Detecting and Investigating Outbreaks due to Commercially Distributed Animals: an Overview

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Estimated 11% (6%-20%) of Salmonella cases are due to animal contact
Reports of Selected Salmonella Outbreak Investigations

2013
- Chicken - Salmonella Heidelberg
- Tahini Sesame Paste - Salmonella Montevideo and Salmonella Mbandaka
- Live Poultry – Salmonella Typhimurium
- Live Poultry – Salmonella Infantis, Salmonella Lille, Salmonella Newport, and Salmonella Mbandaka
- Cucumbers – Salmonella Saintpaul
- Chicken – Salmonella Heidelberg
- Ground Beef – Salmonella Typhimurium
- Small Turtles – Salmonella Sandiego, Salmonella Pomona, and Salmonella Poona

2012
- Peanut Butter – Salmonella Prendery
- Hedgehogs – Salmonella Typhimurium
- Mangoes – Salmonella Braenderup
- Cantaloupe – Salmonella Typhimurium and Salmonella Newport
- Ground Beef – Salmonella Enteritidis
- Live Poultry – Salmonella Hadar
- Live Poultry – Salmonella Montevideo
- Live Poultry – Salmonella Infantis, Salmonella Newport, and Salmonella Lille
- Dry Dog Food – Salmonella Infantis
- Raw Scraped Ground Tuna Product – Salmonella Bareilly and Salmonella Nchanga
- Small Turtles – Salmonella Sandiego, Salmonella Pomona, and Salmonella Poona
General Points

• Outbreaks of salmonellosis due to commercially distributed animals are common
  – Often multi-state
  – Can go on for months-years
  – Children disproportionately affected

• Popularity of animals continues to increase → outbreaks likely will increase too

• Further emphasis on detection & investigation of animal exposures would result in identification of more outbreaks, more rapidly
General Points (cont.)

• Detection of a possible animal source for an outbreak relies on exposure questions about animals
  – Details required

• Confirmation of an animal source typically relies on isolation of the outbreak strain of *Salmonella* from animal/environmental samples

• Tracebacks done to identify ultimate source (i.e., animal breeding facility)

• Lack of specific regulatory authority often hinders traceback efforts, control at source
Salmonella Serotypes Involved in Outbreaks, by Animal Species

**Chicks/Ducklings:** Altona, Braenderup, Hadar, Infantis, Johannesburg, Lille, Mbandaka, Montevideo, Newport, Ohio, Typhimurium, 4,[5],12:i:-

**Turtles:** Enteritidis, Litchfield, Newport, Paratyphi B, Poona, Pomona, Sandiego, Typhimurium, Urbana, 4,[5],12:i:-

**African Dwarf Frogs:** Typhimurium

**Rodents:** Enteritidis, Typhimurium, 4,[5],12:i:-

**Hedgehogs:** Typhimurium, Tilene (sporadic)
Salmonella Serotypes and PFGE Subtypes Involved in Outbreaks

- Same serotype can cause different outbreaks from different sources at same time
  - E.g., concurrent S. Montevideo outbreaks from different chick hatcheries
- There can be multiple PFGE subtypes of same serotype involved in outbreaks at same time
  - E.g., turtles: S. Poona, Pomona, Sandiego
- Same serotype-PFGE combination can occur year after year
  - Pays to know history
Exposure Ascertainment

• Direct contact with pets/animals
• Any pets/animals in household
  – When acquired (recent more suspicious)
  – Source
  – Recent illness in animals
• Any pets/animals in other settings
  – Daycare, school, pet stores, feed stores, other people’s homes, etc.
• Exposures can be hard to elicit
Sampling of Animals/Environment

• Argument: Some animal exposures represent a “red flag” exposure that warrants aggressive efforts to sample
  – Especially chicks/ducklings, turtles
  – Rodents (snakes) if appropriate serotypes
  – Other unusual/interesting species
  – Even if sporadic case
  • Reasonable to good chance that case is/will be part of an outbreak
Hedgehog-Associated S. Typhimurium Cases by Illness Onset, 2010 – 2013, (n=38)

2010–2011 Historic Infections (n=15)

2012–2013 Cases (n=23)
African Dwarf Frog-Associated
S. Typhimurium Cases by Illness Onset &
Age, 2008 – 2011 (n=376)

Historic
n=116

Outbreak
n=260

Month of Illness Onset

Number of Cases

≥ 10 years
< 10 years
Sampling of Animals/Environment: Chicks/Ducklings

USDA APHIS - 9 CFR Ch. I (1-1-06 Edition)
§ 147.12

FDA SE Regulation Environmental Testing

• Fecal material, litter, dust – 5 samples representing all areas of pen (pens less than 500 birds)
• Cloacal swabs
• Chick box papers
  – swab surface
House environmental samples, cloacal swabs, hatchery samples

Pre-enrichment media (BPW) (1:10 ratio)
37°C, 20-24 hours

Inoculate TT\textsuperscript{1}
enrichment broth (1:10 ratio)
37 or 41.5°C, 20-24 hours

Inoculate either MSRV or RV
enrichment media (1:100 ratio)
42°C, 20-24 hours

Inoculate selective plates\textsuperscript{2}
37°C, 20-24 hours

Inoculate three to five suspect colonies into TSI and LIA slants

TSI and LIA Reactions: One positive and one negative for Salmonella

Biochemical identification

Negative for Salmonella
Discard\textsuperscript{3}

Positive for Salmonella
Serogroup

TSI and LIA Reactions: Both negative for Salmonella

Discard\textsuperscript{3}

TSI and LIA Reactions: Both positive for Salmonella

Serogroup

Biochemical identification

Negative for Salmonella
Discard\textsuperscript{3}

Positive for Salmonella
Serotype all Group D1

1. Tetrathionate enrichment broth, e.g., Rappaport-Vassiliades (RV) or modified semisolid RV (MSRV).
2. Selective plates such as Brilliant Green Novobiochin (BGN) or xylose-lysine tergitol 4 (XLT 4).
3. Reevaluate if epidemiologic, necropsy, or other information indicates the presence of an unusual strain of Salmonella.
4. If biochemical identification and serogroup procedures are inconclusive, restreak original colony onto non-selective plating media to check for purity. Repeat biochemical and serology tests.
Sampling of Animals/Environment: Turtles

• Ask family not to clean tank for several days. If large tank, move to smaller tank for a few days
• Collect 1-2 containers of 100 ml of tank water
• Use pipette to stir water, let settle, sample turbid area to get sediment suspended in water
• A larger sample (up to 1,000 ml) will usually increase sensitivity, especially if can be put through a membrane filter
• If smaller volume, centrifuge and set up as if a fecal sample
• Inoculate into enrichment broth at ratio of 1:10
Sampling of Animals/Environment: Rodents

- Live animals: feces from cage
- Dead animals: necropsy and collect intestinal contents, liver, spleen for culture
Sampling of Animals/Environment: Hedgehogs

- Feces from cage
- Rectal swab
Tracebacks of Commercially Distributed Animals

Chicks/Ducklings
- Complex due to drop shipping, outsourcing

Turtles
- Complex, supporting documents critical

Rodents
- Complex, strains often present in multiple breeders/sources
- Pet store chains can be very helpful
Hedgehog-Associated S. Typhimurium Cases by State, 2010 – 2013, (n=38)
Regulatory Agencies by Species

Chicks/Ducklings
- State Boards of Animal Health, USDA

Turtles
- FDA CVM

Rodents
- FDA CVM, USDA-APHIS-Animal Care
  (Animal Welfare Act – some instances)
- State Departments of Agriculture (maybe, if rodents are sold as reptile feed)

Hedgehogs
- USDA-APHIS-Animal Care; ≥3 breeding females
Helping Traceback and Regulatory Efforts

Even after the outbreak vehicle is identified, it is important to continue interviewing cases with the supplemental questionnaire to collect information to help with tracebacks and regulatory action.
Species-Specific Considerations

Chicks/Ducklings

- Some outbreaks have led to foodborne outbreaks when infected persons have included deli workers, caterers
Species-Specific Considerations

Turtles

• Because of federal law regarding turtles <4 inches, it is critical to get any invoices, Bills of Lading, receipts that show sale from supplier to customer
  – Challenge is to have size of turtle shown on the document
  – If turtle size not shown, need other proof by either taking a picture of the turtle (e.g., with a ruler or coin), or obtaining an affidavit from store management
Species-Specific Considerations

Rodents

Pets
• Mice, Rats, Hamsters, Guinea Pigs

Reptile Food
• Mice, Rats
• Live or Frozen

Both pet and feeder rodents can be part of same outbreak
Feeder Mice Sizes

- Pinkies
- Fuzzies
- Hoppers
- Weanlings
- Adult
- Jumbo
Outbreaks of Rodent-associated Salmonellosis in the United States by Year of 1\textsuperscript{st} Case Onset (n=10)

Number of Outbreaks

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases C</td>
<td>15C</td>
<td>7C</td>
<td>5C</td>
<td>16C</td>
<td>77C</td>
<td>11C</td>
<td>46C</td>
<td>6C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>States S</td>
<td>10S</td>
<td>4S</td>
<td>3S</td>
<td>6S</td>
<td>25S</td>
<td>8S</td>
<td>22S</td>
<td>4S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S. Typhimurium or 4,[5],12:i:-
S. Enteritidis

C  = number of cases
S  = number of states
Salmonella enterica Subspecies

- I: 99% of human cases
- IIIa: Primarily reptile-associated
- IIIb: ≤ 1% of human cases
Salmonella Subspecies Isolated from Minnesota Reptiles with PFGE Match to Case, 1996-2011 (n=27)

- Enteritidis: 89% (24)
- Typhimurium: 7% (2)
- Bareilly: 4% (1)

<table>
<thead>
<tr>
<th>Subspecies</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteritidis</td>
<td>11%</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>7%</td>
</tr>
<tr>
<td>Bareilly</td>
<td>7%</td>
</tr>
</tbody>
</table>
Species-Specific Considerations

Rodents

• If case reports a snake, find out what type, and if it has been fed rodents

• Snake types: Gopher, Bull, Rat, Corn, King, Fox, constrictor, pythons often are fed rodents
  – If *Salmonella* serotype is a subspecies I (esp. *Typhimurium*, 4,[5],12:i:-, *Enteritidis*), rodents are more likely the ultimate source

• *Salmonella* strains often multidrug-resistant

• Outbreaks often relatively small, with cases temporally and geographically dispersed
Don’t forget about Dogs and Cats

- **Animal facility outbreaks**
  - Vet clinics, humane societies
    - 4 *S. Typhimurium* outbreaks, 1999-2000
- **Pet food/treat outbreaks**
  - *S. Infantis*: pig ear dog treats
  - *S. Thompson*: beef/salmon dog treats
  - *S. Schwarzengrund*: dry dog and cat food
    - 79 cases in 21 states over 3 years
  - *S. Infantis*: dry pet food, 2012
    - 47 case-patients in 20 states
What is going to be the next “big thing” in salmonellosis outbreaks?
Multidrug-Resistant *Salmonella enterica* Serotype Typhimurium Associated with Pet Rodents

Salmonella Typhimurium

- Most common serotype in humans
- Common in food animals
- Latin translation of Typhimurium = Typhi of mice
  - Can cause severe, typhoid fever-like disease in rodents
- Septicemia
S. Typhimurium Outbreak in Hamsters – August 2004

- 780 hamsters shipped to a Minnesota pet distributor from Iowa
- Sick on arrival, began dying in large numbers
- 7 hamsters submitted to Minnesota Veterinary Diagnostic Laboratory
  - S. Typhimurium isolated
Cases of Rodent-Associated Salmonellosis by Month of Illness Onset (n=15)

<table>
<thead>
<tr>
<th>Month</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Jan</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Feb</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mar</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Apr</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>May</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Jun</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Jul</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aug</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Sep</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

- Primary case (direct rodent exposure)
- Secondary case
Number of Rodent-Associated Cases, by State (n=15)

- MN (1)
- MO (2)
- IL (2)
- KY (2)
- MI (1)
- PA (2)
- NC (1)
- SC (2)
- GA (1)
- NJ (1)
# Frozen Rodent.com

1-800-336-mice(6423) or [ORDER HERE](#)

## Frozen Mouse Information

<table>
<thead>
<tr>
<th>Size</th>
<th>Approximate Wt. Grams</th>
<th>Price</th>
<th>Quantity Per Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinkies</td>
<td>1.5</td>
<td>.25</td>
<td>100</td>
</tr>
<tr>
<td>Fuzzies</td>
<td>5-7</td>
<td>.30</td>
<td>50</td>
</tr>
<tr>
<td>Hoppers</td>
<td>8-9</td>
<td>.40</td>
<td>50</td>
</tr>
<tr>
<td>Weaned</td>
<td>15</td>
<td>.45</td>
<td>50</td>
</tr>
<tr>
<td>Adult</td>
<td>25</td>
<td>.55</td>
<td>25</td>
</tr>
<tr>
<td>Retired Breeder</td>
<td>35-40</td>
<td>.60</td>
<td>25</td>
</tr>
</tbody>
</table>

![Credit Card Logos](image.png)
Source of Rodent Exposures for Primary Cases (n=13)

- Pet hamsters (2)
- Pet mice/rats (4)
- Live feeder mice/rats (7)
Tracebacks of Rodents associated with *Salmonella* Typhimurium Outbreak

**Human Cases**
- KY-1
- KY-2
- GA
- SC-1
- PA
- MI

**Pet Stores**
- KY-1
- KY-2
- GA-1
- SC-1
- GA-2
- MI

**Pet Distributors**
- GA Distributor
- AR Distributor
- IA Distributor

**Pet Stores**
- IL-1
- IL-2
- NJ
- SC-2
- MO
- MN
- NC

**Human Cases**
- IL-1
- IL-2
- NJ
- SC-2
- MO
- MN
- NC
Pulsed-Field Gel Electrophoresis (PFGE) Patterns of *Salmonella* Typhimurium Isolates

<table>
<thead>
<tr>
<th>Source</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MN distributor</td>
<td>hamster</td>
</tr>
<tr>
<td>MN human</td>
<td></td>
</tr>
<tr>
<td>MN pet</td>
<td>mouse</td>
</tr>
<tr>
<td>SC human</td>
<td></td>
</tr>
</tbody>
</table>
# Predominant Antimicrobial Resistance*

## Phenotypes of S. Typhimurium Strains by Outbreak

<table>
<thead>
<tr>
<th>Year</th>
<th>Outbreak</th>
<th>Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Pocket Pet Outbreak</td>
<td>A, C, S, Su, T</td>
</tr>
<tr>
<td>2005-2006</td>
<td>Frozenrodent.com</td>
<td>Pan-susceptible</td>
</tr>
<tr>
<td>2007</td>
<td>MN-WI Hamster</td>
<td>A, C, S, Su, T</td>
</tr>
<tr>
<td>2007</td>
<td>Gourmet Rodents</td>
<td>A, C, K, S, Su, T</td>
</tr>
</tbody>
</table>

* A = ampicillin   C = chloramphenicol   K = kanamycin
S = streptomycin   Su = sulfisoxazole   T = tetracycline
Antimicrobial Use by Rodent Breeders/Distributors

- Routine use documented in facilities involved in 2004 rodent-associated outbreak
- Prophylaxis for non-specific rodent enteritis
- Delivered in water or food
  - spectinomycin, tetracycline
  - time of rodent weaning, prior to transport, and/or upon arrival
  - tetracycline routinely added to rodent feed by one distributor
An outbreak of *Salmonella* Typhimurium DT191a associated with reptile feeder mice

K. S. HARKER*, C. LANE, E. DE PINNA and G. K. ADAK

Gastrointestinal, Emerging and Zoonotic Infections Department, Health Protection Agency, London, UK

(Accepted 7 September 2010; first published online 14 October 2010)

SUMMARY

In December 2008 an increase of tetracycline-resistant *Salmonella* Typhimurium definitive phage-type 191a (DT191a) was identified in England and Wales by the reference laboratory. This was confirmed to have a phage-typing pattern that had not previously been seen. Strong statistical evidence for an association between illness and keeping reptiles was demonstrated by a matched case-case study (mOR 16·82, 95% CI 2·78–∞). Questionnaires revealed an association with frozen reptile feeder mice, and mice representing 80% of the UK supply lines were tested for the presence of *Salmonella*. DT191a was found in three pools of sampled mice, which were traced back to a single supplier in the USA. Imports from this supplier were halted, and tighter regulations are now in place. A leaflet detailing how to prevent contracting *Salmonella* from pet reptiles has been published as well as updated advice on the Health Protection Agency’s website.
United Kingdom Investigation

Salmonella Typhimurium DT 191a reports by month and Year of specimen (04/04/2011)

* Harker, et al. Epidemiol Infect 2010
United Kingdom Traceback Investigation

* Harker, et al. Epidemiol Infect 2010
Facility Investigation — Company A

• FDA visited Company A in July 2010

• Sell ~100,000 frozen rodents/week
  – Direct internet sales
  – Sales to distributors, pet stores, laboratories, zoos
  – International shipments

• Sold in bulk with minimal package labeling
Salmonella 4,[5],12:i:- Outbreak Cases by Month of Illness Onset, December 2009 – March 2011, United States (n=74)*

*Estimated and actual date of illness used; date missing for 3 cases
Geographic Distribution of *Salmonella* 4,[5],12:i:- Outbreak-associated Cases, January 2010 – March 2011 (n=77)
Public Health Interventions, U.S.

• Company A issued international recall
  – Frozen feeder rodents sold May 2009 through July 2010
  – Recalled >6 million frozen rodents
  – Began irradiation of frozen mice
• Internet postings by CDC and FDA
<table>
<thead>
<tr>
<th>Exposure</th>
<th>Cases (n=15) # (%)</th>
<th>Controls (n=29) # (%)</th>
<th>mOR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snake*</td>
<td>10 (67%)</td>
<td>2 (7%)</td>
<td>22.2</td>
<td>(3.5, ∞)</td>
</tr>
<tr>
<td>Lizard</td>
<td>3 (20%)</td>
<td>0 (0%)</td>
<td>7.7</td>
<td>(0.8, ∞)</td>
</tr>
<tr>
<td>Turtle</td>
<td>1 (7%)</td>
<td>2 (7%)</td>
<td>1.0</td>
<td>(0.02, 19.2)</td>
</tr>
<tr>
<td>Frog</td>
<td>0 (0%)</td>
<td>1 (3%)</td>
<td>2.0</td>
<td>(0.0, 78.0)</td>
</tr>
</tbody>
</table>

*Reptile and amphibian exposures were not mutually exclusive*
# Salmonella Awareness

<table>
<thead>
<tr>
<th>Exposure (n=15)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aware of connection between REPTILES and <em>Salmonella</em></td>
<td>60%</td>
</tr>
<tr>
<td>Do not wash hands after handing reptile/food/habitat (n=10)</td>
<td>10%</td>
</tr>
<tr>
<td>Aware of connection between RODENTS and <em>Salmonella</em></td>
<td>13%</td>
</tr>
<tr>
<td>Do not wash hands after handling rodents (n=11)</td>
<td>73%</td>
</tr>
</tbody>
</table>
Salmonella 4,[5],12:i:-, 2011-2012

- 46 cases reported from 22 states
  - PFGE matched the 2010 outbreak strain
- Median age, 11 years; 37% <5 years
- 27 cases interviewed
  - 20 (74%) reptile or amphibian exposure
  - 15 (56%) feeder rodent exposure
- Tracebacks difficult
  - 2 breeders had received mice from Company A

CDC. April 20, 2012 MMWR 61(15);277-277
Reptiles and Feeder Rodents

- Feeder rodents purchased live or frozen
- Frozen
  - Long shelf life (~12 mos)
  - Often stored in refrigerator with human food, defrosted on kitchen counters or in microwaves
  - Distributed internationally
- Distribution networks
Regulation of Pet and Feeder Rodent Industries

- Fragmented/ill defined
- Animal Welfare Act (AWA) is basis for regulation of some rodents in some instances
- Public health not a focus for inspections that are done
Animal Welfare Act

- USDA, APHIS, Animal Care Office
  - Retail pet stores exempt unless sell exotic animals
  - Pet breeders, wholesalers, distributors regulated for hamsters, Guinea pigs
    - If gross >$500 per year
Animal Welfare Act

• Mice, rats as pets were exempt, now included
  – Will take time to implement change
• Mice/rats for reptile food not regulated under AWA
  – State government agencies that regulate animal feed may have jurisdiction in some states
  – FDA role in interstate shipment of feed
Recommendations for Public Health and Regulatory Agencies

• Develop a comprehensive approach to outbreaks associated with pet industry
  – Strengthen pocket-pet trace back capabilities
  • Shipping and commercial records
  – Mechanism for control of outbreaks
  • Swift, comprehensive follow-up at rodent breeders, distributors, retailers
Recommendations for Public Health and Regulatory Agencies

• Develop well defined regulatory authority over pocket pet industry
  – Inspection program that evaluates factors that could enhance infectious disease transmission
Recommendations for the Public

- Awareness of risk
- Do not store or handle reptiles, rodents, or equipment where human food is stored, prepared, or served
- Use dedicated tools to handle frozen rodents
- Wash hands after handling reptiles and live or frozen rodents
- Children <5 years should not handle reptiles or rodents
- Do not allow reptiles to freely roam in house
Recommendations for the Public

- Wash hands after handling reptiles and live or frozen rodents.
- Do not store or handle rodents where human food is stored, prepared, served, or consumed.
- Use dedicated tools to handle frozen rodents.
- Children <5 years should not handle reptiles or rodents.
- Do not allow reptiles to freely roam the house.
- During an outbreak, throw away or return recalled products.

Contact with live and frozen feeder rodents (mice and rats) and reptiles (turtles, snakes, and lizards) can be a source of human Salmonella infections.

- Salmonella germs can cause a diarrheal illness in people that can be mild, severe, or even life threatening.
- Rodents and reptiles can carry Salmonella germs and still appear healthy and clean.
- Salmonella germs are shed in rodent and reptile droppings and can easily contaminate their bodies and anything in areas where they live.
  - These germs can contaminate areas where rodents are housed or handled or where frozen rodents are prepared, thawed, and stored.
  - Reptiles that live in tanks or cages can contaminate their habitats, including water bowls, with germs, which can spread to people.

http://www.cdc.gov/healthypets/resources/feeder-rodent-salmonella-8x11_508.pdf
Recommendations for Industry

• Education about problem
• Develop a “Best Practices” guidance document
• Consult with veterinary experts to develop a *Salmonella* control plan for the facility
• Improve infection control practices at rodent facilities
  – Routine sanitizing of animal transport containers and cages
  – Limit antimicrobial use through improved animal husbandry and hygiene practices
Recommendations for Industry

• Protocols for testing and sale of rodents if substantial diarrhea-associated morbidity or mortality occurs

• Enhance internal record keeping
  – Assign lot codes; track shipments – to whom and when; track production dates

• Validate irradiation procedures

• Seal package to ensure not broken prior to delivery to end user
Reptile Ownership in the United States

• Reptile ownership is at an all time high
  – 3.0 million pet reptiles in 2011*
    ▪ Increase from 1.8 million in 2006
• Estimated 3% of households own at least 1 reptile
• Estimated 1.1% of households own at least 1 snake or lizard → 1,281,000 households

*AVMA U.S. Pet Ownership and Demographics Sourcebook, 2012 Edition
Reptiles and *Salmonella*

- Reptiles commonly colonized with *Salmonella* and shed it intermittently in their stool
  - Asymptomatic carriers, with carriage rates from point prevalence studies up to 94%
- 40% of all *Salmonella* serotypes have been isolated predominantly from reptiles and rarely from humans or other animals
  - “Reptile-associated” serotypes
Reptile-associated Salmonellosis

• Reptiles are a well-documented source of salmonellosis for humans
  – Outbreak investigations, case series, case-control studies
• Estimated 70,000 cases of salmonellosis from reptiles or amphibians in the U.S. every year (6% of all salmonellosis cases)
• “Reptile-associated” serotypes cause $\leq 1\%$ of human salmonellosis
• Reptiles also a source of serotypes that are common in humans (e.g., Typhimurium)
Reptile-associated Salmonellosis (RAS)

- All reptiles, amphibians
  - Turtles
  - Snakes and Lizards
  - Rodents used as reptile food

6% of all human salmonellosis

~50% of RAS (3% of all human salmonellosis)

Unknown % of human salmonellosis
Children are Disproportionately Affected by Reptile-associated Salmonellosis

Mermin et al. case-control study of sporadic salmonellosis (CID 2004)

• Among cases <21 years of age, reptile or amphibian exposure had the largest PAF (9.5%) of any of the risk factors identified

Jones et al. case-control study of sporadic salmonellosis among infants (Pediatrics 2006)

• Reptile exposure had highest PAF (17%) of any of the risk factors identified
Sporadic *Salmonella* Infections and Reptile Exposure, Minnesota, 1996-2011

- 8,389 sporadic nontyphoidonal *Salmonella* infections
  - 3.6% (n=292) of cases reported reptile exposure in the week before illness onset
    - Range, 2.2% to 5.2% annually
<table>
<thead>
<tr>
<th></th>
<th>I No. (%)</th>
<th>II No. (%)</th>
<th>IIIa No. (%)</th>
<th>IIIb No. (%)</th>
<th>IV No. (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lizard</td>
<td>107 (44)</td>
<td>5 (100)</td>
<td>1 (13)</td>
<td>3 (25)</td>
<td>19 (86)</td>
<td>135 (47%)</td>
</tr>
<tr>
<td>Snake</td>
<td>44 (18)</td>
<td>0</td>
<td>5 (63)</td>
<td>7 (58)</td>
<td>1 (5)</td>
<td>57 (20%)</td>
</tr>
<tr>
<td>Turtle</td>
<td>50 (21)</td>
<td>0</td>
<td>1 (13)</td>
<td>2 (17)</td>
<td>1 (5)</td>
<td>54 (19%)</td>
</tr>
<tr>
<td>Combo</td>
<td>40 (17)</td>
<td>0</td>
<td>1 (13)</td>
<td>0</td>
<td>1 (5)</td>
<td>42 (15%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>241</strong></td>
<td>5</td>
<td><strong>8</strong></td>
<td><strong>12</strong></td>
<td><strong>22</strong></td>
<td><strong>288</strong></td>
</tr>
</tbody>
</table>
Salmonella Cases Reporting Reptile Exposure, Minnesota, 1996-2011
(n=292)

Median: 17 cases per year (range: 12 to 30)
Age Distribution of *Salmonella* Cases Reporting Reptile Exposure, Minnesota, 1996-2011 (n=292)

- Median age: 11 years (range: 0 to 70)
- 31% < 5 years of age
- 44% < 10 years of age
- 74% < 25 years of age
Case Illness Severity
(n=292)

Median illness duration (range) 8 days (1-60 days)
Hospitalized 24%
- Median duration 3 days (1-43 days)
Salmonella Subspecies Isolated from Minnesota Salmonella Cases Reporting Reptile Exposure, 1996-2011 (n=288)

- Typhimurium: 15%
- Enteritidis: 7%
- Paratyphi B var. L (+) tartrate (+): 5%
Reptile Type Reported by Minnesota *Salmonella* Cases with Isolate Matching Reptile Isolate by PFGE, 1996-2011 (n=27)

* All were lizard & snake combo
Rodents Fed To Reptiles

- 34% (83/246) of Minnesota *Salmonella* cases who reported reptile exposure reported feeding their reptile some type of rodent
  - 87% (72/83) of snake owners reported feeding them rodents
- Among those who fed rodents:
  - 59% (47/80) fed frozen rodents
  - 41% (33/80) fed live rodents
Pet-related *Salmonella* Outbreaks

http://www.cdc.gov/zoonotic/gi/

L

Zoonotic Diseases (Diseases from Animals)

Gastrointestinal (Enteric) Diseases from Animals

Animals provide many benefits to people. However, some animals can carry diseases that can be shared with people. Zoonotic diseases or zoonoses are diseases caused by germs (pathogens) that can be spread between animals and humans. Many germs have been responsible for illnesses and outbreaks, including *Salmonella*, *E. coli* O157:H7, and *Cryptosporidium*. These germs can come from many types of animals, including pets, wild animals, and farm animals. Did you know that infected animals can make you sick, even if they appear healthy and clean?

Zoonotic diseases can cause many different illnesses in people. Gastrointestinal (enteric) zoonoses are one type of illness that can upset the digestive system (stomach and intestines) and can make people sick.
Introduction

Pets provide many benefits to humans. They comfort us and they give us companionship. However, some animals can also pass diseases to people. These diseases are called zoonoses.

Although animals can carry germs, it is important to know that you are more likely to get some of these germs from contaminated food or water than from your pet or another animal you encounter. CDC has created this Web site to provide you with information about the health-related risks of owning and caring for animals. We encourage you to follow the links located throughout this Web site for general information about companion and wild animals and the diseases they can carry.

Many groups encourage people to enjoy the benefits of common household pets. By following CDC’s simple tips on the Healthy Pets, Healthy People Web site, you can enjoy your pets while protecting yourself against diseases they carry.

Because wild animals can carry diseases that are dangerous to people, CDC discourages direct contact with wildlife. You should never adopt wild animals as...
Salmonella

Eight Multistate Outbreaks of Human Salmonella Infections Linked to Small Turtles (Final Update)

Posted October 18, 2013 3:00 PM ET

These outbreaks appear to be over. However, small turtles continue to be an important cause of human Salmonella infections in the United States. More information about Salmonella from reptiles and amphibians and the steps people can take to reduce their risk of infection is available.

Highlights

- Read the Advice to Pet Owners »
- Read the Advice to Those Who Sell Turtles »

A total of 473 persons infected with the outbreak strains of Salmonella were reported from 41 states, the District of Columbia, and Puerto Rico.

- 29% of ill persons were hospitalized, and no deaths were reported.
- 70% of ill persons were children 10 years of age or younger, and 31% of ill persons were children 1 year of age or younger.
- 44% of ill persons were of Hispanic ethnicity. Information about the association between reptiles and Salmonella is available in Spanish.