Risk Assessments for
***Salmonella* Enteritidis in Shell Eggs and**
***Salmonella* spp. in Liquid Egg Products (Part I)**
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- Centers for Disease Control and Prevention
  - Plans to review

Outline

- Background
- Microbiology of *Salmonella*
- Epidemiology of Human Salmonellosis
- Conclusion

Background

- In 1996, FSIS, in collaboration with FDA, initiated a risk assessment to characterize the public health effects associated with consumption of *S.* Enteritidis-contaminated eggs
- Results indicated multiple interventions along the farm-to-table chain were necessary to reduce significantly the risk of illness from *S.* Enteritidis in eggs
- Results were useful in developing the Egg Safety Action Plan, etc. but were not deemed sufficient for evaluating FSIS risk management options for developing performance standards for eggs

Background

- Since then, however, additional data have become available
  - FSIS has conducted a national baseline survey to measure *Salmonella* levels in liquid egg products produced in the U.S
  - Experimental studies have clarified scientific issues associated with SE contamination in egg yolk
  - The American Egg Board sponsored studies on lethality kinetics of *Salmonella* spp. in liquid egg products
  - A dose-response model for *Salmonella* spp. has been developed by FAO/WHO

Microbiology of *Salmonella*
Nomenclature

- *Salmonella* Enteritidis

Salmonella species and subspecies	No. of Serovars
S. enterica subsp. *enterica* (I)	1,454
S. enterica subsp. *salamae* (II)	489
S. enterica subsp. *arizonae* (IIIa)	94
S. enterica subsp. *diarizonae* (IIIb)	324
S. enterica subsp. *houtenae* (IV)	70
S. enterica subsp. *indica* (VI)	12
S. bongori (V)	20
TOTAL	2,463

The Salmonellae

- Gram-negative, rod-shaped bacteria
- Facultatively anaerobic
- Motile by means of flagella

Affect of Temperature and pH on Growth of *Salmonella*

Condition	**Minimum**	**Optimum**	**Maximum**
Temperature (ºC)	5.2	35–43	46.2
pH	3.8	7–7.5	9.5

Contamination of Shell Eggs

- *S.* Enteritidis is transmitted to eggs through two routes
  - Trans-ovarian (vertical) transmission
    - SE is introduced into the egg from infected ovaries or oviduct tissue before egg is laid
    - Primary route of contamination
  - Trans-shell (horizontal) transmission
    - Can result from fecal contamination of the eggshell

Epidemiology of Human Salmonellosis

Salmonellosis

- Foodborne salmonellosis in the U.S.
  - ~1.3 million illnesses
  - ~15,600 hospitalizations
  - ~550 deaths

Salmonellosis

- Salmonellosis case costs:
  - ~$440 (no physician visit)
  - ~$950 (physician visit)
  - ~$10,700 (hospitalization)
  - ~$455,000 (death)

Disease Characteristics

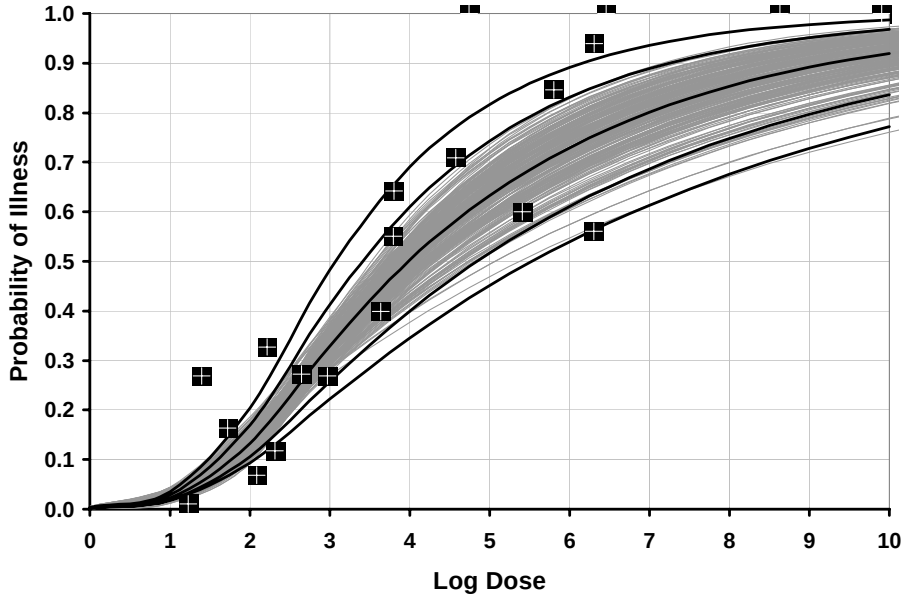
- Symptoms include diarrhea, fever, abdominal pain or cramps, vomiting, headache, and nausea
- Incubation period ranges from 8 to 72 hours with symptoms lasting up to a week
- Severity of infection varies. While most are self-limiting, some are fatal

Sequellae

- Reactive arthritis
  - Symptoms develop 7 to 30 days after intestinal illness
  - Develops in about 2 to 3% of persons with salmonellosis

- Urethritis
- Conjunctivitis
- Weight loss of over 5 kg
- Oral ulcers
- Pneumonia

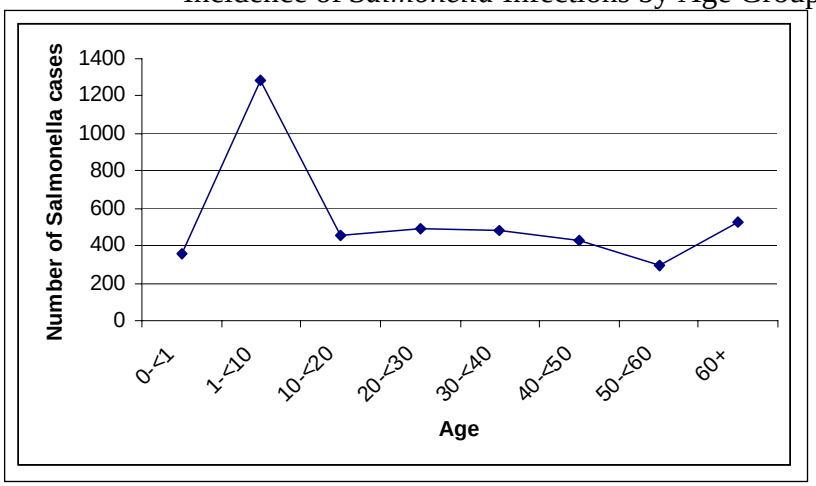
Dose-response and Outbreaks



Salmonella Cases Per 100,000 Population, 2000

Infection from *Salmonella* appears to occur most frequently in the summer. Similar seasonal patterns have been documented for outbreaks of infection caused by *S.* Enteritidis and for *Salmonella*-positive spent hens at slaughter. Warm temperatures provide an environment in which *Salmonella* can grow during the processes of production, transport, and storage. The data presented in this figure may also reflect, in part, picnics, cookouts, and other similar group functions that commonly take place in the summer.

Incidence of *Salmonella* Infections by Age Group (Yrs), 2000



Salmonella Isolates from Human Sources by Serotype and Year, 1976-2000

5,116 *S.* Enteritidis isolates reported for 2002 (comprising 15% of all *Salmonella* isolates). Second only to *S.* Typhimurium (7,062 isolates; 21.9%)

S. Enteritidis and Eggs

- The period 1976 to 1995 saw an 8-fold increase in infections with *S.* Enteritidis reported to the CDC
  - Greater than 75% of the infections were associated with foods containing undercooked eggs

S. Enteritidis and Eggs

- From 1985 through 1998, 794 SE outbreaks were reported to CDC
  - Involved 28,644 illnesses, 2,839 hospitalizations, and 79 deaths
  - Greater than 75 percent were associated with foods containing undercooked eggs

Illness Estimates from Surveillance Data

Surveillance Step	Estimate
1. *Salmonella* illnesses ascertained by FoodNet	4,330
2. Isolates serotyped	3,964
3. Serotyped isolates that were SE	585
4. Ratio of serotyped isolates that were SE	0.15
5. Estimated number of illnesses from *Salmonella* attributable to SE	639
6. Population of catchment area	30,500,000
7. Incidence of SE in catchment area	2.1/100,000
8. U.S. population	281,400,000

9. Estimated cases of SE in U.S.	5,896
10. Illness underreporting multiplier	37
11. Illness from SE	254,688
12. Proportion of SE illnesses from eggs	0.80
13. Estimated annual illnesses from SE in eggs	174,356

Conclusions

- Based on surveillance data, shell eggs have been identified as an important vehicle of infection from *S.* Enteritidis
  - >75% of *S.* Enteritidis outbreaks have been egg-associated
  - We know of no outbreaks from *Salmonella* in liquid egg products
- New data and modeling techniques have enabled us to conduct robust risk assessments for *S.* Enteritidis in shell eggs and *Salmonella* spp. in liquid egg products