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Cost-Effectiveness Analysis of Canine Heartworm Preventive Products

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COLLEGE OF POPULATION HEALTH

Cost-effectiveness analysis of canine heartworm preventive products

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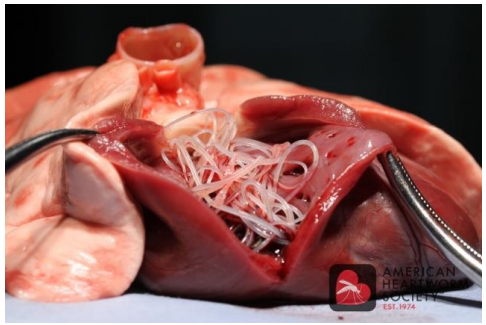
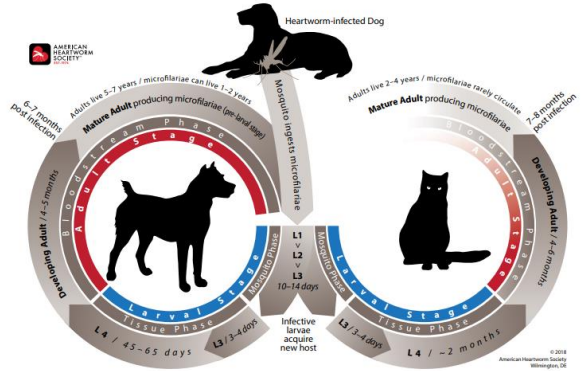
Canine heartworm disease is preventable!

Background: Heartworm Disease (HWD)

- Parasite: *Dirofilaria immitis*
- Transmission: mosquitoes
- Global Distribution
- Species: Dogs, cats, feral/wild animals, humans*
- Worm Lifespan: 5-7 years

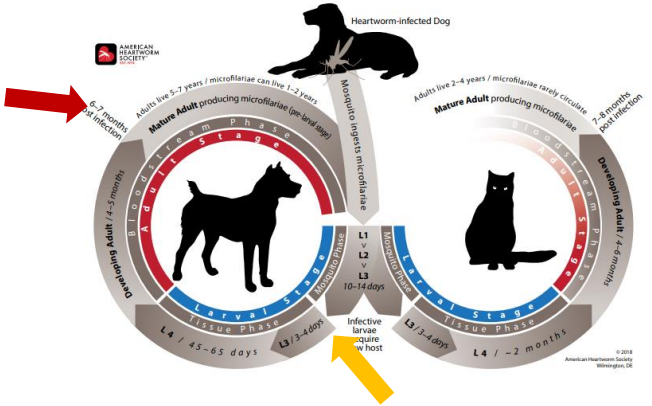


- Canine infection:
  - Infected by L3 stage
  - Pathology: cardiopulmonary damage
  - Disease severity: subclinical -> fatal



Fully preventable!

- Heartworm Preventives
  - Macrocyclic lactones
  - Prevent progression to disease, not parasitic infection
  - Recommendation: year-round, life-long
  - Start as early as 2 months of age
    - Test annually
      - Compliance
      - Product failure
- Mosquito repellent products (EPA)
- Mosquito abatement measures



Heartworm preventive product approval

- FDA approval: Center for Veterinary Medicine
  - Product safety & efficacy
    - Laboratory
    - Limited field
- Product “failure”:
  - Noncompliance*
  - Failure or resistance to active ingredient

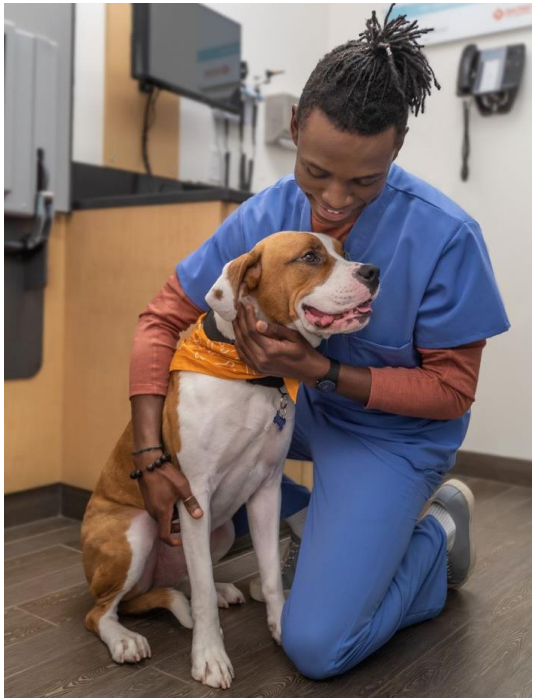
FDA
Center for
Veterinary Medicine

Treatment of HW Infection

- HW infection (HWI)
- Treatment is an option!
  - Adulticide – arsenic-based
  - Supportive medications
  - **Expensive!**
  - **Exercise restrictions > 6 months**
  - Alternative: “Slow kill”
- **Adverse events** – emergency!
- May have residual pathology

Overview: Banfield® Pet Hospital

- >1,080 primary care companion animal veterinary hospitals
- High-volume: 2022
  - Over 2.9M dogs and 0.6M cats
  - > 9M visits
- Preventive care: Since 1980's
- PMRI (Petware®) → centralized DW
  - Since mid-1990s

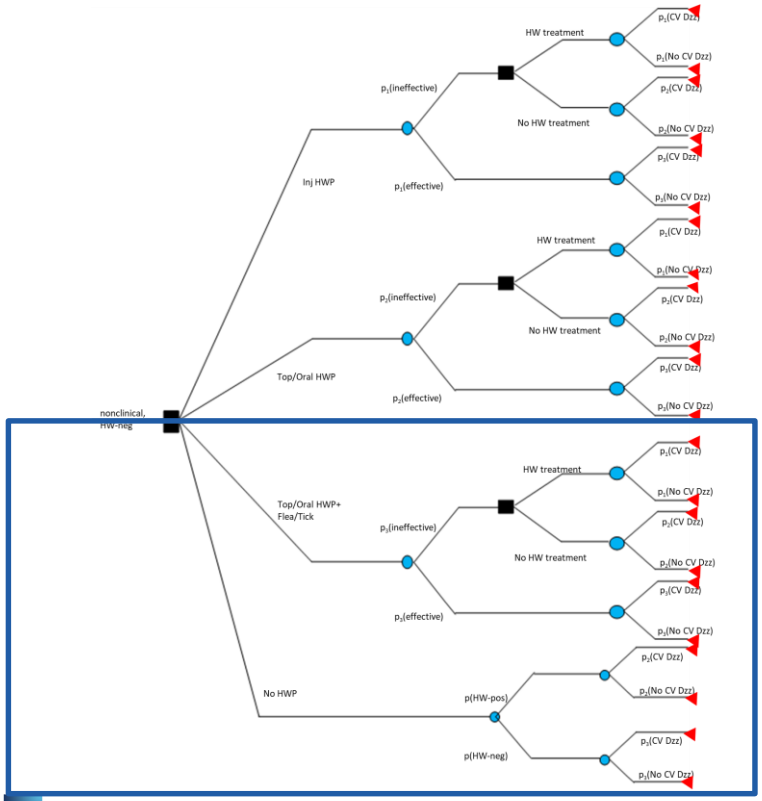


Why CEA on Canine HWP products

- MANY HWP products available
  - ≥10 products in Banfield formulary
  - Hospital pharmacy shelf space, COGs
- CEA is not established in companion animal medicine space
  - Formulary reconsiderations?
  - Improper recommendations?
  - Reasonable owner cost?

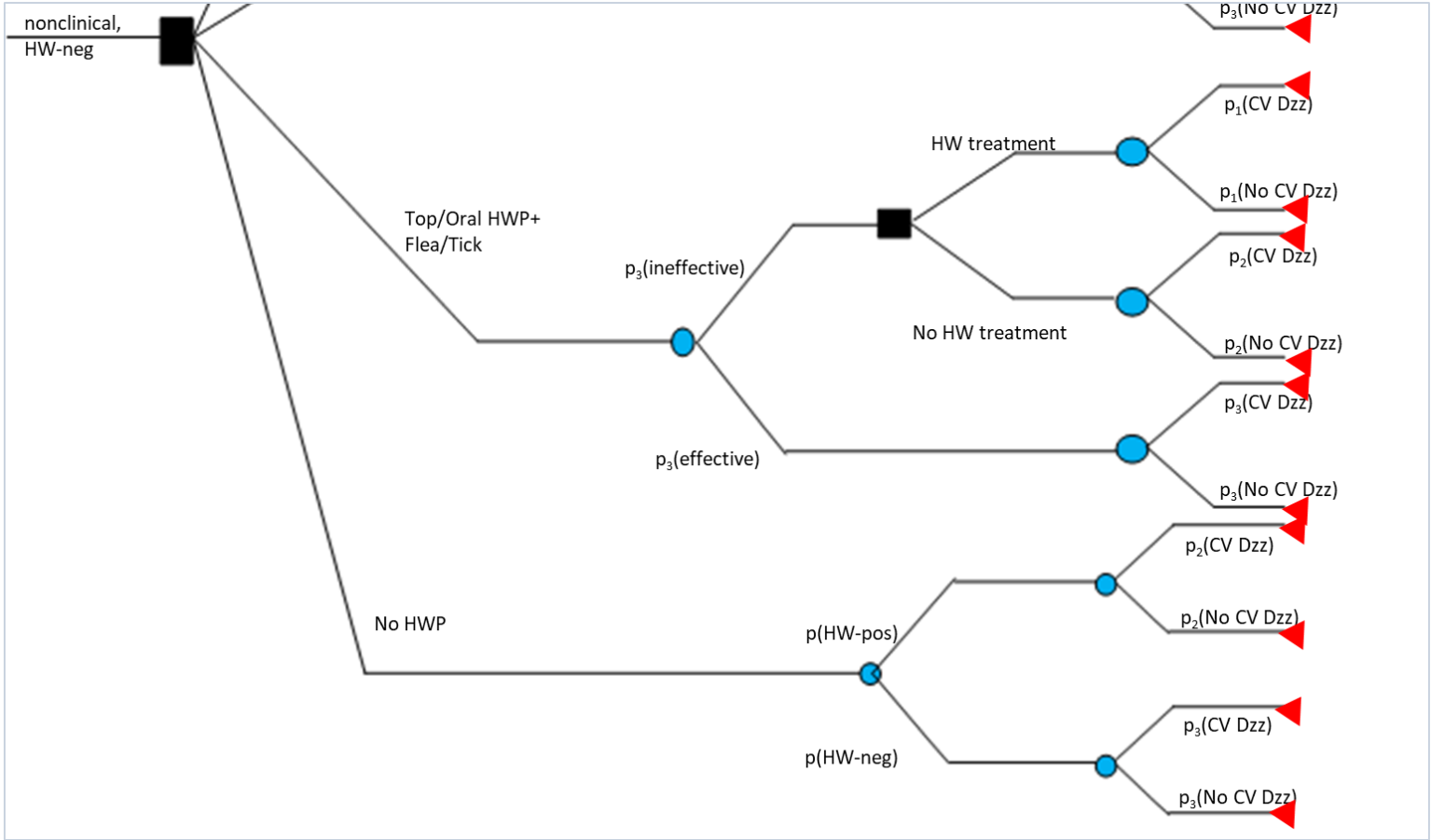
Is there difference in cost-effectiveness in HWP, based on route of administration, compared to no HWP?

Decision Tree



- Rationale for approach
- Lifetime cost to owner for HW

- Data sources:
  - Costs, probabilities: Banfield data (2005 to present)
    - CV treatment time: Bogarelli et al.
    - Owner cost of treatment: direct & indirect
      - Direct: diagnostics, treatment, hosp. fees
      - Indirect: hourly salary (tradingeconomics.com, fed. min. wage, ziprecruiter.com)
  - Outcome: Years-of-life lost (YLL)
    - Expert Opinion


nonclinical,
HW-neg
Top/Oral HWP+
Flea/Tick
No HWP
p3(ineffective)
p3(effective)
HW treatment
No HW treatment
p(HW-pos)
p(HW-neg)
p1(CV Dzz)
p1(No CV Dzz)
p2(CV Dzz)
p2(No CV Dzz)
p3(CV Dzz)
p3(No CV Dzz)
p2(CV Dzz)
p2(No CV Dzz)
p3(CV Dzz)
p3(No CV Dzz)

Model Assumptions

- Models for national canine population –
  - Ignore pet age or size
  - Uniform risk across country
  - Ignore disease severity – most subclinical
- Banfield canine patient population = representative of national population
  - **If on HWP, decision to treat HWI: 100%**
  - **Product ineffectiveness/breakthrough infection rate**
  - **Risk of infection if not on HWP**
  - Treatment for all HW-related and cardiac management at Banfield – not external
- Potential for infection = once in pet's life
- Intention-to-treat (HWP, adulticide) – ignore temporal coverage
- Owner not change decision to put on HWP during pet's life
  - Can change HWP any time after the 1st year
  - If HW+ not get adulticide, pet will be kept on a HWP ("slow kill") for remainder of life
- Adulticide treatment course 100% effective
  - No death while under treatment

Model parameters (Banfield data)

Probability	Estimate
Ineffective – Inj. HWP	0.04%
Ineffective – top/oral HWP only	0.22%
Ineffective – top/oral HWP/F/T	0.09%
Infection – no HWP	2.19%
CV disease – HW+ treated	4.79%
CV disease – HW+ untreated	6.00%
CV disease – never HW+	4.00%

Owner cost	Average (Range)
Inj. HWP (annual)	$110 ($12-$471)
Top/oral HWP only (annual)	$77 ($6-$586)
Top/oral HWP/F/T (annual)	$211 ($1-$980)
Direct Cost (HW treatment)	$3,389 ($148-22,000)
Indirect cost (HW treatment)	$113 ($29-$212)

Model parameters (Banfield, other sources)

Lifetime Cost (HWP, year 2+)	Average (Range)
CV disease – HW+ treated	$724 ($4-7,888)
No CV disease – HW+ treated	$714 ($0-15,904)
CV disease, HW+ untreated	$858 ($2-14,385)
No CV disease, HW+ untreated	$786 ($0-17,894)
CV disease – never HW+	$987 ($6-12,014)
No CV disease – never HW+	$818 ($8-10,652)

Lifetime Cost	Average (Range)
CV disease – HW+ treated	$917 ($0-40,880)
CV disease – HW+ untreated	$308 ($0-6,101)
CV disease – never HW+	$282 ($0-55,117)

Years-of-Life Lost	Average (Range)
CV disease – HW+ treated or never HW+	2 yrs (1-4)
No CV disease – HW+ treated or never HW+	0
CV disease – HW+ untreated	7 yrs (2-10)
No CV disease – HW+ untreated	5.5 (0-9)

CEA Model results

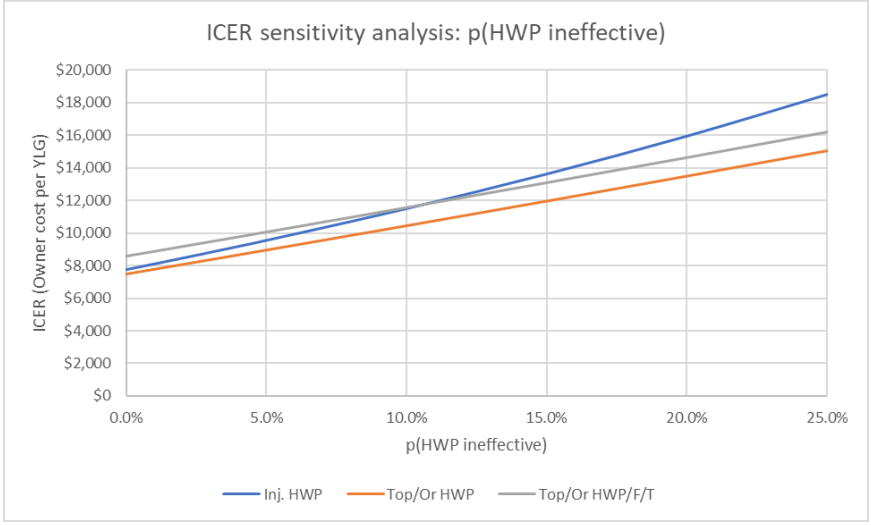
	Injectable HWP		Top/Oral HWP		Top/Oral HWP/F/T		No HWP* (comparator)
p(HW-pos treated)	100%	0%	100%	0%	100%	0%	0%
Expected Cost (USD)	$947	$945	$920	$910	$1,050	$1,046	$11
Expected Outcome (YLL)	0.08004	0.08000	0.08004	0.07982	0.08001	0.07993	0.20067
C-E	$11,828	$11,812	$11,494	$11,405	$13,127	$13,090	$57
ICER* (USD/YLG)	$7,753	$7,736	$7,531	$7,439	$8,610	$8,571	-

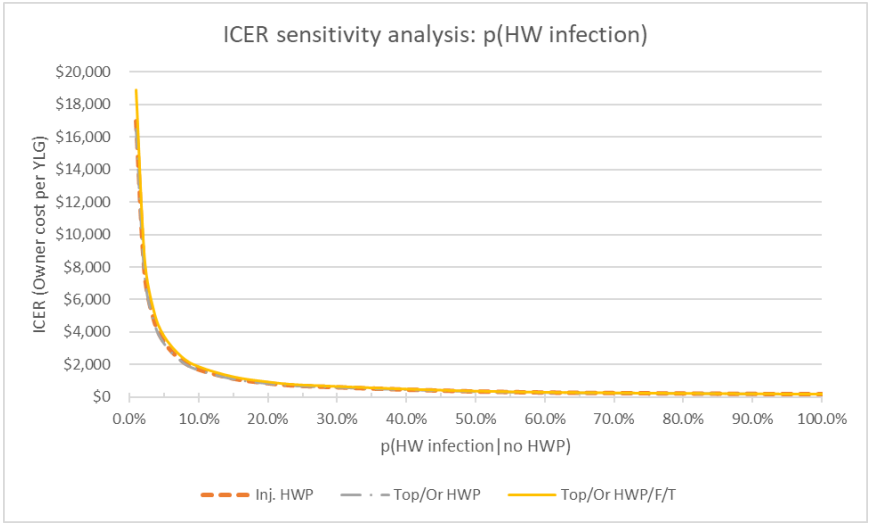
CEA Model: Sensitivity analysis #2

	Injectable HWP		Top/Oral HWP		Top/Oral HWP/F/T		No HWP* (comparator)
p(ineffective)	0.04%	25x (1.00%)	0.22%	25x (5.50%)	0.09%	25x (2.25%)	
Expected Cost (USD)	$947	$980	$920	$1,101	$1,050	$1,124	$11
Expected Outcome (YLL)	0.08004	0.08100	0.08004	0.08087	0.08001	0.08036	0.20067
C-E	$11,828	$12,100	$11,494	$13,612	$13,127	$13,992	$57
ICER* (USD/YLG)	$7,753	$8,087	$7,531	$9,093	$8,610	$9,250	-

Assume: 100% HW+ treatment for cleaner presentation purposes

CEA Model - Sensitivity analyses (cont'd)





The good news

- HWP type: No great impact on expected cost & outcome
  - Very low rates of ineffectiveness/"breakthrough"
  - Cardiac disease occur at low rate (<5%)
  - Outcome (years of life gained) low for each branch
    - Compared to no HWP, see difference of ~0.12 year (1.4 mos.)
    - Expert opinion-based
    - Note: 1 year of dog life ≠ 1 year of human life

No substantial differences, but…

- Comparison based on administration route:
  - Large # oral/topical SKUs vs 2 injectable SKUs
  - Charging differences: package vs volume
  - HWP only vs HWP/F/T products
- ITT (year-round coverage) assumption
- Externalities

- Other limitations:
  - Veterinary clinical research
  - Decision to clear infection
  - Pet death while under adulticide treatment
  - Additional costs
  - Paucity of validated outcome measures/instruments in companion animal medicine

Summary

- ICERs high ($7.5-8.6K per YLG)
  - No obvious difference in outcome based on administration route
  - WTP? What is value of pet's life?
    - Pets => family member
- Proof of concept project
  - Identification of potential future direction/further refinement → Compare specific products for formulary reviews, data specifications, other model parameters

- ✓ Improper products?
- ✓ Improper recommendations?
- ✓ Reasonable cost?

Thank you, Drs. Won Lee and Vittorio Maio!

Questions?

Jefferson

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