Antimicrobial Resistance in Companion Animals
What’s Hot and What’s the Risk?

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# U.S. Pet Ownership

- **Dogs**: 70,000,000
d- **Cats**: 74,100,000

<table>
<thead>
<tr>
<th></th>
<th>Dogs</th>
<th>Cats</th>
<th>Birds</th>
<th>Horses</th>
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<tbody>
<tr>
<td>Percent of households</td>
<td>37.2%</td>
<td>32.4%</td>
<td>3.9%</td>
<td>1.8%</td>
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<tr>
<td>Average number per household</td>
<td>1.7</td>
<td>2.2</td>
<td>2.5</td>
<td>3.5</td>
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63.2% of pet owners consider their pets to be family members

[American Veterinary Medical Association, 2007](#)
[NC State University](#)
The Changing Relationship Between Owners and Pets

% of Respondents

- Keeps dog(s) in house
- Allows dog(s) to lick hands
- Allows dog(s) to lick face
- Washes dog in same tub
- Allows dog(s) on sofa
- Allows dog(s) in bed

N = 108; Dog show participants

Walther et al., 2012
U.S. Pets and TheirVeterinarians

• **Dog** owners average **2.6** visits to their veterinarian each year
  – Average $356
• **Cat** owners average **1.7** visits to their veterinarian each year
  – Average $190
• Most common infections
  – Skin (and ear) infections
  – Urinary tract infections
  – Wound infections
  – Respiratory tract infections
• Antibacterial drugs are also used prophylactically to prevent infections prior to surgery
Use of antibiotics in companion animals

- There is no central registry or survey data to described which medications are used most often
- **Baker et al., 2012**
  - 435 dogs enrolled after admission to a teaching hospital
  - 55.6% had received at least one antimicrobial in the previous 12 month
    - β-lactams (72.7%)
      - Cephalexin
    - Aminoglycoside (32.2%)
      - Neomycin
      - Gentamicin
    - Quinolone (23.1%)
      - Enrofloxacin
  - Dose, route, duration were not well documented in medical records
Monitoring Resistance in Companion Animals

- National monitoring programs for development of antimicrobial resistance in animals generally do not include companion animals

- Where is the data being generated?
  - State veterinary diagnostic laboratories
  - Commercial laboratories
  - Teaching hospital laboratories*
Antibiotic Resistant Organisms

• The most common organisms developing resistance in companion animals (dogs, cats, horses)
  – *E. coli*
  – *P. aeruginosa*
  – *Enterococci*
  – *Staphylococcus* species (incl. MRSA)

• Hot topics at NCSU VHC
  – Methicillin-resistant *S. pseudintermedius*
  – ESBL-producing *Klebsiella* and *E. coli*
Methicillin-Resistant *Staphylococci*

- Methicillin (oxacillin) resistance confers resistance to
  - Pencillins
  - β-lactam/β-lactamase inhibitor combinations
  - Antistaphylococcal cephems
  - Carbapenems
- Mediated by the *mecA* gene and PBP2a protein
- Occurs in multiple staphylococcal species
  - *S. aureus* (MRSA)
  - *S. pseudintermedius* (MRSP)
Methicillin-Resistant *Staphylococci*

- *S. pseudintermedius* is the predominant *Staphylococci* of dogs
  - 20-90% of healthy canine skin/mucous membranes
  - Most common cause of skin infections
  - Cats can be colonized; less frequent

**Micky; 4 year old FS pug**

Previously responded to Cephalexin; Clavamox
Now failing to respond to Cefpodoxime
Methicillin-Resistant *S. pseudintermedius*

- Pinchbeck et al. (2006)
  - Results suggest most *S. pseudintermedius* strains associated with pyoderma are endogenous

- MRSP carriage can last more than one year after clinical infection is “cleared”

- Concurrent resistance to other antimicrobial classes is common
  - Bryan et al. (2012) suggest the majority of pyoderma cases resolve regardless of methicillin susceptibility
MRSP Resistance to Other Antimicrobial Classes

N=67 MRSP isolated from canines at NCSU-CVM June-November
Zoonotic Transmission

• Zoonotic transmission of *S. pseudintermedius* has been documented
  – Owning a dog is a significant risk factor
    • Especially if it has dermatitis

• Microorganisms residing on the skin or mucosal surfaces are the most likely to be transmitted
  – Sharing environments (bed; sofas; bath tubs)

• The reverse is also true!
  – *S. aureus*
Zoonotic Transmission?

- Keeps dog(s) in house: 90%
- Allows dog(s) to lick hands: 100%
- Allows dog(s) to lick face: 70%
- Washes dog in same tub: 40%
- Allows dog(s) on sofa: 60%
- Allows dog(s) in bed: 30%

N = 108; Dog show participants

Walther et al., 2012
What are we Sharing?

**S. aureus** in **18.5%** of owners; **1.8%** of dogs
None simultaneously
Dog isolates were genetically similar to human lineage

**S. pseudintermedius** in **5.6%** of owners; **13.9%** of dogs
One owner did have a MRSP
Owners with > 2 dogs, higher risk of colonization
None of the other risk factors were statistically significant

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Extended Spectrum Beta-Lactamases (ESBL)

- **ESBL**’s are enzymes mediating resistance to all penicillins and cephalosporins
- *Enterobacteriaceae* can produced ESBL’s
  - *E. coli, Klebsiella, Proteus*
  - Originally observed in HA infections from human hospitals
  - Emergence of these resistant organisms in community strains threatens effective therapy for all Gram negative infections
    - Plasmid associated
    - Associated with resistance to aminoglycosides and TMS
- Little description of these isolates in companion animals
  - Increasingly recognized in food animals
At NCSU VHC

• Presumptive ESBL organisms are identified based on initial susceptibility to cefpodoxime
  – Confirmatory E-test is used prior to notifying clinicians
  – The specific resistance mechanisms are not being evaluated at this time

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<tr>
<td><em>E. coli</em></td>
<td>9</td>
<td>3</td>
<td>2</td>
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<tr>
<td><em>Klebsiella</em></td>
<td>10</td>
<td>0</td>
<td>1</td>
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Isolates from nasal swabs, corneas, wounds, urine
Enterococcus

• Normal inhabitants of the GI tract
  – Not typically associated with severe disease in companion animals
    • Commonly found in UTIs
    • Nosocomial complications
      – Often found in the presence of another pathogen
• Resistance is widespread and of public health importance
  – Resistance develops rapidly
  – Resistance genes are readily shared with other organisms
• Use clinical judgment to decide if this organism is significant prior to treatment
Psuedomonas aeruginosa

• Predominantly associated with skin and ear infections
  – Evidence for increasing resistance to fluoroquinolones in otitis externa cases
  – Rubin et al. (2008)
    • ~30% resistant to fluoroquinolones
    • 10-90% resistance to aminoglycosides
    • Resistance to tetracycline, sulphonamides, and chloramphenicol remain high (>75%)
Conclusions

• Companion animals are reservoirs for antimicrobial resistant organisms
• We may be under-recognizing their potential contribution to populations of antimicrobial resistant organisms
  – Their association with human health is still unclear
• Work is needed to better describe the relationship between resistant microorganisms in humans and their pets
  – Potential collaboration and a one health approach
Questions?