr>
<td>Boystown trap success</td>
<td>20/40 (50%)</td>
<td>11/117 (9%)</td>
</tr>
<tr>
<td>SNV seroprevalence *</td>
<td>10/73 (14%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Tuolumne Meadows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall trap success</td>
<td>N/A</td>
<td>41/89 (46%)</td>
</tr>
<tr>
<td>Lodge and Tent Cabins</td>
<td>N/A</td>
<td>26/54 (48%)</td>
</tr>
<tr>
<td>SNV seroprevalence *</td>
<td>N/A</td>
<td>2/26 (8%)</td>
</tr>
</tbody>
</table>

* Seroprevalence results for *Peromyscus maniculatus* only, tested by ELISA at VRDL

Trap Success is + Traps / No. of Traps (%)
What is unique about signature cabins?
Evaluation of the Signature Cabin

All signature tent cabins were vacated and closed indefinitely on August 28, 2012.
Serosurvey of Park Employees

- CDPH Occupational Health Branch led
  - Survey of work-related duties
  - Blood draw for serological testing

- Total of 569 park staff tested by VRDL

- Less than 1% positive
Summary

- Largest outbreak since 1993
  - 10 confirmed cases
  - 9 stayed in Signature tents during incubation period
- Shorter timeframe & smaller geographic area
- Laboratory role in outbreak investigation
  - Diagnostic testing of patients
  - Serum testing for rodent seroprevalence
  - Serum surveillance testing of park employees
  - Prompt consultation, reporting and liaison
- Importance of prepared response capability to EID
- Well organized teamwork among all partners