Carrier Cows, Menacing Microbes, and Human Health: An introduction to STEC preharvest food safety

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E. Coli is (mostly) harmless

- ***E. coli*** **is a common intestinal bacterium of mammals**
- **Many diverse strain types (serotypes)**
- **Most are harmless or beneficial**
- **Several serotypes cause disease**
- **Enterohemorrhagic *E. coli***
  - Diarrhea, bloody diarrhea, HUS
  - Shiga toxin → STEC

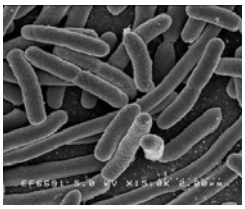


Image: MicrobeWiki

STEC and Foodborne Illnesses in the USA

- **Diarrheal disease, all causes: 47,800,000 / year**
  - STEC = 3.6%
- **Hospitalizations, all causes: 128,000 / year**
  - STEC = 1.85%
- **Deaths** due to all causes of foodborne illness: **3,000 / year**
  - STEC = 0.7% (~21)

CDC: http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html

STEC and Foodborne Illnesses

- Diarrheal disease: 47,800,000 / year
  - 3.6% STEC: **110,000 non-O157; 63,000 O157**
- Hospitalizations: 128,000 / yr
  - 1.85% STEC: **2,100 O157; 270 non-O157**
- Deaths: 3,000 / yr due to foodborne illness
  - 0.7% STEC: **20 due to O157; 0-1 due to non-O157**

CDC: http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html

E. coli O157:H7 as a Case Study

Why is *E. coli* O157:H7 still a problem, 15 years after "Jack in the Box"?

- **Ubiquitous**
- **Broad host range**
- **Invisible**
- **Prolific**
- **Potent**
- **Hardy**

E. coli O157 and Cattle Husbandry

E. coli O157 10% (0 – 100%)

E. coli O157 10% (0 – 100%)

Pre-harvest Food Safety:

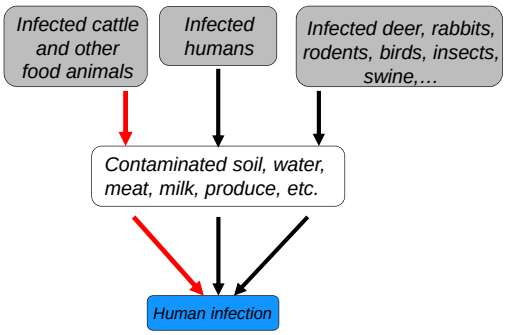
- **"Control of Zoonotic Diseases by Intervention in Animal Husbandry"**
- **Control / eradication programs for:**
  - Bovine tuberculosis
  - Brucellosis
  - *Trichinella spiralis* ("food safety for our food")

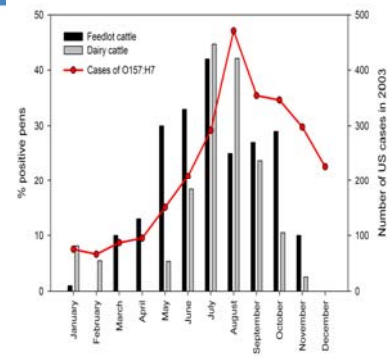
Broad host range

Animal reservoirs of *E. coli* O157 : cattle

- **Cattle as a reservoir**
  - No disease!
  - Summertime seasonal peak
  - Short-lived 'infection'
  - Low fecal shedding
    - <100–100,000 cells/g feces
  - Easily infected: 100-1,000 cells
  - Young animals (1 week - 2 yrs)

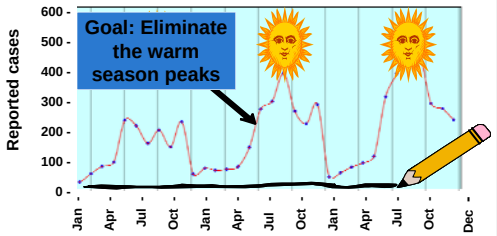
Sources / Routes of human infection



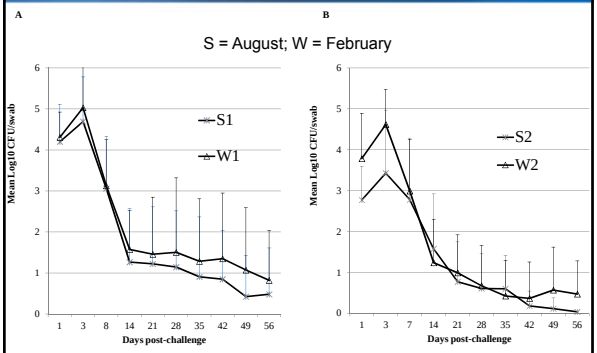


Data from CDC and Stanford et al 2005

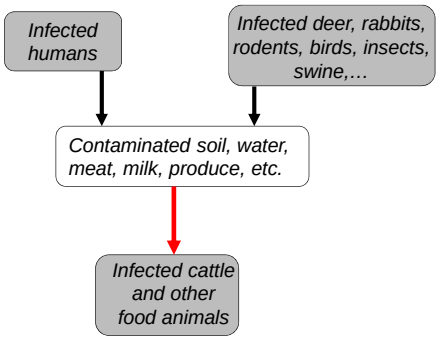
E. coli O157:H7 Cases in the U.S.



Cattle seasonal shedding due to seasonal exposure



Sources / Routes of infection



Whose fault is the *E. coli* O157:H7 problem?

Cattle ranchers and feeders?

As of 2013, the best science has to offer ranchers and feeders are interventions like vaccines that will (after multiple doses) reduce (but not eliminate) cattle shedding *E. coli* O157 in their feces for a limited time.

Meatpackers?

"*E. coli* path shows flaws in meat inspection"
NYT Michael Moss, 10/3/2009

Factors:

- **Modern plants; larger batch sizes**
  - probably unrelated to risk
  - Increase likelihood of detection
- **Safety through testing? No way!**
- **Challenge: 10,000 infected cattle/day (peak summer)**
- **HACCP: Mandated focus on process improvement**
- **Large investments in interventions:**
  - hide washers, carcass rinses, steam closets, etc.

Consumers?

"If consumers would just cook their food properly the O157:H7 problem wouldn't exist"

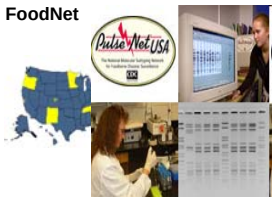
"FSIS reminds consumers of the importance of following food safety guidelines. Ground beef should be cooked to an internal temperature of 160°F or higher."

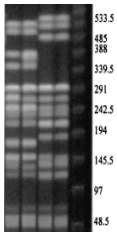
Factors:

- **Messy packaging**
- **Cross contamination in the kitchen**
- **Proper use of meat thermometer**
- **Salad vegetables**

Public health agencies?

- **Reporting regulations**
- **Pulsed field gel electrophoresis**
- **PulseNet**
- **FoodNet**





Summary

- ***E. coli* O157:H7 – a multi-faceted problem**
- **No broadly effective controls in animal reservoirs**
- **No current prospects for an *E. coli* O157:H7-free food supply or environment**

How safe is safe enough?

Cause of death	Annual	Lifetime
Heart disease	652,486	1 in 5
Cancer	553,486	1 in 7
Hospital-acquired infection	99,000	1 in 38
Car accident (2009)	44,757	1 in 100
Suicide (2009)	31,484	1 in 121
MRSA (resistant bacterium)	19,000	1 in 197
Drowning	3,306	1 in 4,919
Salmonella	378	1 in 9,915
Sun / heat stroke	273	1 in 13,729
Lightning strike	47	1 in 83,930
E. coli O157:H7	20	1 in 187,403
Fireworks accident	11	1 in 340,733
Shark attack	1	1 in 3,748,067
E. coli non-O157	0-1	≤1 in 3,748,067

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