Rodent-borne viral zoonoses – climate and environmental changes

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Steningevik, 121210
## Viral zoonoses

<table>
<thead>
<tr>
<th>Virus</th>
<th>Host</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arenaviruses</td>
<td>Rodents</td>
</tr>
<tr>
<td>Filoviruses</td>
<td>? (Bats?)</td>
</tr>
<tr>
<td>Bunyaviruses</td>
<td>Arthropods</td>
</tr>
<tr>
<td></td>
<td>- ticks</td>
</tr>
<tr>
<td></td>
<td>- mosquitos</td>
</tr>
<tr>
<td></td>
<td>- flies</td>
</tr>
<tr>
<td>Flaviviruses</td>
<td>Rodents</td>
</tr>
<tr>
<td></td>
<td>Arthropods</td>
</tr>
</tbody>
</table>

**ArBo-virus** = Arthropode-borne  
**RoBo-virus** = Rodent-borne
Rodent-borne viruses

• Arena
  – Lassa, Junin, Machupo, Guanarito, Sabia, LCMV

• Bunya
  – Hanta

• Pox
  – Cowpox

• Filo
  – Bats?
## Arenaviruses

<table>
<thead>
<tr>
<th>Virus</th>
<th>Origin of Name</th>
<th>Year</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lassa</td>
<td>Town, Nigeria</td>
<td>1969</td>
<td>West Africa</td>
</tr>
<tr>
<td>Junin</td>
<td>Town, Argentina</td>
<td>1957</td>
<td>South America</td>
</tr>
<tr>
<td>Machupo</td>
<td>River, Bolivia</td>
<td>1962</td>
<td>South America</td>
</tr>
<tr>
<td>Guanarito</td>
<td>Area, Venezuela</td>
<td>1989</td>
<td>South America</td>
</tr>
<tr>
<td>Sabia</td>
<td>Town, Brazil</td>
<td>1990</td>
<td>South America</td>
</tr>
</tbody>
</table>

(LCMV Clinical disease 1933 Worldwide)
Lassa virus

Endemic in areas of West Africa, including Nigeria, Liberia, Sierra Leone, and Guinea

Up to 500,000 infections/year, with 5-50,000 deaths

Rodent-to-human transmission (the "multimammate rat", *Mastomys* species-complex)

Secondary human-to-human transmission with the potential for nosocomial outbreaks with high case-fatality
## Bunyaviruses

<table>
<thead>
<tr>
<th>Virus</th>
<th>Origin of Name</th>
<th>Year</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hantaviruses</td>
<td>River, Korea</td>
<td>1977</td>
<td>Worldwide</td>
</tr>
<tr>
<td>CCHFV</td>
<td>Crimean and Congo</td>
<td>1944/1969</td>
<td>Europe/Africa/India</td>
</tr>
<tr>
<td>RVFV</td>
<td>Area, Kenya</td>
<td>1900</td>
<td>Africa/Middle East</td>
</tr>
</tbody>
</table>

CCHFV = Crimean-Congo hemorrhagic fever virus  
RVFV = Rift Valley fever virus
Hantavirus

Human infection: HFRS or HCPS
Transient

Rodent infection: Asymptomatic Chronic
Korean War 1951-1953

Close to a small river called Hantaan in Korea, 3000 United Nations soldiers experienced an acute febrile illness with acute renal failure and shock.

Mortality = 7%

HFRS was discovered by "western medicine"
Hemorrhagic fever w. renal syndrome (HFRS)

Known in China for more than 1000 years
First described in Sweden 1934
Euro-Asia, around 200'000 cases annually
Mortality differs from <0,1% to 10% depending on virus
Clinical severity ranges from asymptomatic infection to fulminant hemorrhagic shock

Often five different phases of the disease:
1. Febrile
2. Hypotensive
3. Oliguric
4. Polyuric
5. Convalescent
However, considerable variation between patients
Hantavirus cardio-pulmonary syndrome (HCPS)

First case in 1993, Four-Corner region, USA

Americas, less than 1´000 recognized cases annually

Mortality around 50%

Cardiac and respiratory symptoms, normally less renal and bleeding manifestations compared to HFRS
## Characteristics of some hantaviruses

<table>
<thead>
<tr>
<th></th>
<th>Hantaan</th>
<th>Seoul</th>
<th>Puumala</th>
<th>Dobrava</th>
<th>Sin Nombre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geographic region</strong></td>
<td>Central and eastern Asia</td>
<td>Worldwide</td>
<td>Northern Europe</td>
<td>South-eastern Europe</td>
<td>North America</td>
</tr>
<tr>
<td><strong>Reservoir</strong></td>
<td>Striped field mouse</td>
<td>Rat</td>
<td>Bank vole</td>
<td>Yellow-necked mouse</td>
<td>Deer mouse</td>
</tr>
<tr>
<td><strong>Pathology</strong></td>
<td>HFRS</td>
<td>HFRS</td>
<td>HFRS</td>
<td>No known human disease</td>
<td>HCPS</td>
</tr>
<tr>
<td><strong>Mortality</strong></td>
<td>5 - 15%</td>
<td>1%</td>
<td>1%</td>
<td>5-15%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Puuma hantavirus

Causes a milder form of HFRS (Nephropathia epidemica), epidemics in Northern Europe
Largest outbreak ever in Sweden - 2007/2008, in total > 2150 patients
Human cases - causal virus

- DOBV
- PUUV
- TULV

Map of Europe showing the distribution of human cases caused by different viral strains, with numbers indicating the counts in different regions.
Changes

• Changes in agriculture
  – Hantaan in China

• War
  – E.g. World War II, Korean War (Hantaan), former Yugoslavia (Dobrava)

• Climate
  – ”More food” (mast years in Central Europe)
Publications


• Tersago K. et. al. Hantavirus disease (nephropathia epidemica) in Belgium: effects of tree seed production and climate Epidemiology and Infection 2009; 137: 250-256
Urgent need for more knowledge

- Hantaviruses in Europe?
- Arenaviruses in Europe?
- Surveillance (rodent and human)
- Hard-core epidemiology and virology
Myodes glareolus
Bank vole
Myodes glareolus
Bank vole
Myodes glareolus
Bank vole
Apodemus flavicollis
Yellow-necked mouse
Apodemus flavicollis
Yellow-necked mouse
Apodemus flavicollis
Yellow-necked mouse
Apodemus agrarius
Striped field mouse
Apodemus agrarius
Striped field mouse
Apodemus agrarius
Striped field mouse
Saaremaa hantavirus in *Apodemus agrarius*

- Distinct from Dobrava hantavirus (in *A. flavicollis*)?
- Clinics?
- Milder than Puumala virus infections/Nephropathia epidemica?
Human cases - causal virus

<table>
<thead>
<tr>
<th>Virus</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOBV</td>
<td>39</td>
</tr>
<tr>
<td>PUU/DOB</td>
<td>24672</td>
</tr>
<tr>
<td>PUUV</td>
<td>1320</td>
</tr>
<tr>
<td>TULV</td>
<td>1856</td>
</tr>
</tbody>
</table>

*no report*

![Map of Europe showing human cases of causal viruses with regions colored according to virus type and numbers indicating the cases.]
Emerging, vector-borne diseases in a changing European environment

EDEN
FP 6 Large integrative project
Biology and control of vector-borne infections in Europe

- Date of start: 2011/01/01
- End: 2014/12/31

Goals of the project

Welcome to the website of EDENext. Biology and control of vector-borne infections in Europe, a research project bringing together 46 international partners dedicated to investigating the biological, ecological and epidemiological components of vector-borne disease introduction, emergence and spread, and the creation of new tools to control them. Due to environmental and socio-economic changes, vector-borne diseases (VBD) are becoming an increasing challenge for human and veterinary public health not only in Europe, but across the globe. Emerging infectious diseases (EID) are often detected in Europe and North America but also in other continents, and a high number of VBD, in many cases linked to human activities.
Results and ongoing in Stockholm

• Hanta-Euro-survey (Turkey, Romania, etc)
• Host-virus competence
• Risk factors – PUUV infection
• PUUV impact on bank voles
• New rodents trapped around the southern NE-border in Sweden (M. Löhmus, SVA)
• SEOV-case in France (H. Zeller, ECDC)
PUUV impact on bank voles

- Dominant vs. subordinate (susceptibility)
- Testosterone levels (susceptibility)
- Peeing!
- Infected males pees "a lot"...
Rodents trapped around Uppsala (M. Löhmus)

- TBEV - all negative
- Hantavirus – several positive, also *Apodemus flavicollis* - confirmed by FRNT (J. Verner-Carlsson)!
- Ongoing: Arena, Toxoplasma, Borna
Euro-survey

- Hantaviruses in Romania
- SEOV in the Netherlands
- Hantaviruses in Turkey
  - First manuscript in VBZD
  - Human PUUV and DOBV/SAAV in several other regions
  - Heavily under-diagnosed
New group

Biomedicine
Population genetics
Entomology
Virology
Immunology
Networks!
Thank you!!