ORV STRATEGY USING RABORAL V-RG® FOR CONTROLLING RACOON RABIES

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Merial, A Sanofi Company
**RABORAL V-RG®: Product Description**

Produced by Merial Limited - Athens, Georgia

Two formats for wildlife species:

<table>
<thead>
<tr>
<th>Fishmeal polymer bait: fishmeal, tetracycline, polymer, compressed extruded block containing vaccine filled sachet – now white plastic sachet</th>
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<tr>
<td>Coated sachet: same vaccine-filled sachet covered in paraffin waxes plus fishmeal crumbles and cod liver oil</td>
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US Field Immunogenicity/Efficacy proven: Raccoons, Coyotes, Gray Foxes, testing in skunks

Excellent Vaccine Thermostability

Bait Thermostability – suitable for warm temperatures (<30 C) for 3-5 days; can last 2-3 weeks in the field under moderate temp (25-30 C)

ORV = oral rabies vaccine
RABORAL V-RG®

- A recombinant vaccinia virus expressing the rabies glycoprotein
- Only US licensed oral rabies vaccine for wildlife
  - Raccoon and coyote
- Licensed for red foxes in Europe
- Applied experimentally:
  - Gray foxes in Texas
  - Raccoons in Canada
  - Red fox, golden jackal in Israel
  - Raccoon dogs in South Korea
  - Skunks in Texas
US ORV history of success

ORV programs targeting wild raccoons implemented in the 1990s to prevent expansion of raccoon rabies variant

Raboral V-RG successes:

- Elimination of canine variant in Texas coyotes
- Nearing elimination of Texas gray fox variant
- Local elimination of raccoon variant transmission
- Prevention of westward expansion of raccoon variant
Wildlife rabies control and prevention

- Ultimate goal is preventing human rabies
  - Domestic animal vaccination barrier
  - Wildlife management and vaccination
  - Education

- Wildlife rabies management is expensive, but is also cost-effective
  - Reduced PEP costs
  - Reduced risks to human life

- ORV programs must be tailored to the target species demographics and ecology

- The type of ORV is very important but **how it is used is critical to success**
Wildlife rabies control

Product + Program + Perseverance (Funding)
Wildlife rabies control

Product + Program + Perseverance (Funding)

Product/vaccine characteristics:
- Safety in target species
- Safety in non-target species
- Duration of immunity
- Thermo-stability of vaccine
- Thermo-stability of bait matrix
- Attractant suitable for target species
- Shelf-life/Storage conditions/Handling in the field
- Flexibility of distribution – airplane, helicopter, vehicle, bicycle, hand
Wildlife rabies control

Product + Program + Perseverance (Funding)

Program characteristics:
- Pre-ORV epidemiology analysis
- Strategic goals – barrier, prevent spread, elimination, timeline
- Geographic barriers (mountains, rivers, roadways)
- Number of campaigns per year – resource management
- Bait density – Optimal number of doses to vaccinate sufficient number of target species over time
- Surveillance before and after ORV campaigns
- Communications of ORV campaigns to the public
- Distribution methods – one or multiple channels/bait uptake rates
- Quarantine of animal movements (translocation)
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Bait density vs. strategic goal

- Different strategic goals require different program structures:
  - Creating a barrier to entry
  - Preventing spread (containment)
  - Elimination
    - Decrease human exposure
    - Eliminate rabies variant locally/regionally
    - Eliminate rabies variant nationally

- Different strategic goals may also require different bait densities
  - Timelines
  - Resource stability
  - Political will
Vaccinating wildlife populations

- Effective vaccination of dynamic wildlife populations is challenging

Field data: Measures of success
- Bait uptake – biomarker
- Rabid animal reports (passive vs. active surveillance)
- Serology
Target species characteristics: Raccoon

- Understanding local raccoon ecology and demographics is important for ORV program design
  - Habitat use and behavior
  - Breeding cycle
  - Food sources and feeding habits
  - Population turnover – average age of adult
  - Population structure – juveniles vs. adults
  - Presence of non-target species
  - Population density
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<th>Goal</th>
<th>Bait Density</th>
<th>Years to Goal</th>
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# Bait density versus time to achieve strategic goal

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<td>420-712</td>
<td>Barrier</td>
<td>100/km²</td>
<td>10+ years, breached ($$)</td>
</tr>
<tr>
<td>Cape May, NJ (peninsula)</td>
<td>552 km²</td>
<td>Barrier</td>
<td>64/km²</td>
<td>3 yrs, discontinued</td>
</tr>
<tr>
<td>Ohio-Penn Border (mainland)</td>
<td>10-12k km²</td>
<td>Barrier</td>
<td>75-150/km²</td>
<td>On-going</td>
</tr>
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Case study: Long Island
Strategic goal - Elimination

- Rabid raccoons first detected 1993
- Epizootic in Nassau Co. by 2004

Long Island characteristics
- Highly populated, heterogenous landscape
- Raccoons primary susceptible species; no skunks

Early point-infection-control intervention unsuccessful
- Lower bait density used, less intensive effort

2006 – 2010 - intensive campaign to mitigate human health risks
- Higher-density baiting (target bait density = 250/km²)
- Multi-modal approach (helicopter and ground distribution)
- Biannual baiting – summer and fall to target juveniles

Specchio S. Feb 23, 2011. CU establishes a raccoon rabies-free zone in Long Island. Cornell Chronicle Online
Case study: Long Island

Case study: Long Island

- Post-baiting serology showed a steady increase in seroconversion
  - Within two years, ~30% seropositive (*at 0.5 IU/ml)
  - Concurrent decline in rabid raccoon reports
  - Raccoon variant eliminated from Long Island by 2011

- Intensive program economically viable if elimination is rapid
  - Similar findings in previous focal elimination campaigns
  - e.g. Anne Arundel Co., MD

- Maintenance of raccoon rabies free zone requires continued commitment to maintaining an ORV barrier
  - Loss of funding and political will can permit re-establishment of rabies
  - e.g. Cape Cod, MA; Cape May, NJ

### Bait density considerations summary

- Some ORV program elements are more malleable than others
  - Bait density can be adjusted to reach management goals

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<tr>
<th>Variable</th>
<th>Relationship to bait density</th>
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<tr>
<td>Raccoon density</td>
<td>Positive correlation – goal 1:1+</td>
</tr>
<tr>
<td># campaigns/year</td>
<td>Annual versus biannual</td>
</tr>
<tr>
<td></td>
<td>Timing related to breeding season/surveillance</td>
</tr>
<tr>
<td>Distribution method</td>
<td>Negatively correlated with degree of habitat targeting</td>
</tr>
<tr>
<td>Strategic goal</td>
<td>Negative correlation with time to reach goal</td>
</tr>
<tr>
<td></td>
<td><em>higher bait density for rapid elimination, focal area</em></td>
</tr>
<tr>
<td></td>
<td><em>lower bait density to hold barrier w/ natural barriers</em></td>
</tr>
<tr>
<td>Time to reach goal</td>
<td>Negatively correlated to baiting intensity</td>
</tr>
<tr>
<td></td>
<td><em>reduced program costs by achieving success faster</em></td>
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Key take-away points

- ORV programs have made strong contributions to rabies control and prevention
  - Successful elimination of canine rabies variant from the US
  - Reduction in wildlife virus variant circulation nationally
  - Created barrier to prevent raccoon variant expansion

- Bait density and program strategy are critical for success
  - Bait density must match target population, goals, and timelines
  - Appropriate bait density is species and landscape dependent

- Ultimate goal is to mitigate human health risks and to reduce rabies prevention costs
  - ORV is a cost-effective strategy
  - ORV success is jeopardized by insufficient long-term funding
Rabies Prevention – Three Layers of Protection

Family:
- Avoid dog/cat bites
- Proper care of bite wounds
  - Wash with soap/water
  - Seek medical advice

Domestic animals:
- Vaccinate dogs, cats, horses
- Vaccinate show livestock

Wildlife:
- Rabies does not always stay wild!
- Minimize pet food access
- Use gloves handling bats
- Report strange acting wildlife

*Rabies prevention is One Health in action!*
Acknowledgments

- MANY thanks to all of the partners at the state and national level who maintain wildlife rabies control programs in the face of budgetary restrictions and challenging circumstances
- Many thanks to Merial VPH for the opportunity to work on this very important topic

Working together, we can defeat rabies!
Thank you for your time and attention!

Questions? Comments?

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