Rabies Epidemiology and Vectors

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FDA workshop: Developing Rabies Monoclonal Antibody Products as a Component of Rabies Post-Exposure Prophylaxis

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Global Epidemiology of Rabies

• Global perspective on:
  – rabies prevalence in animals
  – rabies exposures in humans
  – rabies infections in humans

• Different vectors in different countries

• Distribution of different rabies virus strains
Rabies virus and human disease

Lyssavirus Genus (ICTV website): Currently listed with 14 species (+ more?)

Human infections documented:

<- ABLV: occasional
<- Duv: occasional
<- ELBV1 and 2: occasional
<- Mokola: occasional
<- Rabies: Estimated at around 59,000

All human cases symptomatically “rabies-like”
Main route of transmission is by bite / scratch

Distribution suggests that Lyssaviruses co-evolved in bats, over millenia.
Rabies transmission patterns

- Rabies virus can theoretically infect any mammal
- Most likely origin is bats and bats worldwide known to be infected with lyssaviruses
- Not all mammals maintain the disease indefinitely (ie. act as reservoirs)
- Most common reservoirs are carnivores and bats
- From these reservoirs a broad range of animals can be infected (spillover hosts)
- Humans can be infected by any infected host (vectors)
- Contact patterns of different animals with humans create different public health risks
- By far the most common public health threat globally is from the domestic dog (>99% human cases result from dog bites)
The burden of canine rabies

For CANINE ENDEMIC Countries (N=122)

<table>
<thead>
<tr>
<th></th>
<th>Deaths</th>
<th>Exposures to Rabid Animals *</th>
<th>PEPs delivered</th>
<th>Prevented deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>21,502</td>
<td>847,326</td>
<td>1,387,848</td>
<td>139,490</td>
</tr>
<tr>
<td>Americas</td>
<td>182 $</td>
<td>122,701</td>
<td>835,656</td>
<td>23,131</td>
</tr>
<tr>
<td>Asia</td>
<td>37,266</td>
<td>14,633,844</td>
<td>26,589,222</td>
<td>2,743,164</td>
</tr>
<tr>
<td>Europe</td>
<td>41</td>
<td>91,035</td>
<td>362,379</td>
<td>17,255</td>
</tr>
<tr>
<td>Grand Total</td>
<td>58,991</td>
<td>15,694,905</td>
<td>29,175,105</td>
<td>2,923,041</td>
</tr>
</tbody>
</table>

From Hampson et al (2015) Reassessing the burden of Rabies

- *An estimated 19% of rabid exposures result in death if they do not receive PEP
- $ Deaths in the Americas primarily in Haiti and these may be lower now.
The relative importance of wildlife rabies

Human cases from dogs
Human cases from bats

Rabies Cases across Latin America, 1982 – 2013

Graph drawn by PAHO, from SIRVERA data
Where diagnostic facilities are strong we have the ability of produce very detailed maps of rabies reservoir species.

Distinct variants of the rabies virus are adapted to different reservoir species.

From: Rabies surveillance in the United States during 2015
Rabies variants in the US

In 2015: 5,508 rabies positive animals and 26.8% of those typed

- Clearly there is spill-over from the main reservoir into other wild and domestic species.
- These are highly contact dependent and do cause exposures to humans.
- Cases in dogs are not the US dog adapted variant which was confirmed eliminated in 2007
- Only 1 human case acquired in the US (from a bat)

From: Birhane et al (2017) JAVMA
Rabies in Europe, 2010 - 2015

Data from Rabies Bulletin Europe, FLI

Terrestrial Wildlife cases
N=17,891

Bat cases
N=193

Domestic animal cases
N=18,323

But human cases from 2010-5 = 59 (47 in Russian Fed., Georgia and Turkey)
Rabies Reservoir species

- Black-backed jackals in South Africa
- Kudu in Namibia
- Ferret Badgers in Taiwan (2013)
- Circumpolar transmission of an arctic RABV variant by arctic foxes

At least 39 Genera of Insectivorous bats across many countries

But in many countries adequate surveillance has not been carried out
Rabies prevalence in animals

- It depends on which animals you are testing:

Animals tested in the US 2015:

- 13% of Raccoons, 6.6% of Bats, 28% of Skunks, 18% of Foxes
- 0.3% of Dogs, 2% of Horses, 6.8% of Cattle

Wild-caught and apparently healthy bats in US:

- 0.6% of *Tadarida brasiliensis*, 2.5% of *Eptesicus fuscus*

Grounded bats underneath a large colony:

- 92% of *T. brasiliensis*

Dogs tested in Philippines:

- 18% in 2012, 23% in 2013, 28% in 2014, 26% in 2015, 27% in 2016

- Even sampled animals that people were bitten by may not be randomly chosen, so the interpretation of this data is often very difficult
What else is out there?

• Rabies can jump species to establish reservoirs in new host species
• Surveillance in many canine rabies endemic countries is very poor, with few labs, small numbers of samples tested, and variant typing usually not possible locally.
• Partnerships with reference labs and support are available and are working to help countries.
• As dog rabies has been reduced in Latin America, vampire bat rabies has become a larger public health concern
• Quite possible that the dog rabies is masking more wildlife reservoirs
A tale of two worlds

- Understand the epidemiology of rabies
- Know the likelihood that a particular exposure is a rabies risk
- Good advice on and access to PEP

- Human cases, 2015 = 3 (1 US exposure)

- Rabies is in dogs, presumed everywhere
- Little idea of wildlife reservoir species
- All dogs (and often all animal) bites need to be treated as a rabies exposure
- Poor access to PEP

- Human cases, 2015 = est. 21,500
Thank you for your attention

Global Alliance for Rabies Control

www.rabiesalliance.org

End Rabies Now

www.endrabiesnow.org