SOIL-TRANSMITTED HELMINTHES: A TRIAD OF WORMS, ANIMALS, & HUMANS

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Introduction

BS Agriculture Kansas State University 1986

DVM Kansas State University 1989

Practiced in Amarillo, TX and Olathe, KS
Scientists Make a Gross Discovery After Examining the Body of Richard III Found Under a Parking Lot

Sep. 4, 2013 7:26am | Associated Press

LONDON (AP) — Not only was Richard III, the hunchback king, probably infected with parasitic worms that grew up to a foot in length. Credit: University of Leicester

3, 2013. The remains of England's King Richard III which were found in a dig in Leicester England in Sept 2012. Not only was Richard III one of England's most reviled monarchs, but it now turns out the hunchback king was probably infected with parasitic worms that grew up to a foot in length. Credit: University of Leicester
“The bare mention of the question will make those of you with nosogeographical interests--or, better, helminthogeographical interests--warily scratch a mental ear and mull over a remark that ends ‘where angels fear to tread.’”

Norman R. Stoll, This Wormy World
Basic Definitions

- **ZP**—zoonotic parasitism
- **Zoonosis**—disease transmitted between humans & animals
- **Parasitism**—non-mutual symbiotic relationship
- **Soil-transmitted helminthes (STH)**—parasites whose infectious stages are found in contaminated soil
Zoonotic STH’s—A Triad

- Humans
- Animals
- Worms
“Parasitic infections affect millions around the world causing seizures, blindness, infertility, heart failure, and even death. They’re more common in the US than people realize and yet there is so much we don’t know about them. We need research to learn more about these infections and action to better prevent and treat them.”

Tom Frieden, MD, MPH - Director of the Centers for Disease Control and Prevention
Neglected Parasitic Infections in the United States

Parasitic infections are a global public health problem and often affect the poorest people in low-income countries. However, US residents may also acquire parasitic infections in the United States, in their country of origin, or during international travel. The Centers for Disease Control and Prevention (CDC) has prioritized 5 parasitic infections for public health action in the United States: Chagas disease, cysticercosis, toxocariasis, toxoplasmosis, and trichomoniasis. Referred to as the "neglected parasitic infections (NPIs) in the United States," these infections share common characteristics in that they affect large numbers of people and are often underrecognized, and preventive or curative interventions are often lacking.

Image from Dreamstime / CDC / Wikimedia Commons
<table>
<thead>
<tr>
<th>DOGS</th>
<th>CATS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helminths</strong></td>
<td><strong>Helminths</strong></td>
</tr>
<tr>
<td><strong>Nematodes</strong></td>
<td><strong>Nematodes</strong></td>
</tr>
<tr>
<td>Toxocara canis</td>
<td>Toxocara cati</td>
</tr>
<tr>
<td>Ancylostoma caninum</td>
<td>Ancylostoma tubaeforme</td>
</tr>
<tr>
<td>Ancylostoma braziliense</td>
<td>Ancylostoma braziliense</td>
</tr>
<tr>
<td><strong>Cestodes</strong></td>
<td><strong>Cestodes</strong></td>
</tr>
<tr>
<td>Dipylidium caninum</td>
<td>Dipylidium caninum</td>
</tr>
<tr>
<td>Echinococcus multilocularis</td>
<td>Echinococcus multilocularis</td>
</tr>
<tr>
<td>Echinococcus granulosus</td>
<td></td>
</tr>
<tr>
<td>Taenia serialis</td>
<td></td>
</tr>
<tr>
<td>Taenia multiceps</td>
<td></td>
</tr>
<tr>
<td><strong>Protozoa</strong></td>
<td><strong>Protozoa</strong></td>
</tr>
<tr>
<td>Giardia duodenalis (intestinalis)</td>
<td>Giardia duodenalis (intestinalis)</td>
</tr>
<tr>
<td>Cryptosporidium canis</td>
<td>Cryptosporidium felis</td>
</tr>
<tr>
<td></td>
<td>Toxoplasma gondii</td>
</tr>
</tbody>
</table>

This partial list of parasitic infections in dogs or cats omits some zoonotic parasites adapted to other mammalian hosts that occasionally and facultatively infect dogs or cats (e.g., Baylisascaris procyonis, a common intestinal helminth of raccoons that occasionally infects dogs).

Table 1: Gastrointestinal Parasitic Infections in Dogs and Cats in North America That Are Transmissible to People
Peter M. Schantz, VMD, PhD

NHANES III—1988-1994

Toxocara seroprevalence by age and race/ethnicity
NHANES III

Almost 14% of the U.S. population has been exposed to the parasite.


Congdon and Lloyd, 2011.
Fig. 2 Estimated county infection rates (percents for females), United States, 1988–1994.
Fig. 1 Estimated county infection rates (percent for males), United States, 1988–1994.

Congdon and Lloyd, 2011.
Ascarids/Roundworms
Ascarids/Roundworms
Transmission and Exposure Risks

- Exposure due to pets and pet-related hygiene behaviors
Transmission and Exposure Risks

• Exposure due to wildlife and free-ranging dogs
Transmission and Exposure Risks

• Exposure due to contaminated food
Transmission and Exposure Risks

- Exposure due to human factors
  - Immunosuppression
  - Poverty
  - Housing & sanitation
  - Low education
  - High soil exposure
  - Local food habits
Children at Risk

• Pica: “the craving to eat nonfood items, such as dirt, paint chips, and clay.”

• Soil-ingestion (geophagia): “the consumption of soil resulting from various behaviors, including, but not limited to, mouthing objects or dirty hands, eating dropped food, and intentionally consuming soil.”

CDC
Ascarids/Roundworms

Transmission and Exposure Risks

NEGLECTED PARASITIC INFECTION:

Toxocariasis

Each year in the United States at least 70 people are blinded by the parasite that causes toxocariasis; most of them are children.

Learn more: www.cdc.gov/parasites/npi/
Ascarids/Roundworms

“Nonetheless, the substantial rates of *T. canis* infection in children that we and others have observed suggest that unrecognized childhood *T. canis* infections, if associated with adverse health or neuropsychological effects, may constitute an important public health problem.”

Marmor, et al.
Ancylostamids/Hookworms
Ancylostama/Hookworms

1. Eggs in feces
2. Rhabditiform larva hatches
3. Rhabditiform larva develops into filariform larva in the environment
4. Infection occurs in the environment
5. Adults in small intestine
6. CDC logo with website link: http://www.dpd.cdc.gov/dpdx

Symbols:
- ▲ = Infective Stage
- ▲ = Diagnostic Stage

Diagram illustrates the lifecycle of Ancylostama/Hookworms from eggs in feces, through larval stages, to adults in the small intestine.
Internship

• Lawrence-Douglas County Health Department (LDCHD) in Lawrence, Kansas
• Summer/Fall 2013

  • *Are public spaces contaminated with dog feces?*

  • *Do pets have parasites?*

• Surveys/fecal exams
Internship
Lawrence, Kansas Data

- Fecal Collection
- Veterinary Information
# Fecal Samples—Selected Areas

<table>
<thead>
<tr>
<th>Setting</th>
<th>Sample</th>
<th>Parasites</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer's Market</td>
<td>Dessicated/decomposing</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d/d</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d/d</td>
<td>n/a</td>
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</table>
## Fecal Samples—Selected Areas

<table>
<thead>
<tr>
<th>Setting</th>
<th>Sample</th>
<th>Parasites</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>Walnut</td>
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</tr>
<tr>
<td></td>
<td>d/d</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d/d</td>
<td>n/a</td>
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<tr>
<td>John Taylor</td>
<td>d/d</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d/d</td>
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<tr>
<td></td>
<td>d/d</td>
<td>n/a</td>
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</tr>
<tr>
<td>Brook Creek</td>
<td>d/d</td>
<td>n/a</td>
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<tr>
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<td>d/d</td>
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<td>d/d</td>
<td>n/a</td>
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<tr>
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<td>d/d</td>
<td>n/a</td>
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<tr>
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<td>d/d</td>
<td>n/a</td>
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</table>
# Fecal Samples—Selected Populations

<table>
<thead>
<tr>
<th>Setting</th>
<th>Dog</th>
<th>Sex</th>
<th>Age (Yrs)</th>
<th>Parasites</th>
<th>Type</th>
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<tbody>
<tr>
<td>Senior</td>
<td>Cookie</td>
<td>F</td>
<td>1-5</td>
<td>Y</td>
<td>3+ Ancylostoma, 3+ Eimeria</td>
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<tr>
<td></td>
<td>Hera</td>
<td>FS</td>
<td>&gt;10</td>
<td>N</td>
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</tr>
<tr>
<td></td>
<td>Jill</td>
<td>FS</td>
<td>6-10</td>
<td>N</td>
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<td></td>
<td>Millie</td>
<td>FS</td>
<td>6-10</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bailey</td>
<td>FS</td>
<td>1-5</td>
<td>N</td>
<td></td>
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<tr>
<td></td>
<td>Bella</td>
<td>FS</td>
<td>1-5</td>
<td>N</td>
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</tr>
<tr>
<td>Childcare</td>
<td>Sheridan</td>
<td>FS</td>
<td>1-5</td>
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<tr>
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<td>Hagan</td>
<td>FS</td>
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<td>Lucy</td>
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<td>Zoey</td>
<td>FS</td>
<td>1-5</td>
<td>N</td>
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<tr>
<td></td>
<td>Zoey</td>
<td>FS</td>
<td>6-10</td>
<td>N</td>
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<tr>
<td></td>
<td>Frieda</td>
<td>FS</td>
<td>6-10</td>
<td>Y</td>
<td>1+ Paragonimus</td>
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## Fecal Samples—Selected Areas

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<thead>
<tr>
<th>Prairie Park</th>
<th>Fresh</th>
<th>N</th>
<th>Fresh</th>
<th>Y</th>
<th>1+ Ancylostoma</th>
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</thead>
<tbody>
<tr>
<td>Fresh</td>
<td></td>
<td></td>
<td>Fresh</td>
<td>Y</td>
<td>1+ Ancylostoma</td>
</tr>
<tr>
<td>Fresh</td>
<td></td>
<td></td>
<td>Fresh</td>
<td>N</td>
<td></td>
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<tr>
<td>Fresh</td>
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<td>Fresh</td>
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<td></td>
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<tr>
<td>Fresh</td>
<td></td>
<td></td>
<td>Fresh</td>
<td>Y</td>
<td>1+ Isospora</td>
</tr>
<tr>
<td>Fresh</td>
<td></td>
<td></td>
<td>Fresh</td>
<td>Y</td>
<td>1+ Isospora</td>
</tr>
</tbody>
</table>

*Note: The table represents the results of fecal samples from different areas, indicating the presence or absence of specific parasites.*
## Fecal Samples—Selected Areas

<table>
<thead>
<tr>
<th>Location</th>
<th>Condition</th>
<th>Toxocara</th>
<th>Trichuris, Ancylostoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naismith Valley Park</td>
<td>Fresh</td>
<td>N</td>
<td>4+ 2+</td>
</tr>
<tr>
<td></td>
<td>Fresh</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Fresh</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fresh</td>
<td>Y</td>
<td>4+ Toxocara, 2+ Trichuris, 2+ Ancylostoma</td>
</tr>
<tr>
<td>Riverfront</td>
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<td>N</td>
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</tr>
<tr>
<td></td>
<td>Fresh</td>
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<td></td>
</tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>Fresh</td>
<td>Y</td>
<td>1+ Toxocara</td>
</tr>
</tbody>
</table>
Fecal Samples—Selected Areas

• All parks were contaminated

• Dog owners less likely to clean up pet stool in “nature parks”

• “Nature parks” do not have posted rules or pick-up stations like dog parks
## Fecal Samples—Selected Populations

<table>
<thead>
<tr>
<th>Setting</th>
<th>Dog</th>
<th>Sex</th>
<th>Age (Yrs)</th>
<th>Parasites</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doggy Daycare</td>
<td>Pablo</td>
<td>N</td>
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<td></td>
<td>Molly</td>
<td>N</td>
<td></td>
<td>N</td>
<td></td>
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<tr>
<td></td>
<td>Zoey</td>
<td>Y</td>
<td>1-5</td>
<td>N</td>
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</tr>
<tr>
<td></td>
<td>Kirby</td>
<td>MN</td>
<td>1-5</td>
<td>N</td>
<td></td>
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<tr>
<td></td>
<td>Luna</td>
<td></td>
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<td>N</td>
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</tr>
<tr>
<td></td>
<td>Reba</td>
<td></td>
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<td>Annabelle</td>
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<td>Minnie</td>
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<td>Rico</td>
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<td>Digby</td>
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## Fecal Samples—Selected Populations

<table>
<thead>
<tr>
<th>Setting</th>
<th>Dog</th>
<th>Sex</th>
<th>Age (Yrs)</th>
<th>Parasites</th>
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<tbody>
<tr>
<td>MuttRun</td>
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<td>Sophie</td>
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<td>Katie</td>
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<td></td>
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<tr>
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<td>Socrates</td>
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<td>Abby</td>
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<td>Y</td>
<td>1+ Isospora</td>
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<td>Tashama</td>
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<td>Baxter</td>
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<td>Gracie</td>
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<td>Sam</td>
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<td></td>
<td>Bella</td>
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<td>N</td>
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</tr>
<tr>
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<td>Beatrice</td>
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</table>
Fecal Samples—Selected Populations

Routine veterinary care + Routine heartworm preventative

Less parasitism

It’s not rocket science!
# Interviews with Veterinarians

<table>
<thead>
<tr>
<th>Facility</th>
<th>Year</th>
<th># Tests</th>
<th># Positive for parasites</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Hospital of Lawrence</td>
<td>2012</td>
<td>616</td>
<td>39+ for rounds/hooks/or both</td>
<td>book</td>
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* Computerized records of results of individual tests not readily accessible.
NR--no response
Interviews with Veterinarians

- Roundworms/Hookworms/Both: 6-15%

- Recordkeeping
  - Written
  - Computerized

- Hard to access data
Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

Q12 Are you aware that some parasites will infect humans as well as dogs?

Answered: 35  Skipped: 0
Q13 How concerned are you that you or your family may be infected by parasites from your dog?

Answered: 35  Skipped: 0
Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

Q5 Do you wash your hands after contact with your pet?

Answered: 35  Skipped: 0

- Rarely
- Everytime
- Frequently
- Sometimes
Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

Q7 How often does your dog sleep in your bed (or a family member's)?

Answered: 34  Skipped: 1
Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

Q8 How often do you scoop your dog's feces in your yard?

Answered: 35  Skipped: 0
Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

Q17 How often do you give heartworm preventive medication to your dog?

Answered: 35   Skipped: 0
Barriers to Addressing ZP

“I was thinking of installing one of those automatic garage door openers over the weekend. The directions say ‘make certain the garage door is square and straight and the garage floor is level.’ Directions always read like that. Is everything in your [house] straight, square and level? If my house was straight, square and level, I would never have to fix anything. What we all need are directions that tell us what to do when everything is crooked, off-center and all screwed up.”

Andy Rooney

“Wicked Problems”

- “Wicked Problem”—a term coined by urban planners at UC-Berkley in 1973
- Are complex => difficult to define clearly
- Are constantly changing
- Have multi-causal natures
- Lead to conflicting goals
- Involve social & individual behaviors

Misconceptions about STH’s

• Worms are not present if you do not see them (?!)

• ZP is only a problem in tropical climates

• Easily-controlled means well-controlled
Lack of Awareness

• Human healthcare providers:
  • Many do not ask about pet ownership—78-90%
  • May not make understanding zoonotic diseases a priority in practice
  • May not live in same community as patients
  • May not understand culture of their patients

Barton, 2013; Stull et al. 2012.
Lack of Quantitative Facts

• Collecting information
  • Different agencies for animals & humans
  • Different testing methods
  • Rare (?) diseases do not get priority
  • Different communities get different priorities

• Understanding information
  • Common metrics may not be useful *
  • Confounding factors **

** Torgerson and Macpherson, 2011.
Diverse Views

• Is ZP relevant?
  • NHANES III showed 13.9% *Toxocara* seroprevalence
  • Health, social & economic effects **
  • Biases lead to under-reporting ***

• Different goals:
  • Human healthcare
  • Veterinary profession
  • Agricultural authorities

* Hotez and Wilkins, 2009.
** Torgerson and Macpherson, 2011.
*** Hotez et al. 2008.
Lack of Communication

• Patient/Client
  ➔
• Physician
  ➔
• Veterinarian
People and pets

Summary points

Over 90% of pet owners regard their pet as a valued family member

Reluctance to part with a pet may lead to non-compliance with health advice

Pets may be of particular value to older people and patients recovering from major illness

The death of a pet may cause great distress to owners, especially when the pet has associations with a deceased spouse or former lifestyle

Many people would welcome advice and support to enable them to reconcile or manage pet ownership and health problems whenever possible

ZP is a “Wicked Problem”

- Paradox of disease control
  - Successful interventions => decreased attention
  - Parasitism receives <1% of global research funding
- Changing environments
  - Climate
  - Urban wildlife
- Priority given to unrelated (?) issues
  - Chronic diseases vs. infectious diseases
  - Social issues
  - Government policies

Hotez et al. 2008.
ZP is a “Wicked Problem”

Neglected Zoonotic Diseases?

Or

“Diseases of Neglected Populations?”

Doble and Fevre, 2010.
Neglected Parasitic Infections in the United States

Monica E. Parise, MD
May 6, 2014

NPIs: Key Gaps in Prevention and Control

Additional work is needed in 3 major areas to advance prevention and control of NPIs in the United States: (1) better estimates of disease burden and a better understanding of how to reduce the risk of acquiring NPIs, (2) improved diagnostic tests and medications, and (3) expansion of programs that provide proven interventions.[1]

Image courtesy of CDC Foundation / David Snyder

www.cdc.gov
The Solution...

A Multidisciplinary Approach
One Health Framework

“Between animal and human medicine there is no dividing line—nor should there be. The object is different but the experience obtained constitutes the basis of all medicine.”

Rudolph Virchow

“Two tenets at the core of the One Health concept are the belief that human and animal health are irrevocably entwined and that the improvement of both requires close collaboration between the medical and veterinary professions with support from allied disciplines.”

Doble and Fevre, 2010.
One Health Framework

- COMMUNICATION
- COLLABORATION
- DATA COLLECTION
- EDUCATION

Courtesy of eyeflow.com
One Health: Who is Responsible?

- Veterinarians
  - Promote pet’s health
  - Focus on preventive care
  - Provide client education

- Human healthcare
  - Add zoonotic diseases as Rule/Out’s
  - Promote sanitary habits
  - Understand family dynamics (including pets)
One Health: Who is Responsible?

- Academia
  - Educate new parasitologists
  - Focus on research
  - Serve as a resource

- Animal Industry
  - Promote food safety
  - Invest in new technology/treatments
One Health: Who is Responsible?

• Public Health Community
  • Keep accurate statistics
  • Lobby to increase priority
  • Create resource for knowledge & cooperation
  • Reach out to marginalized populations

• Local government
  • Provide safe environments
  • Enact legislation
One Health: Who is Responsible?
One Health: Who is Responsible?

CVBD® WEB CONFERENCE 2015

Powerful Insights Into Real Clinical Cases

View renowned global presenters as they explore relevant case workups at the 4th Annual International Webconference on Human and Companion Animal Vector Borne Diseases. Learn the implications of diseases that may seem secondary but are being diagnosed more frequently ... and spreading.

- Top Veterinary And Human Specialist Presenters
- First Time Hosted In The United States
- Choose Up To 7 Challenging Veterinary And Human Clinical Cases
- Webcast Available In More Than 80 Countries

Attending is Easy

- Preregister using the link below
- Login Instructions Will Be Sent By Email After You Preregister
- Session Begins 8:00 pm EDT
- Choose As Many Cases As You Wish
- Each Case Discussion Is About 30 Minutes
- 30-Minute Panel Discussion

http://www.cvbd2015us.com/
Risk Analysis Framework

HAZARD IDENTIFICATION

Risk Assessment
Science-based

Risk Management
Policy-based

Risk Communication
Interactive exchange of information & opinions concerning risks
Risk Assessment

- Risk factors
- Regional

Data

Tools

Research

• GIS
• PQF
• Fecal exam

• Targeted
• Co-morbidities
• Confounding
Risk Management

People:
• Surveillance
• Treatment
• Education
• Sanitation

Dogs:
• Routine fecal analysis
• Chemoprophylaxis
• Surveillance
Risk Management

PPP: Public Private Partnerships
Risk Management

Legislation

Public services
Risk Management

Medical Ecology—manipulating the environment

- Special surfaces
- Barriers
- Long grass
- Controlling feeding stations
- Feces disposal
Risk Management

The regulatory predicament

- Unclear policy
- Clear policy
- Clear science
- Unclear science

No decisions
Difficult decisions
Easy decisions
Risk Communication

WORMS??

nationalpostnews.files.wordpress.com
“Helminthiases do not have the journalistic value of great pandemics like flu or plague, although they may have an as yet unrecognized relation to them; they do not, for the most part, present dramatic clinical cases, but to make up for their lack of drama, they are unremittingly corrosive.”

Norman Stoll
Risk Communication

- Public Health Education
  - University--all healthcare fields
  - School children
  - Families
  - Doctors and patients
Risk Communication

• Messages for Individuals

Public

Courtesy of Clendening Library, 2015.
Risk Communication

- Messages for Individuals

Dog owners
Risk Communication

- Messages for Communities

**The scoop on cleaning up dog poop is ... it matters to your health**

By Deb Glaum | Community Health Intern and veterinarian

Oct. 25, 2013 — Lawrence is a wonderful community for dogs and dog lovers. There are so many places that owners and their canine companions can enjoy in and around the city. Besides spending time at the off-leash dog parks, many people like to take their pet wherever they go in public, and in many places, the dogs are welcome. However, it’s inevitable – if you’re going to have dogs
Risk Communication

- Messages Globally
“Ours is the age of the specialist, and long gone is the day of the educated amateur, the person of letters who could paint, write, and serve in elected office, who could lead in battle and yet publish in science and compose sonnets. The vapid dating line, ‘What’s your sign?’ has given way to the even more insulting, because it is so limiting, ‘What’s your major?’”

Steve Perkins

Closing Thoughts

Be:

• Sensible
• Safe
• Aware

Questions???
Sources


Sources


