Introduction

Rationale – Across the Americas, great horned owls are often presented to veterinarians for conditions that require pain management. While recent studies have evaluated the use of opioid drugs in raptor species 6,7, analgesic effects in owls have yet to be investigated.

Opioids: A group of drugs that causes analgesia by reversibly binding to four types of nervous system receptors: μ-opioid, δ-opioid, κ-opioid, & NOP. 6,7

- Hydromorphone: full μ-opioid agonist, morphine derivative with fewer side effects than morphine, commonly used in dogs and cats. 4
- Achieved significant thermal antinociception in American kestrels (Falco sparverius) for 6 hours at 0.1, 0.3, & 0.6mg/kg (compared to saline). 2

Hypothesis – Intramuscular administration of hydromorphone would cause a significant dose-dependent increase in the thermal foot withdrawal threshold in great horned owls and will provide analgesia for 3–6 hours.

Materials & Methods

Thermal Withdrawal Threshold – A measure of antinociception defined as the temperature at which the animal lifts its foot (a pain response).
- Thermal stimulus analgesiometry has been validated as reliable and ethical in many species. 3

Study Design – A randomized, blinded, and balanced complete crossover
- 6 adult great horned owls (1 male, 5 females)
- Treatments: Hydromorphone at 0.3 & 0.6mg/kg, saline
- Testing time points: baseline, 0.5, 1.5, 3, & 6 hours
- 7-day washout period between the three testing periods

Results

Thermal Antinociception – Baseline thermal withdrawal thresholds of all birds ranged from 55.8 to 61.8°C. Total standard deviation of the model was 1.9 °C. Compared to the control, the 0.6mg/kg dose resulted in significantly higher mean withdrawal thresholds from 0.5 hours (p=0.035) to 1.5 hours (p=0.001), while the 0.3mg/kg dose resulted in significantly higher mean withdrawal thresholds from 0.5 hours (p=0.001) to 3 hours (p=0.005) (Figure 1).

Table 1: Apetion-sedation scores, used to assess possible behavioral effects of hydromorphone treatment administered to great horned owls (Bubo virginianus).

<table>
<thead>
<tr>
<th>Sedation Score</th>
<th>Description</th>
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<tr>
<td>0</td>
<td>Owl remains still on perch, is calm, may look around but no panting</td>
</tr>
<tr>
<td>1</td>
<td>Owl reacts mildly to gentle taps on the glass in front of the box</td>
</tr>
<tr>
<td>2</td>
<td>Owl reacts mildly to loud taps on the glass in front of the box</td>
</tr>
<tr>
<td>3</td>
<td>Owl does not react to taps and only reacts when the back of the box is open</td>
</tr>
<tr>
<td>4</td>
<td>Owl is only responsive when touched</td>
</tr>
</tbody>
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Table 2: Proportional odds ratio of different hydromorphone doses compared to saline for increasing the sedation score by 1 (becoming more agitated).

<table>
<thead>
<tr>
<th>Treatment (mg/kg)</th>
<th>OR</th>
<th>95% CI</th>
<th>P Value</th>
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<tr>
<td>0.3</td>
<td>0.90</td>
<td>0.02–0.40</td>
<td>0.001</td>
</tr>
<tr>
<td>0.6</td>
<td>0.92</td>
<td>0.02–0.33</td>
<td>0.001</td>
</tr>
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</table>

Other Adverse Effects - No other adverse effects (e.g. vomiting, diarrhea) were associated with hydromorphone in this study other than two instances of tremoring (after administration of the 0.6mg/kg dose) that did not persist after the 0.5hr timepoint.

Discussion

- Hydromorphone hydrochloride administered IM at 0.3mg/kg and 0.6mg/kg was associated with significant changes in the thermal antinociception threshold, which is suggestive of analgesic effects
- These results are consistent with findings in American kestrels 2 and orange-winged Amazon parrots 10
- Hydromorphone caused significant sedation at 0.3 and 0.6mg/kg.
- Compared to saline, the 0.3mg/kg dose of hydromorphone resulted in a longer significant increase in thermal foot threshold than the 0.6mg/kg dose. It is likely that the 0.6mg/kg dose has a longer effect, but the small sample size of this study led to high variability, resulting in type II error. Further studies with a larger sample size are required to better characterize the dose-dependent effect of hydromorphone in these birds.
- As a non-releasable colony, all birds included in this study have previously suffered from injuries or ailments such as wing fractures and ocular disease. While we do not expect this medical history to have an impact on the thermal foot withdrawal threshold, further studies are required to assess the degree to which these historical conditions play a role.

Acknowledgements

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References

5. Guzman DSM, Drapeau EC, Olsen GH, Wilkie NH, Paul Murphy JR. Evaluation of thermal antinociceptive effects after intramuscular administration of hydromorphone hydrochloride to American kestrels (Falco sparverius). American Journal of Veterinary Research, 2013;74(5):875-882
8. Michalski CEG, Dynan DH, Grant Mace M. Effects of oxypronine and hydromorphone on the retention and subcutaneous concentration of isoflurane in dogs. Veterinary Anaesthesia and Anaesthesia 2006;33(2):70-77