A One Health and Emerging Poxviruses

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Two Poxviridae subfamilies

I. Chordopoxvirinae
   - Orthopoxvirus
     - variola, monkeypox, cowpox, vaccinia, raccoonpox, camelpox, skunkpox, ectromelia, taterapox
   - Parapoxvirus
   - Yatapox
   - Molluscipoxvirus

II. Entomopoxvirinae
   - Insect poxviruses

Poxvirus Characteristics and Routes of Exposure

- Poxviruses are stable in a wide range of environmental temperatures and humidity and may be transmitted by fomites.

- Virus may enter the body through mucous membranes, broken skin, or by ingestion, parenteral inoculation or droplet or fine-particle aerosol inhalation.

- Sources of laboratory-acquired infection include exposure to aerosols, environmental samples, naturally or experimentally infected animals, infectious cultures, or clinical samples, including vesiculopustular rash lesion fluid or crusted scabs, various tissue specimens, excretions and respiratory secretions.
ABSL-3 practices, containment equipment, and facilities are recommended for monkeypox work in experimentally or naturally infected animals.

BSL-2 facilities with BSL-3 practices are advised if vaccinated personnel perform other work with monkeypox virus.

Attenuated vaccinia strains are BSL-1 except in work areas where other Orthopoxviruses are manipulated.

BSL-2 and ABSL-2 plus vaccination are recommended for work with most other poxviruses.
Enzootic Poxviruses in Animals

- Avipoxviruses
e.g. Canarypox, Fowlpox

- Suipoxvirus
e.g. Swinepox; mild, louse transmission

- Leporipoxvirus
e.g. Hare rabbit and squirrel fibroma, Myxoma

- Capripoxviruses
  - Goatpox, Goats, Asia, Africa, 50%-100% mortality in young
  - Lumpy skin disease; cattle, Africa, high mortality (~100%)
  - Sheeppox; Sheep, Asia, Africa, 50-100% mortality in young
Molluscum Contagiosum

- Molluscum contagiosum virus (MCV) is the only virus belonging to the genus *Molluscipoxvirus*
- The genome is ~190 kbp and consists of four genotypes (MCV 1-4)
- Certain genotypes dominate geographical locations and clinical groups

- Humans are the only host

- MC is common in young children, young adults, and the immunocompromised

- Transmission occurs through contact with the infectious material via direct skin-to-skin contact, fomites

Images 1&2 from Bernard Cohen/DermAtlas
Image 3 from Shahbaz Janjua/DermAtlas
Image 4 from CDC’s Public Health Image Library
Variola had a Zoonotic origin (ca. 70000 ybp)

Variola Major reached Asia by 1600 ybp and started the smallpox pandemic

Worldwide, all live variola virus work is to be done only within WHO approved BSL-4/ABSL-4 facilities:
- CDC Atlanta
- The State Research Center of Virology and Biotechnology (VECTOR) in Koltsovo, Russia.

- Variola had a Zoonotic origin (ca. 70000 ybp)
- Variola Major reached Asia by 1600 ybp and started the smallpox pandemic
Zoonotic Poxviruses

Parapoxviruses

Yatapoxviruses

Orthopoxviruses
## Parapoxvirus

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
<th>Geographic</th>
<th>Other infected hosts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausdyk</td>
<td>Camel</td>
<td>Africa, Asia</td>
<td>Humans</td>
</tr>
<tr>
<td>Orf</td>
<td>Sheep, goats</td>
<td>Worldwide</td>
<td>Other ruminants, humans</td>
</tr>
<tr>
<td>Bovine papular stomatitis virus, pseudocowpox</td>
<td>Cattle</td>
<td>Worldwide</td>
<td>Humans</td>
</tr>
<tr>
<td>Red deer parapoxvirus</td>
<td>Red deer</td>
<td>New Zealand</td>
<td>Not known</td>
</tr>
<tr>
<td>Sealpox</td>
<td>Seals</td>
<td>Worldwide</td>
<td>Humans, dogs?, cats</td>
</tr>
</tbody>
</table>
Deer-associated Parapoxvirus

January 2009 CDC rec’d a calls from 2 states about a suspected orf cases

Both patients were deer hunters, both had nicked their fingers while dressing deer in mid-November

Less than a month following exposure both developed lesions

Genetic typing indicating virus was ‘pseudocowpox-like’, but sufficiently divergent to be novel

1 out of 20 Americans ≥ 16 years old* hunt deer

Outreach/education

Novel Deer-Associated Parapoxvirus Infection in Deer Hunters
Amira A. Roess, et al.
Yatapoxvirus
brick-shaped, G+C 33%, ~145 kbp
primates

- Tanapox (Yaba-like disease virus)
  - Febrile prodrome
  - Self limiting
  - Reservoir host unknown
  - E. Central Africa
  - No human to human transmission

- Yaba monkey tumor virus
  - Reservoir host unknown
  - West Africa
  - Human infection of animal handlers
## Genus Orthopoxvirus

<table>
<thead>
<tr>
<th>Orthopoxvirus species</th>
<th>Geographic distribution</th>
<th>Reservoir host</th>
<th>Other naturally infected hosts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eurasian (Old World)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camelpox</td>
<td>Africa, Asia</td>
<td>Camels</td>
<td>None</td>
</tr>
<tr>
<td>Cowpox</td>
<td>Europe, western Asia</td>
<td>Rodents</td>
<td><strong>Humans</strong>, Cats, Cows, Zoo animals</td>
</tr>
<tr>
<td>Ectromelia</td>
<td>Europe</td>
<td>Rodents</td>
<td>None</td>
</tr>
<tr>
<td>Horsepox</td>
<td>Central Asia</td>
<td><strong>Unknown</strong></td>
<td>Horses</td>
</tr>
<tr>
<td>Monkeypox</td>
<td>Western, central Africa</td>
<td><strong>Unknown</strong></td>
<td><strong>Humans</strong>, Monkeys</td>
</tr>
<tr>
<td>Taterapox</td>
<td>Western Africa</td>
<td>Gerbils</td>
<td>None</td>
</tr>
<tr>
<td>Uasin Gishu</td>
<td>Eastern Africa</td>
<td><strong>Unknown</strong></td>
<td>Horses</td>
</tr>
<tr>
<td>Vaccinia</td>
<td>Worldwide</td>
<td><strong>Unknown</strong></td>
<td><strong>Humans</strong>, Rabbits, Cows, River buffaloes</td>
</tr>
<tr>
<td>Variola</td>
<td>Worldwide</td>
<td><strong>Humans only</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>North American (New World)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raccoonpox</td>
<td>Eastern USA</td>
<td>Raccoons</td>
<td>Cats</td>
</tr>
<tr>
<td>Skunkpox</td>
<td>Western USA</td>
<td>Skunks</td>
<td>None</td>
</tr>
<tr>
<td>Volepox</td>
<td>Western USA</td>
<td>Voles</td>
<td>None</td>
</tr>
</tbody>
</table>
Monkeypox

- First described in primate outbreak in 1958
- Association with human disease discovered in 1970
- Endemic in Congo basin
- >90% of cases in DRC
Monkeypox Importation to the United States, 2003
In general, all persons working in or entering laboratory or animal care areas where activities with vaccinia, monkey pox, or cowpox viruses are being conducted should have evidence of satisfactory vaccination.

Vaccination is advised every three years for work with monkeypox virus and every 10 years for cowpox and vaccinia viruses.

Neither vaccination nor vaccinia immunoglobulin protect against poxviruses of other genera.
“In the present age of scientific investigation it is remarkable that a disease of so peculiar a nature as the cow-pox, which has appeared in this and some of the neighboring counties for such a series of years, should so long have escaped particular attention”

Edward Jenner June 21st 1798 a letter to his friend C.H. Parry of Bath
Cowpox: Where is it now?
Vaccinia in Brazil

- Manual milking
- Milkers travel from farm to farm

Defining Cowpox Species

Genetic distance

- Variola virus vs Taterapox virus
- 5 possible species
  - 4 Cowpox-like
  - 1 Vaccinia-like

doi:10.1371/journal.pone.0023086
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0023086
Just when you think you have things figured out……

Brand New Smallpox-Related Virus Emerges In Country Of Georgia

The Huffington Post by Amanda L. Chan

• Posted: 05/01/2014 11:31 am EDT Updated: 05/01/2014 11:59 am EDT

Published Date: 2014-05-02 19:00:10
Subject: PRO/AH/EDR> Novel Orthopoxvirus - Georgia: potential biohazard?
Archive Number: 20140502.2445865

NOVEL ORTHOPOXVIRUS - GEORGIA: POTENTIAL BIOHAZARD?
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The last few decades have seen the description of three OPXV’s from North America named after the species in which they were originally isolated: *Raccoonpox virus, Skunkpox virus, and Volepox virus*
A Novel Poxvirus Isolated from Big Brown Bats in Northwestern United States

EID 19:6—June 2013
Novel Poxvirus in Big Brown Bats, Northwestern United States
Field Research Challenges

Effective use of PPE
Knowledge of protocols (and biology of the relevant diseases)
Knowledge of local culture (myths, customs)
Always use protection!

http://www.flowjo.com/newsletter/newsmail18c.html

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