
PHO Grand Rounds
Tuesday April 21, 2015

Dean Middleton
Enteric, Zoonotic and Vector-Borne Diseases Unit
Outline

• Introduction
• Purpose of the Study
• Methods
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• Discussion
• Conclusions

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Introduction

- Rabies is caused by a group of antigenically related viruses in the genus *Lyssavirus*.
- Rabies affects mammals, including humans.
- Virus infects the neurologic system. Symptoms related to this.
- Once symptoms of rabies are exhibited in humans, the disease is almost always fatal.
- Transmission to humans is usually through saliva via the bite of an infected animal.
- Worldwide, an estimated 55,000 human deaths occur annually (*Hemachuda et. al*, 2008).
Introduction

• In Canada, 9 human cases occurred between 1960 and 2009 (NACI, 2012).

• In Ontario, 1 human case occurred in 2012 that was acquired while travelling outside of Ontario.

• The last case of human rabies that was acquired in Ontario occurred in 1967.

• Historically, skunks, foxes and raccoons are the main reservoirs in Ontario.

• In Ontario, bats currently pose the biggest threat of transmitting the virus to humans.
In Ontario, four main strategies have been used to prevent rabies cases in humans.

1. Public Health messaging informing people to avoid contact with wild animals.
2. Wildlife rabies control programs targeting skunks, raccoons and foxes.
3. Vaccinating bridge vectors such as dogs, cats, other pets, and farm animals.
2. Wildlife rabies control programs targeting skunks, raccoons and foxes.

1. Oral Vaccination via aerial baiting
2. Point Infection Control (PIC)

- Different aspects of the program have been implemented annually since 1989.
4. Human Rabies Post-Exposure Prophylaxis (RPEP)

1. A course of four rabies vaccines as well as rabies immune globulin (RIG).

2. Public health staff have a role that includes assessing human exposures to animals to advise on the need for RPEP.
   a. Dogs, cats and ferrets may be observed for 10 days post-exposure.
   b. Other animals assessed by different criteria.
Costs Associated with RPEP Administration

- Vaccine (5-dose series) and rabies immune globulin for a 70 kg person was approximately $2,200 CAD (2011).
- Public Health staff time.
- A study in Quebec estimated $1,189 to $1,590 CAD per person for household bat exposures (Huot et al., 2008). These costs included:
  - nurses’, physicians’ and veterinarians’ time,
  - obtaining the bats for testing,
  - the cost of testing the bats,
  - and excluded biologics.
Purpose of the Study

• To describe the relationship between the number of animal rabies cases and the number of RPEP administered in Ontario from 2001–2012.

• Further, to describe the relationship between various categories of animal rabies cases and the number of RPEP administered due to each of those animal categories respectively from 2007–2012.
Objective

- To evaluate whether the decrease in the number of animal rabies cases resulted in a decrease in the number of RPEP administered.
Study Design and Ethical Approval

- A retrospective, descriptive epidemiological study

- Ethical approval was not required to publish the findings for this analysis because this was considered a public health investigation under the Ontario *Health Protection and Promotion Act* (1990, R.S.O. 1990, c.H.7) (HPPA).
Animal rabies cases are reportable under the *Health of Animals Act* (*s.c. 1990, c. 21*).

**2001-2012 Animal Rabies Case Data Source**

- Ontario Ministry of Natural Resources (from the Canadian Food Inspection Agency, Nepean)
Exposures to animals that *may result* in rabies are reportable under the *HPPA* and in accordance with the Ontario Rabies Prevention and Control Protocol.

**RPEP Data Source**

- **2001-2006** - Reports manually provided from Ontario health units
  - Domestic vs. travel exposures could not be differentiated
  - Animal type could not be differentiated
- **2007-2012** – *iPHIS* *(integrated Public Health Information System)*
  - Exception for one health unit in 2007-2008 when data were provided manually
### Categories of animals that resulted in RPEP being administered and animals diagnosed with rabies in Ontario

<table>
<thead>
<tr>
<th>Category</th>
<th>Rabies Post-Exposure Prophylaxis Administered Due To:</th>
<th>Animals Diagnosed with Rabies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Animals for which the 10-day observation period applies</strong></td>
<td>Dogs, cats, ferrets.</td>
<td>Dogs, cats.</td>
</tr>
<tr>
<td><strong>B. Farm Animals</strong></td>
<td>Cattle, horses, donkeys, sheep, goats and ‘other’ farm animals</td>
<td>Livestock.</td>
</tr>
<tr>
<td>Bats</td>
<td>Bats.</td>
<td>Bats.</td>
</tr>
<tr>
<td>Terrestrial Animals, excluding A and B</td>
<td>Foxes, raccoons, skunks, wild ferrets, pet rabbits, squirrels, chipmunks and ‘other’ terrestrial animals.</td>
<td>Foxes, raccoons, skunks, ‘other’ wildlife.</td>
</tr>
<tr>
<td>Unknown</td>
<td>Unknown.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Missing</td>
<td>Missing data.</td>
<td>Not applicable.</td>
</tr>
</tbody>
</table>
Results
**Animal rabies cases, RPEP administered and RPEP rate: Ontario**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Median</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual number of animal rabies cases 2001-2012</td>
<td>96</td>
<td>89</td>
<td>26</td>
<td>210</td>
</tr>
<tr>
<td>Annual number of RPEP administered 2001-2012 (only due to exposures in Ontario 2007-2012 data)</td>
<td>1,774 (1,758)</td>
<td>1,659 (1,588)</td>
<td>1,426 (1,352)</td>
<td>2,692 (2,544)</td>
</tr>
<tr>
<td>Annual rate of RPEP administered per 100,000 persons 2001-2012 (only due to exposures in Ontario 2007-2012 data)</td>
<td>13.9 (13.4)</td>
<td>13.1 (11.9)</td>
<td>11.1 (10.1)</td>
<td>20.8 (19.7)</td>
</tr>
</tbody>
</table>
Animal Rabies Cases and RPEP Data, Ontario, 2001–2012


- **RPEP Rate/100,000**:
  - 2001: 13.8
  - 2002: 14.3
  - 2003: 12.2
  - 2004: 11.5
  - 2005: 12.2
  - 2006: 15.7
  - 2007: 17.6
  - 2008: 20.8
  - 2009: 12.8
  - 2010: 11.7
  - 2011: 11.3
  - 2012: 13.3
Animal Rabies Cases and RPEP Data, Ontario, 1958–2012

- All RPEP administered using human diploid vaccine
- Includes bat found in room when a person was sleeping unattended
- Last human rabies case acquired in Ontario
- MNR wildlife control

RPEP administered for exposures that occurred within Ontario (i.e., domestic) and animal rabies cases, 2007–2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic RPEP</th>
<th>Animal Rabies Cases</th>
<th>RPEP Rate/100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>2062</td>
<td>106</td>
<td>16.1</td>
</tr>
<tr>
<td>2008</td>
<td>2544</td>
<td>79</td>
<td>19.7</td>
</tr>
<tr>
<td>2009</td>
<td>1547</td>
<td>50</td>
<td>11.8</td>
</tr>
<tr>
<td>2010</td>
<td>1412</td>
<td>39</td>
<td>10.7</td>
</tr>
<tr>
<td>2011</td>
<td>1352</td>
<td>26</td>
<td>10.1</td>
</tr>
<tr>
<td>2012</td>
<td>1629</td>
<td>28</td>
<td>12.0</td>
</tr>
</tbody>
</table>
Annual number of RPEP administered for exposures to animals for which the 10-day observation period applies that occurred within Ontario (domestic), and number of rabid animals for which the 10-day observation period applies.

### Number of RPEP and Rabid Animals

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic RPEP</th>
<th>Rabid Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>742</td>
<td>2</td>
</tr>
<tr>
<td>2008</td>
<td>1397</td>
<td>5</td>
</tr>
<tr>
<td>2009</td>
<td>869</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>810</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>784</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>882</td>
<td>2</td>
</tr>
</tbody>
</table>

2008 - At least 377 RPEP resulted from exposure to a single rabid puppy and its littermates.
Annual number of RPEP administered for exposures to bats that occurred within Ontario (domestic) and annual number of rabid bats, 2007–2012

Aug 7, 2008 - RPEP recommendations changed to ...

Bat bite, scratch, or direct contact required.

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic RPEP for Bats</th>
<th>Rabid Bats</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>1130</td>
<td>62</td>
</tr>
<tr>
<td>2008</td>
<td>880</td>
<td>38</td>
</tr>
<tr>
<td>2009</td>
<td>396</td>
<td>30</td>
</tr>
<tr>
<td>2010</td>
<td>357</td>
<td>29</td>
</tr>
<tr>
<td>2011</td>
<td>316</td>
<td>24</td>
</tr>
<tr>
<td>2012</td>
<td>463</td>
<td>25</td>
</tr>
</tbody>
</table>
Annual number of RPEP administered for exposures to terrestrial animals that occurred within Ontario (domestic) and annual number of rabid terrestrial animals, 2007–2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic RPEP for Terrestrial Animals</th>
<th>Rabid Terrestrial Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>233</td>
<td>30</td>
</tr>
<tr>
<td>2008</td>
<td>213</td>
<td>27</td>
</tr>
<tr>
<td>2009</td>
<td>254</td>
<td>11</td>
</tr>
<tr>
<td>2010</td>
<td>225</td>
<td>10</td>
</tr>
<tr>
<td>2011</td>
<td>245</td>
<td>1</td>
</tr>
<tr>
<td>2012</td>
<td>250</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The category terrestrial animals excludes animals for which the 10-day observation period applies and farm animals, e.g., foxes raccoons, skunks.
Annual number of RPEP administered for exposures to farm animals that occurred within Ontario (domestic) and annual number of rabid farm animals, 2007–2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Domestic RPEP for Farm Animals</th>
<th>Number of Rabid Farm Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>2008</td>
<td>49</td>
<td>9</td>
</tr>
<tr>
<td>2009</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>2010</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2012</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

2008 – 1 rabid horse and 3 cattle combined for 29 RPEP
The annual number of animal rabies cases decreased steadily to unprecedented low numbers.

The number of RPEP administered was stable over the study period.

The decrease in animal rabies cases did not result in a decrease in the number of RPEP administered.
Animal Categories

Difference between the number of RPEP administered and corresponding number of rabid animals

1. 10-day Observation group (dogs, cats, ferrets) (>740)
2. Bats (~1000 vs >300)
3. Terrestrial animals (not including “10-day” and “farm”) (>200)
4. Farm animals (40 max)
1. Wildlife rabies cases decrease due to vaccination

2. Companion and farm animals (bridge vectors) rabies infections decrease

Both result in a decrease in the risk of rabies infections in humans.

P.S. - The wildlife rabies control program has no effect on bat rabies.
• 1980s - the annual number of animal rabies cases was most frequently > 2,000; following the RPEP recommendations verbatim likely served its purpose well in preventing human cases of rabies.

• 2001-2012 - strictly following the recommendations as they were written would result in RPEP administration that, more often than not, would not prevent a case of rabies.

• 2012 – new ‘Canadian Immunization Guide’ recommendations provide more flexibility with regard to “risk assessment”.
• How prevalent is rabies in the species of animal involved in the exposure?
  • In North America, rabies occurs mainly in bats, foxes, skunks, raccoons, stray dogs and cats.

• How prevalent is rabies in the involved species in the geographic area?
  • Presently in Ontario, mainly bats.
Factors to Consider

- Can a bite or saliva exposure into a scratch, wound or mucous membrane be ruled out?
  - *Rabies transmission occurs most commonly through a bite. ... transmission through scratches, wounds, or mucous membranes contaminated from saliva are rare.*

- What were the circumstances of the exposure (e.g., provoked or unprovoked attack)?
  - *An unprovoked attack is more likely to indicate that the animal is rabid.*
Effect of RPEP Recommendations on RPEP Associated with Bat Exposures

Aug 7, 2008 - RPEP recommendations changed to ...
Bat bite, scratch, or direct contact required.

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<td>2012</td>
<td>463</td>
<td>25</td>
</tr>
</tbody>
</table>
Erring on the Side of Safety

• RPEP is a safe intervention compared with the almost certainty of death in an individual infected with, and exhibiting symptoms of, rabies.
• Reported positive animals only represent a fraction of the true number of positive animals.
• Rabid animals are identified in the USA close to the Ontario border.
• Bat rabies continues to be a threat.
Conclusions

- A decrease in the number of RPEP administered would provide some financial savings for the government.

- Ideally, an increased use of the risk assessment approach in keeping with recent guidelines, rather than adhering to previous prescriptive recommendations for RPEP administration, coupled with a continuing low incidence of animal rabies cases will result in decreased, and yet appropriate, use of RPEP.
• iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent a snapshot at the time of extraction and may differ from previous or subsequent reports.

• The data were extracted from iPHIS on March 17, 2014.

• The data only represent cases reported to public health and recorded in iPHIS. As a result, all counts will be subject to varying degrees of underreporting due to a variety of factors, such as disease awareness, medical care seeking behaviours, reporting behaviours, clinical practice, and severity of illness.
Acknowledgements

• Staff in Ontario health units for providing the RPEP data.
• Bryna Warshawsky for reviewing the manuscript and presentation.
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• Sarah Morgan and Rajitha Liyanage for their work managing references.

PHO Grand Rounds – Tuesday April 21, 2015

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Animal Rabies Cases and RPEP Data, Ontario, 1958–2012

All RPEP administered using human diploid vaccine

Includes bat found in room when a person was sleeping unattended

Last human rabies case acquired in Ontario

MNR wildlife control