Looking below the surface of foodborne illnesses

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Professor of Food Safety
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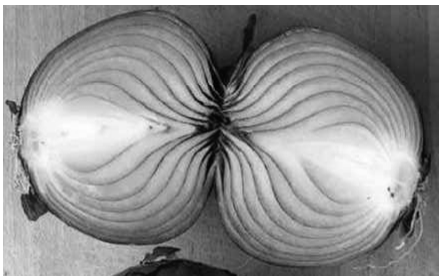
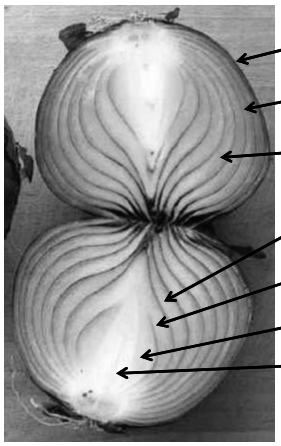


Why we still have FBD



Clinical Presentation

Source of Exposure

Route of Contamination

Pathogen Reservoir

Clinical Presentation (Reservoir)

Source of Exposure (Reservoir)

Route of Contamination (Reservoir)

Among all human pathogens, 61% are zoonotic

Farm-to-Table Concept







Clinical Presentation in Animals

Agricultural Fairs Positive for *E. coli* O157

Species	Positives	Percentage
Cattle	31/32	**97**
Pigs	19/32	**60**
Sheep	5/12	**42**
Goats	2/4	**50**
Flies	4/21	**19**
Any animal	32/32	**100**

Pathogen Prevalence, cattle

Pathogen	Animal Prevalence	Illness in humans	References
Salmonella sp.	23%	Enteritis, septicemia	(Troutt et al., 2001)
Shiga Toxin-producing *E. coli*	0-100%	Enteritis, HUS	(Wilson et al., 1992)
E. coli O157	0-80%	Enteritis, HUS	(Mechie et al., 1997)
Campylobacter jejuni	37%	Enteritis, Guillian-Barre Syndrome	(Wesley et al., 2000)
Listeria monocytogenes	12% (herd prevalence)	Meningitis, abortion, enteritis	(Hassan et al., 2000)
Cryptosporidium parvum	89% (herd prevalence)	Enteritis	(Ruest et al., 1998)
Giardia lambda	9%	Enteritis	(Wade et al., 2000)
Leptospira sp.	2%	Hepatitis, nephritis	(Miller et al., 1991)
Brucella abortus	Eradicated in US herds	Systemic Disease	(Timoney et al., 1988)
Mycobacterium bovis	Eradicated in US herds	Pneumonia, Systemic Disease	(Timoney et al., 1988)

Targeted Areas of Intervention

Pre-harvest

- Diet
- Probiotics
- Vaccines
- Phages
- Niche Engineering
  - Environment
  - Feed
  - Water

Post-harvest

- Washes
- Irradiation
- Consumer Education

Cannot "test" safety into food

Examples: "Foodborne" Pathogens transmitted by non-foodborne routes

Well water, OR 4.4

Riding in Shopping Cart, OR 4.0

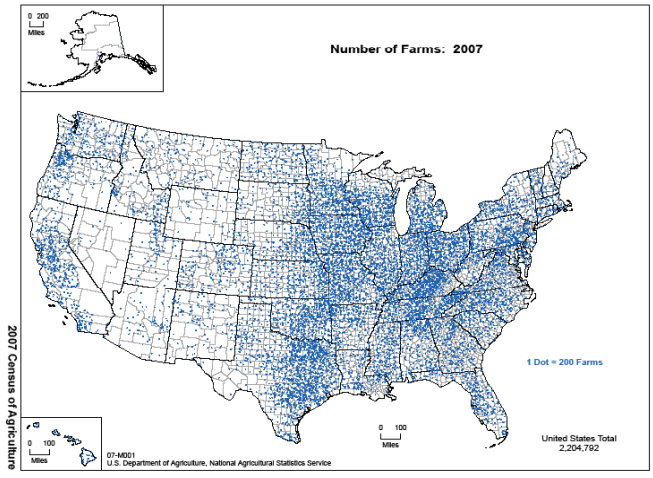
Farm residence or visit, OR 6.2

Pet with diarrhea, OR 4.4

International Travel, all ages, OR 19.3

- **Salmonella**
  - **in 14% of feces from raw meat-fed dogs**
  - **In 10% of household vacuum waste (vs. 4.5 %)**

Number of Farms in the United States

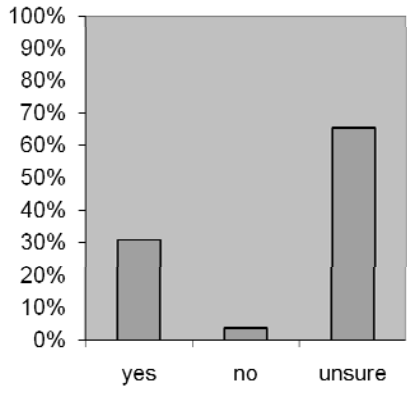


L. *monocytogenes* contamination of ruminant farms & non-farms by specific source

Sample source	N=52	%	Non-farm	%	Farm	%	*P*
Shoes	**13**	**25.0**	**3**	**11.5**	**10**	**38.46**	**0.052**
Food	**4**	**7.7**	**3**	**11.5**	**1**	**3.8**	**0.6**
Sinks	**3**	**5.8**	**1**	**3.8**	**2**	**7.69**	**1.0**
Washer	**2**	**3.8**	**0**	**0**	**2**	**7.69**	**0.49**
Gloves			**N/A**		**6**	**23.1**	
Feces			**N/A**		**9**	**34.6**	

Fisher's Exact Test

Farmer Knowledge

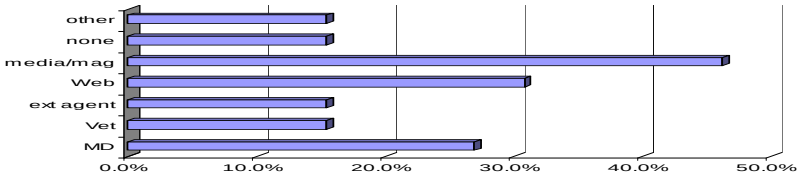


Do you feel your knowledge regarding Infection transmission, and prevention of zoonoses is sufficient to protect you and your family?

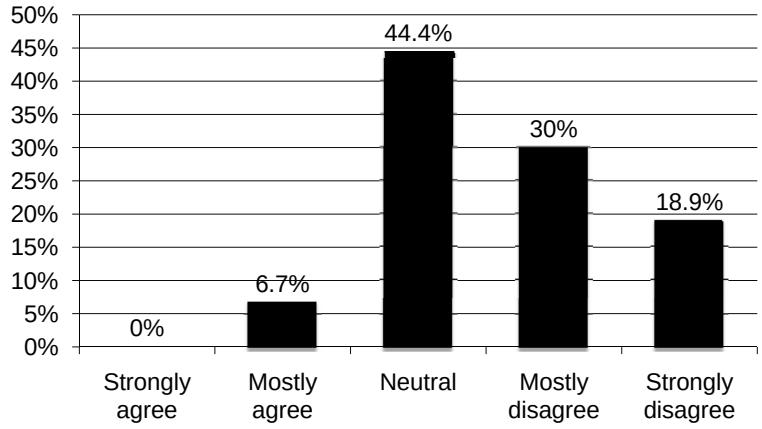
Farmer Knowledge

Pathogen	Consider as a Human Pathogen
Salmonella spp.	74%
Listeria monocytogenes	19%
Cryptosporidium	12%
Campylobacter	9%

Primary Sources for Information Regarding Zoonoses

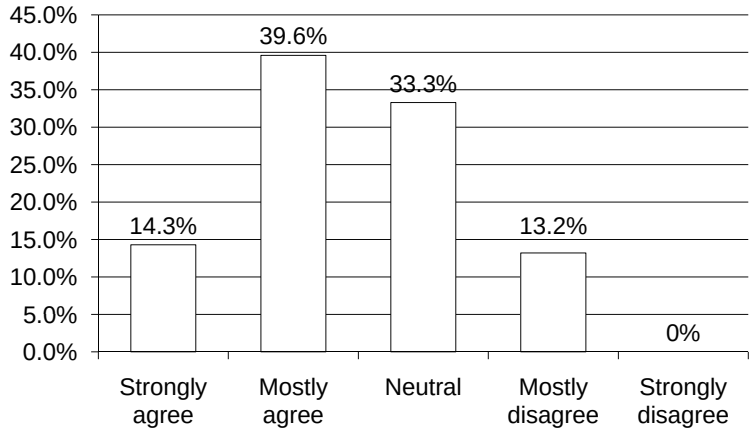


Patients



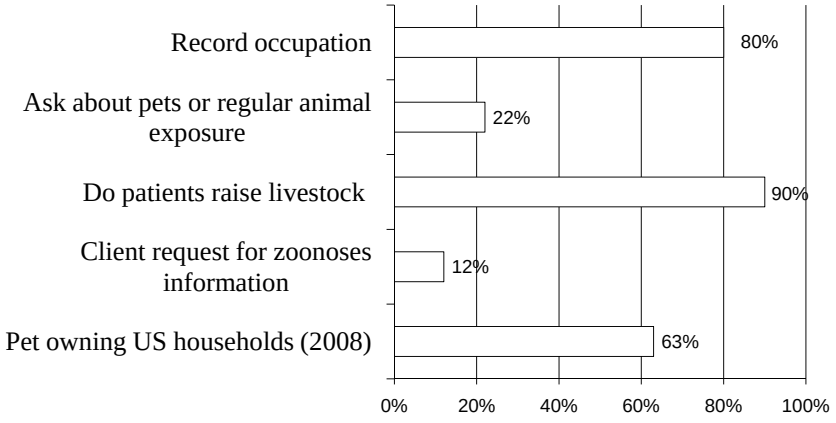
My patients seem knowledgeable about zoonoses

Zoonoses Exposure

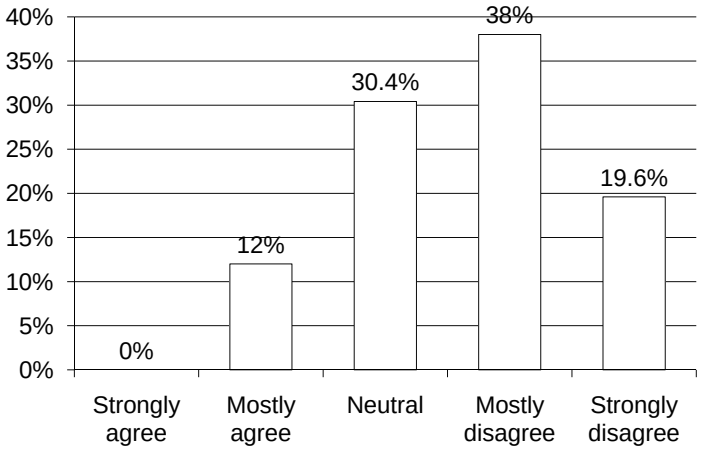


Asking about zoonoses exposure should be routine for patients' involved in livestock production

Physicians Responses



Physicians



I am comfortable with my knowledge of zoonoses

Educating Individuals about Agricultural-related Zoonoses

- Ag Extension agent
- Nurse/ Nurse Practitioner/Physician Assistant
- Physician
- Public Health official
- Veterinarian
- Other

Who do you believe should be most responsible for educating individuals about agricultural-related zoonoses?

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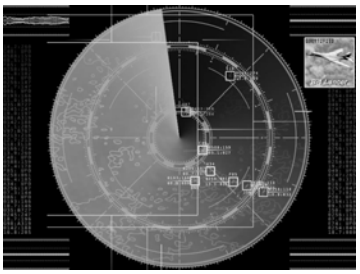
Diagnosis

- **87% of physicians reported rarely or never diagnosing zoonotic diseases**
- **70% had not diagnosed a zoonotic infection in the past year, 20% reported never having diagnosed a zoonotic infection.**

Implications



In addition to eating, many other human/animal interactions routinely put patients a risk for exposure to enteric enteropathogenic organisms.

Keep it on the RADAR

Foodborne Illness

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A (possible) Case of Foodborne Illness

Presented at the 2010 National ACP Meeting, San Diego, J. Goodman, OSUMC.

- **51 yo homeless Laotian man, HIV+, CD4 64, DM type 2**
- **ED presentation: Fever, diarrhea, weight loss, low back pain, tachycardia treated as sepsis with broad empiric antibiotics**
- **Blood & Stool cultures - negative**
- **Back pain persisted**
- **MRI lumbar spine app 4X2 cm prevertebral fluid collection**

A (possible) Case of Foodborne Illness

Presented at the 2010 National ACP Meeting, San Diego, J. Goodman, OSUMC.

- **Site aspiration – purulent fluid that eventually grew *Salmonella typhimurium***
- **Coincident with CDC. Investigation Update: Outbreak of Salmonella typhimurium infections, 2008-2009. http://www.cdc.gov/salmonella/typhimurium/update.html**
- **Source not confirmed, but patient reported frequent consumption of peanut butter in his homeless shelter.**
- **Prolonged ciprofloxacin therapy eventually resulted in a cure.**

Lessons from an unusual case…

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- **There are common presentations for foodborne illnesses that overlap with other causes of infectious gastroenteritis**

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- Some foodborne illness can result in serious morbidity & mortality
- Most individual cases are not linked to the source
- Source tracing can be accomplished during outbreaks
- Knowledge of the epidemiology & typical presentations can inform decisions about presumptive management.

Foodborne Illness in the US: Scope of the problem

Recent CDC data* distinguishes total infectious GI illness from that which was foodborne in origin

Overall incidence 37.2 million/yr; Foodborne 9.4 million/yr

- **5.5 million (59%) by viruses**
- **3.6 million (36%) by bacteria**
  - **Non-typhoidal salmonella 11%**
  - ***C. perfringens* 10%**
  - **Campylobacter 9%**
- **0.2 million (2%) by parasites**

***Scallan E et al. Foodborne illness acquired in the United States– major pathogens. Emerg Infect Dis 2011 Jan.**

Foodborne Illness in the US: Scope of the problem

Hospitalizations/yr – 55, 961

- **Bacteria 64%, Viruses 27%, Parasites 9%**
- **NT Salmonella 35%, Norovirus 26%, Campylobacter 15%**

***Toxoplasma gondii* 8%**

Deaths/yr - 1351

- **Bacteria 64%, Parasites 25%, Viruses 12%**
- **NT Salmonella 28%, Toxo 24%, Listeria 19%, Norovirus 11%**

Common Presentations of Food-borne Illness

Gastrointestinal

- **Rapid onset, predominantly nausea/vomiting**
- **Acute gastroenteritis with Watery diarrhea**
- **Acute dysentery**
- **Acute Hepatitis A**

Extra-GI Symptoms

- **Bacteremia and Meningitis (Listeria)**
- **Febrile Illness (Typhoid)**
- **HUS/TTP**
- **Neural toxins**

Rapid onset, predominantly nausea/vomiting

- **Ingestion of preformed heat stable entertoxin**
  - ***Bacillus cereus*** **(e.g., leftover fried rice)**
  - ***Staphylococcus aureus*** **(e.g., potluck potato salad)**

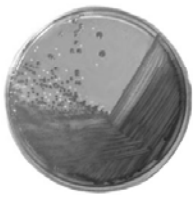
- **Oral ingestion of the organism**
  - **Noroviruses (Norwalk Agent, etc.) & other caliciviruses (fecal oral)**

Acute gastroenteritis with Watery diarrhea

- Ingested bacteria that produces enterotoxin
  - Enterotoxigenic *E. coli*
  - Salmonella (non-*typhi*)
  - Clostridium perfringens
  - Vibrio cholera
- Ingested protozoa
  - Cryptosporidia
  - Cyclospora
- Viral Exposures
  - Rotaviruses (especially children)
  - Noroviruses/Calici viruses

Acute dysentery

- Damage or invasion of enterocytes
- Fever
- Abdominal pain
- +/- Fecal leukocytes +/- Blood
- SSYC – Salmonella, Shigella, Yersinia, Campylobacter
- Enteroinvasive *E. coli*
- Shiga toxin producing (Enterohemorrhagic) *E. coli*
- *Vibrio parahaemolyticus*



Common Presentations of Food-borne Illnesses

Extra-GI Symptoms

- **Neural toxins – e.g., Ciguatera, Scromboid, Botulism**

FoodNet

- **Surveillance by CDC in 10 States (or parts of states) since 1996.**
- **Tracks *Campylobacter*, *Cryptosporium*, *Cyclospora*, *Listeria*, *Salmonella*, *E. coli* O157, *Shigella*, *Vibrio*, *Yersinia* across time**
- **Set National targets in Healthy People 2010 for Campylobacter, Listeria, Salmonella, and Shiga toxin-producing E. coli (STEC) O157**

FoodNet

- **Steepest progress occurred before 2004**
- **Target for STEC has been met**
- **Salmonella still the farthest from target**

Non-Typhoidal Salmonella

- **Watery diarrhea or dysentery**
- **Some decreased incidence since 1996-98, but not much improvement lately**
- **Transmitted via food from animals, produce, processed foods, chicks, reptiles, frogs, and (less commonly) water**
- **Only 5-8% cases were part of outbreaks**

***Foodnet MMWR, CDC.**

Non-Typhoidal Salmonella

Salmonella typhi

- **Mainly colonizes humans→ food/water fecal contamination**
- **Enteric fever commonly lacks diarrhea**
- **Antibiotic treatment is always indicated ***

Campylobacter

- Common US source of dysentery, mainly foodborne
- Associated w/ Poultry

Shigella

- Low infectious dose
- Spreads human to human (often food handlers) – not animals
- Declining incidence -- likely not attributable to food safety

Yersinia

- Dysentery and/or mesenteric lymphadenitis
- Seasonal increases and historic link to chitterling consumption
- Clinical labs may only check when prompted (not all include Y in “SSYC” bacterial stool cultures)

Vibrio infections

- **Diarrhea and sepsis**
- **Foodborne outbreaks usually *V. parahaemolyticus***
- **Saltwater niche**
- **Raw oyster consumption – Why avoid months <u>without</u> “R”? Why avoid months <u>with</u> “R”?**
- **Only Foodnet surveillance pathogen with increased incidence 2009 compared to 1996-98.**

Could be addressed in oysters

- ✓ **Rapid refrigeration**
- ✓ **Heat treatment**
- ✓ **Freezing**
- ✓ **Pressure treatment**
- ✓ **Cooking**

Treatment of bacterial enterocolitis

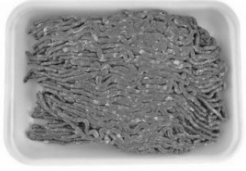
Salmonella	**No treatment or TMP/SMZ* or Quinolone* or Ceftriaxone**
Shigella	**TMP/SMZ* or Quinolone* or Ceftriaxone or Azithromycin**
Yersinia	**Doxycycline + aminoglycoside or TMP/SMZ or Quinolone**
Campylobacter	**Erythromycin**
Vibrio sp	**Doxycyline or TMP/SMZ or Quinolone**

* If not resistant to antimicrobial

IDSA Practice Guidelines for Infectious Diarrhea. Clin Infect Dis 2001;32:331-51.

Shiga-Toxin Producing *E. coli*

- **0157/H7 and more than 50 other strains**
- **Target for decreased incidence 0157 met Healthy People 2010 target**
- **Multiple foodborne sources including beef and produce**
- **Presentation with watery →bloody diarrhea, often <u>without</u> fever.**
- **Complicated by HUS-TTP**



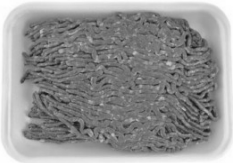
Shiga-Toxin Producing *E. coli*

Diagnosis

- Shiga toxin assay detects all strains;
- Culture technique using sorbitol MacConkey plates does not.

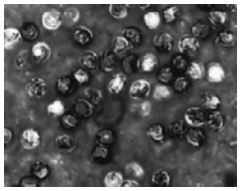
Management

- Possible Increased risk of HUS-TTP with antibiotic therapy
- Avoid treatment with antimotility agents



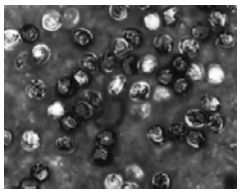
Cryptosporidia

- **Protozoa**
- **Sources: Treated or untreated water supply, pools, livestock**
- **Watery diarrhea– acute, subacute or chronic**
- **Self limited in immunocompetent**



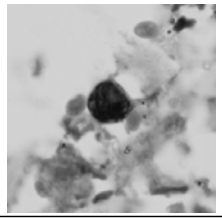
Cryptosporidia

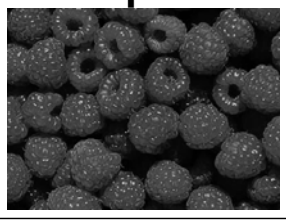
- **Persistent/complicated in immunocompromised (e.g., AIDS)**
  - ✓ **Extraintestinal complications include cholangitis**
- **Treatment in compromised patients**
  - ✓ **Nitazoxanide (data in children)**
  - ✓ **Paramomycin, azithromycin– if desperate**



Cyclospora

- **Foodborne outbreaks have included Guatemalan raspberries**
- **Watery diarrhea (acute) noted more commonly in the immunocompromised.**
- **Necessary lab studies - not done as part of Ova & Parasite**
- **Treatment condition – trimethoprim sulfa**





Listeria

- **Unpasteurized milk and soft cheeses, etc. from animal sources**
- **Cold tolerant bacteria**
- **Cases of acute gastroenteritis, miscarriages – usually not diagnosed**
- **Sepsis (worse if defects in cell mediated immunity, pregnant)**

Listeria

- **Meningitis, particularly extremes of age**
- **Decreased after 1996, but some increase in FoodNet 2009 in older age groups.**
- **Consider when cultures positive for Gram positive rods**
- **Treatment with ampicillin/gentamicin**

Norovirus (AKA Norwalk agent)

- Most common etiology for adult acute gastroenteritis
- Not tracked by FoodNet
- Humans are primary reservoir
- Low infectious dose – can infect via food, drink, utensils, other surfaces
- Vomiting, diarrhea, abdominal discomfort, dehydration typically limited to 48 hours – but shedding several days
- Tested by state health departments with RT PCR
- No specific treatment & no vaccination
- Hand washing with soap & water

Reasons to pursue diagnostic workup

- Diagnose (or pre-empt) an Outbreak
- Rule out Shiga-toxin producing *E. coli*
- Considering antimicrobial therapy
- Immunocompromised patients
- Risk factors for *C. difficile* colitis
- Lethal conditions under consideration (Typhoid, Listeria, other sepsis)