

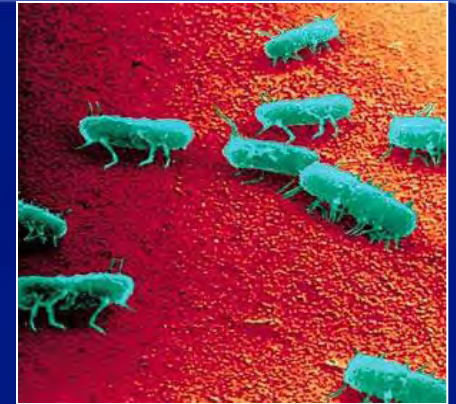
The Rise and Fall and Rise of *Salmonella* Serotype Enteritidis (SE) Infections

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Centers for Disease Control and Prevention

**Collaborative Food Safety Forum
November 3, 2011**

Salmonella



- ❑ **Most common bacterial cause of foodborne disease in the US**
 - 1 million foodborne illnesses and 380 foodborne deaths annually
- ❑ **Many food sources, e.g., meat, poultry, produce**
- ❑ **Also transmitted by water, contact with animals and their environment**
- ❑ **>2,500 serotypes**
 - serotype Enteritidis is responsible for ~18% of *Salmonella* infections in the United States

***Salmonella* Infection**

- ❑ Time between ingesting *Salmonella* and getting sick is 8 to 72 hours
- ❑ Illness typically lasts 4 to 7 days
- ❑ **Illness**
 - ❑ Usual: diarrhea (sometimes with bloody stools), abdominal cramps, fever, vomiting
 - ❑ Serious: meningitis, bloodstream infection, joint infection
 - more common in young children, elderly, immunocompromised

The First Problem of *Salmonella* and Eggs

- ❑ **Early 1960s: outbreaks of *Salmonella* infections linked to eggs**
 - caused by contamination on shell
 - many serotypes involved
 - control program: eggs are now washed and graded
- ❑ **Egg-associated *Salmonella* illnesses declined**



A New Problem – *Salmonella* serotype Enteritidis

- In 1985, CDC noted that infections with *Salmonella* serotype Enteritidis (SE) had markedly increased



A Smart phone Analogy

Surveillance systems are like “apps” – each has a different purpose

CDC Enteric Disease Surveillance



PulseNet



LEDSS



NARMS



Listeria Initiative



FoodNet



FDOSS



CaliciNet



NVEAIS

Surveillance for SE

CDC Enteric Disease Surveillance



PulseNet



FoodNet



LEDs



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Surveillance for SE

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Laboratory-based Enteric Disease Surveillance LEDS



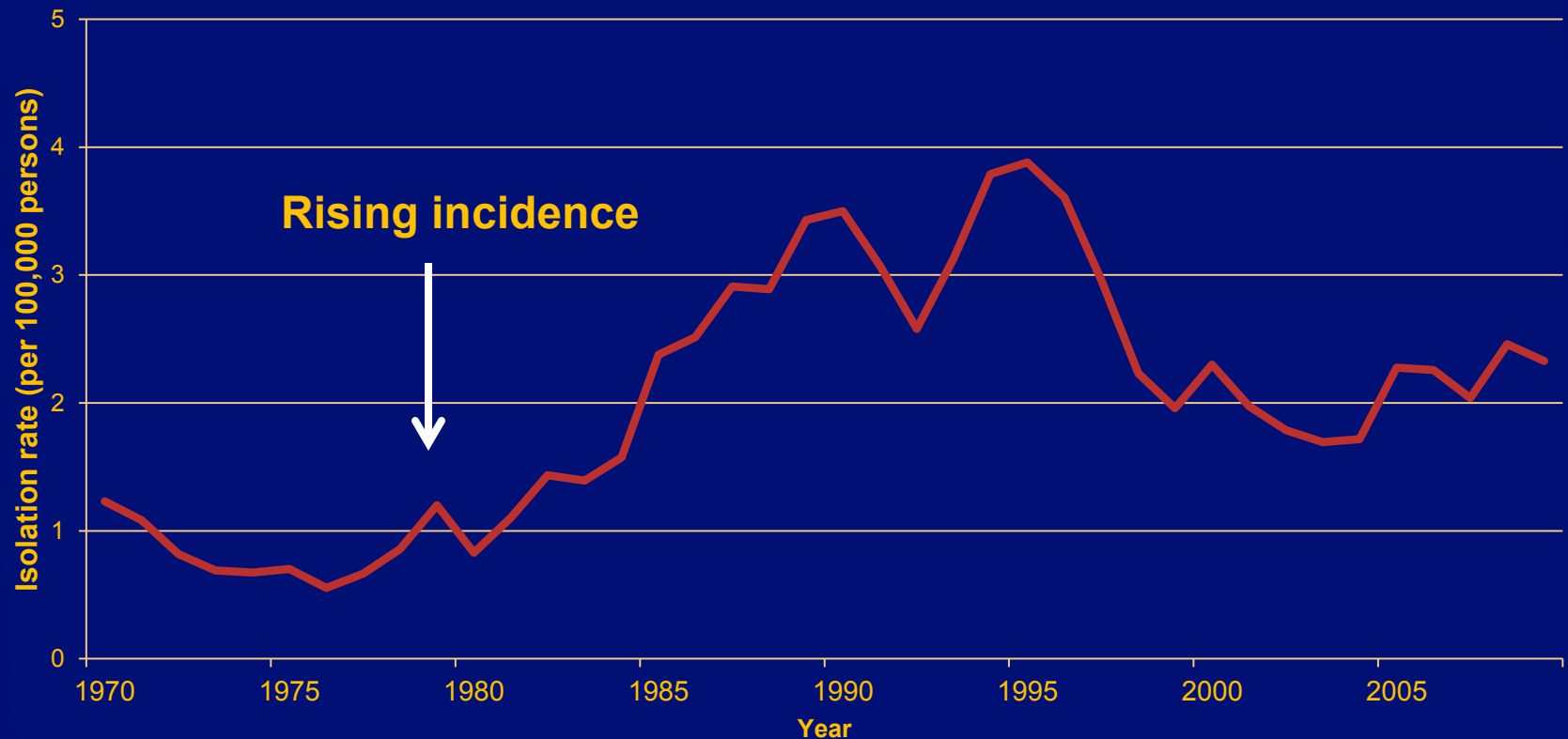
Collects laboratory data, eg, serotype, on *Campylobacter*, *E. coli*, *Shigella*, and *Salmonella*

Developed: National *Salmonella* serotype surveillance began in 1963.

Because: Serotyping is needed to track trends and detect outbreaks, in synergy with PulseNet.

Now: State public health labs send serotype data (with patient age, sex, residence) electronically to CDC.

Incidence of *Salmonella* Serotype Enteritidis Infections, United States, 1970-2009



Data from Laboratory-based Enteric Disease Surveillance (LEDS)

Surveillance for SE

CDC Enteric Disease Surveillance



PulseNet



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Salmonella Egg Problem Returns, in a Different Form



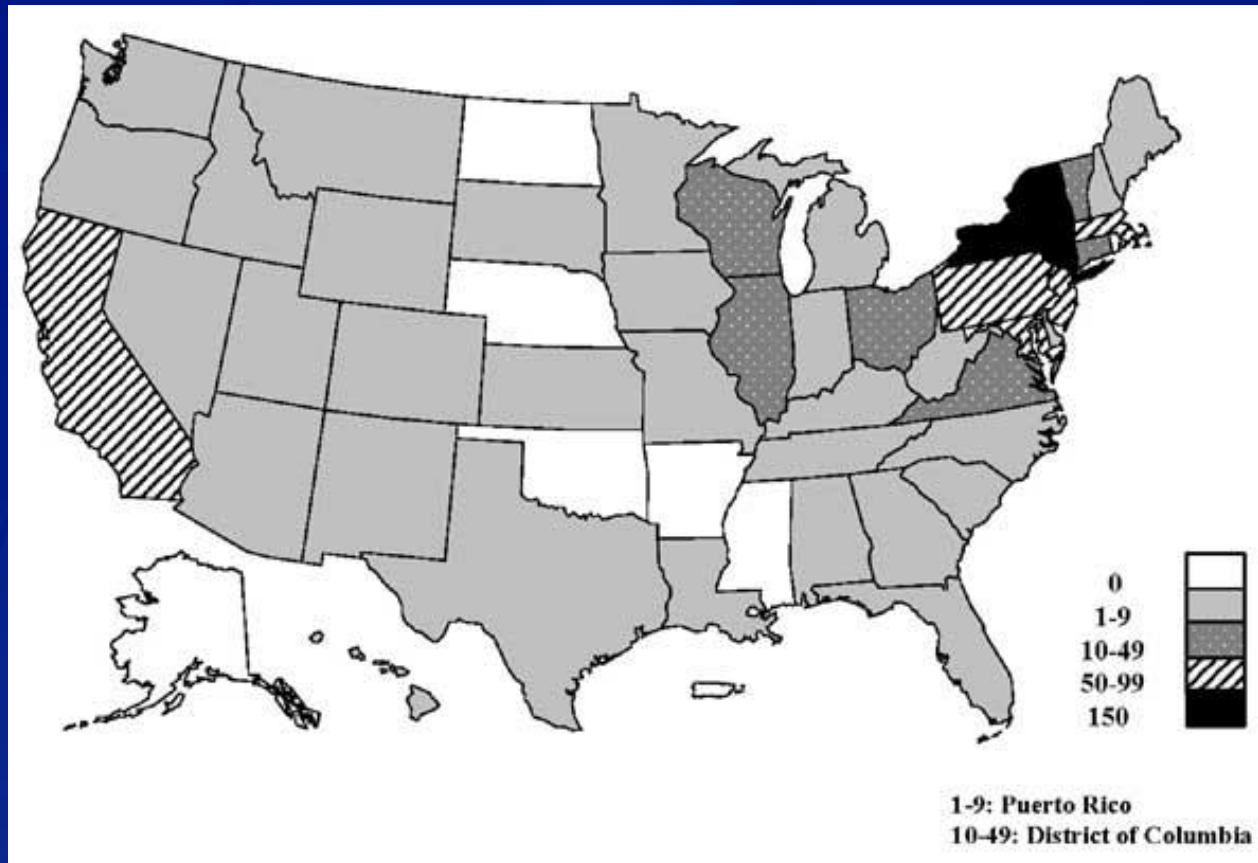
- Review of reports in Foodborne Disease Outbreak Surveillance System
 - many SE outbreaks
 - few listed “eggs” as the vehicle
 - many vehicles were foods that contained eggs, e.g., lasagna, home-made ice cream

***Salmonella* Egg Problem Returns, in a Different Form**



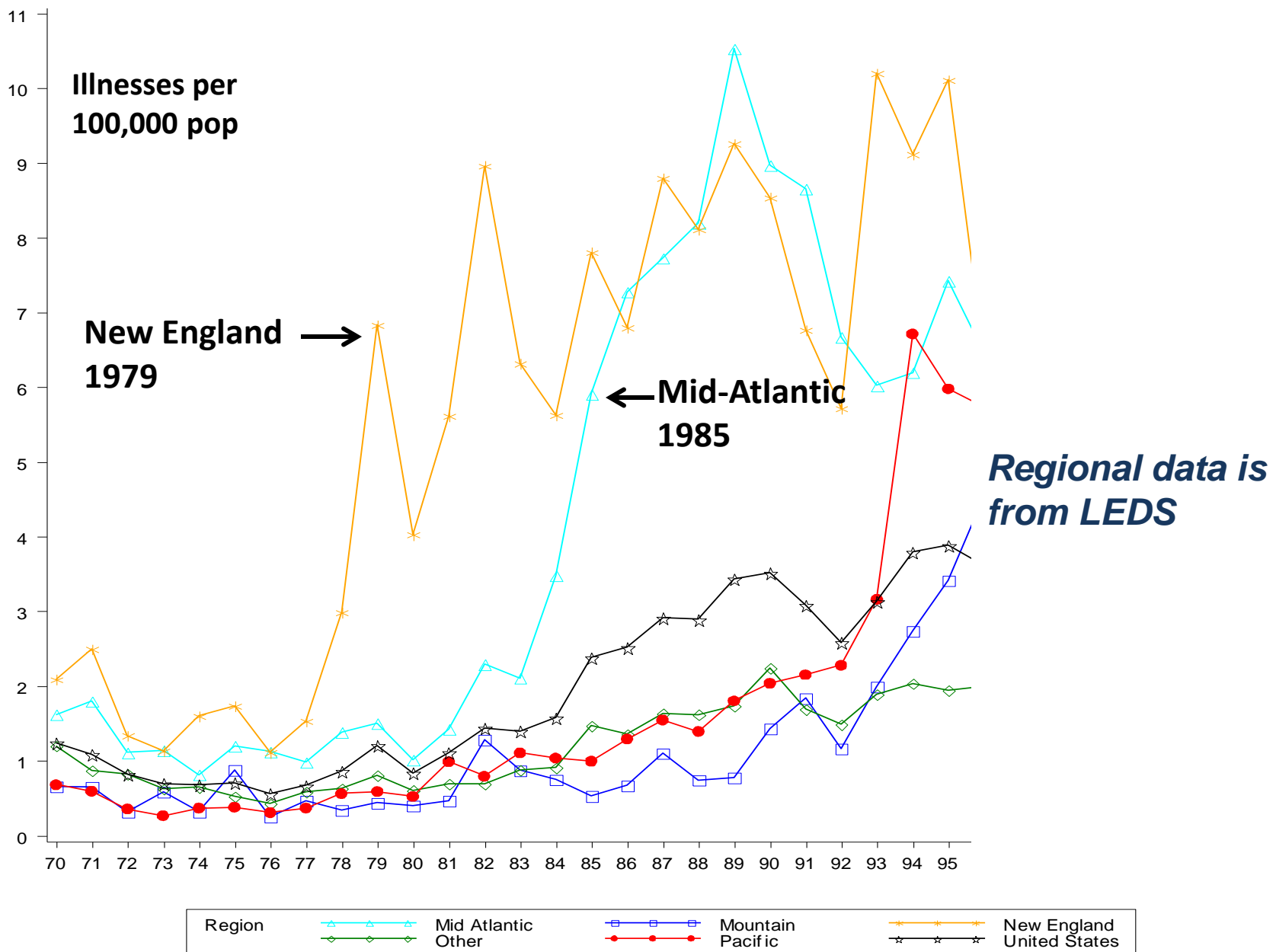
- ❑ **Review of reports in Foodborne Disease Outbreak Surveillance System**
 - many SE outbreaks
 - few listed “eggs” as the vehicle
 - many vehicles were foods that contained eggs, e.g., lasagna, home-made ice cream
- ❑ **CDC hypothesis: SE was infecting hen’s ovaries, so eggs were internally contaminated**
- ❑ **Over the next decade, many investigations verified**
 - that eggs were the predominant source of SE infections
 - and that hens’ ovaries were infected

Number of SE Outbreaks, by State, 1985-1999



- ❑ Epidemic began in NE United States, spread across nation; also came from West eastward
- ❑ Epidemic peaked in mid 1990s
- ❑ Pandemic (worldwide)

Rise of Serotype Enteritidis, by Region, 1970–1996



Recommendations for Food Preparation

- ❑ For all consumers → avoid raw eggs
- ❑ For high risk consumers → use pasteurized eggs
- ❑ For food establishments → avoid pooling eggs and serve pasteurized eggs instead of raw eggs

Unique Challenges with Control of SE in Eggs

❑ Serotype Enteritidis (SE)

- causes no illness in the chicken
- colonizes chicken ovary
 - so, infects eggs before shell formed
 - so, next generation of chickens is infected before birth
- persists in henhouses via rats (rats scavenge, chickens eat feces)

❑ Eggs

- consumption not always recalled
 - eg, an ingredient in baked lasagna
 - eg, used in brooding chicken and fish

❑ Outbreak investigations

- egg distributors began mixing eggs from different farms
 - this limited ability to trace eggs in outbreaks to farm of origin

SE Control Measures

- ❑ **USDA piloted an Egg Quality Assurance Program (EQAP) in Pennsylvania, which was later adopted by other states**
 - chicks from SE-free breeders
 - clean water and SE-free feed
 - biosecurity and rodent control
 - cleaning and disinfection of hen houses between flocks
 - refrigeration of eggs from farm onwards
- ❑ **FDA showed that refrigerating eggs prevents growth of SE**
- ❑ **CDC showed that states with EQAP had fewer people sick with SE**

But EQAP was not mandatory in every state

Fall of SE

- ❑ **Decline in SE illness incidence in late 1990s through early 2000s**
 - documented by Laboratory-based Enteric Disease Surveillance (LEDS)
- ❑ **Decline in egg-associated SE outbreaks**
 - documented by Foodborne Disease Outbreak Surveillance System (FDOSS)

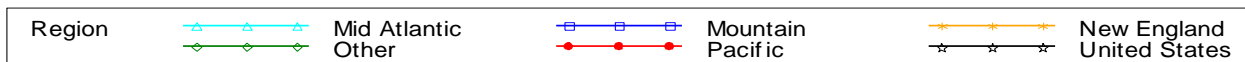
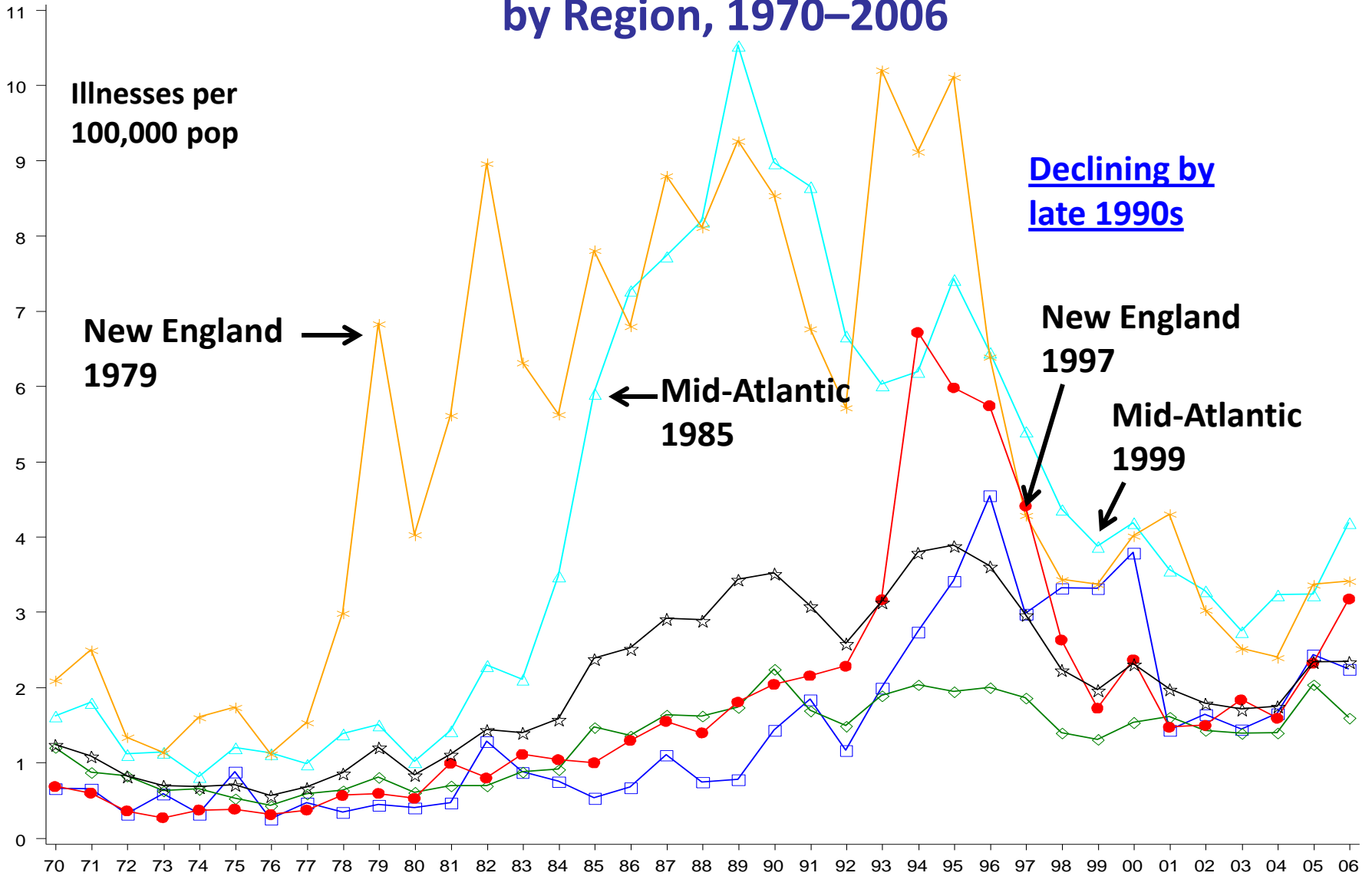


LEDS

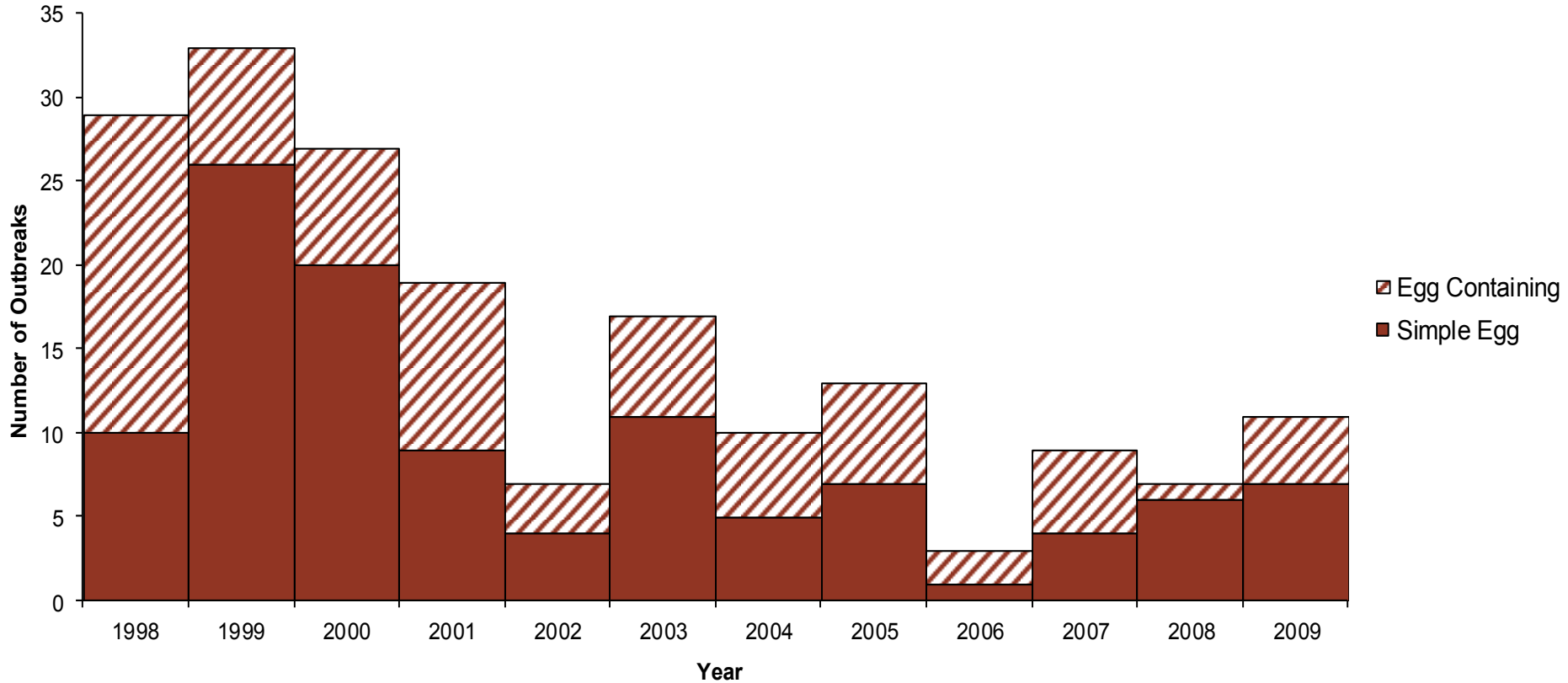


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Incidence of *Salmonella* Serotype Enteritidis infections, by Region, 1970–2006



Salmonella serotype Enteritidis Outbreaks due to Eggs or Egg-containing Food, 1998–2009



The next chapter

Cycle of Foodborne Disease Control and Prevention



Surveillance Shows SE Rising Again!

- Increase began ~2005
- Why? Reasons
 - Known: egg control measures were still not mandatory
 - Possible: other source(s) becoming more important modes of transmission

Incidence of SE Infections, FoodNet, 1996–2010



Other Sources for SE

- ❑ **FoodNet case-control studies of sporadic illnesses**
 - 1996: associated with eating chicken outside the home
 - 2002: associated with
 - eating undercooked eggs
 - eating chicken outside the home
 - international travel, and
 - having bird or lizard at home
- ❑ **Other data pointing to chicken**
 - NARMS Retail Food Study
 - 2006-2009: 1.8% of chicken breast samples contaminated with SE
 - a 3-fold increase from previous 4 years
 - Europeans have long reported SE outbreaks from eating chicken

What's Ahead for Source Tracking of SE?

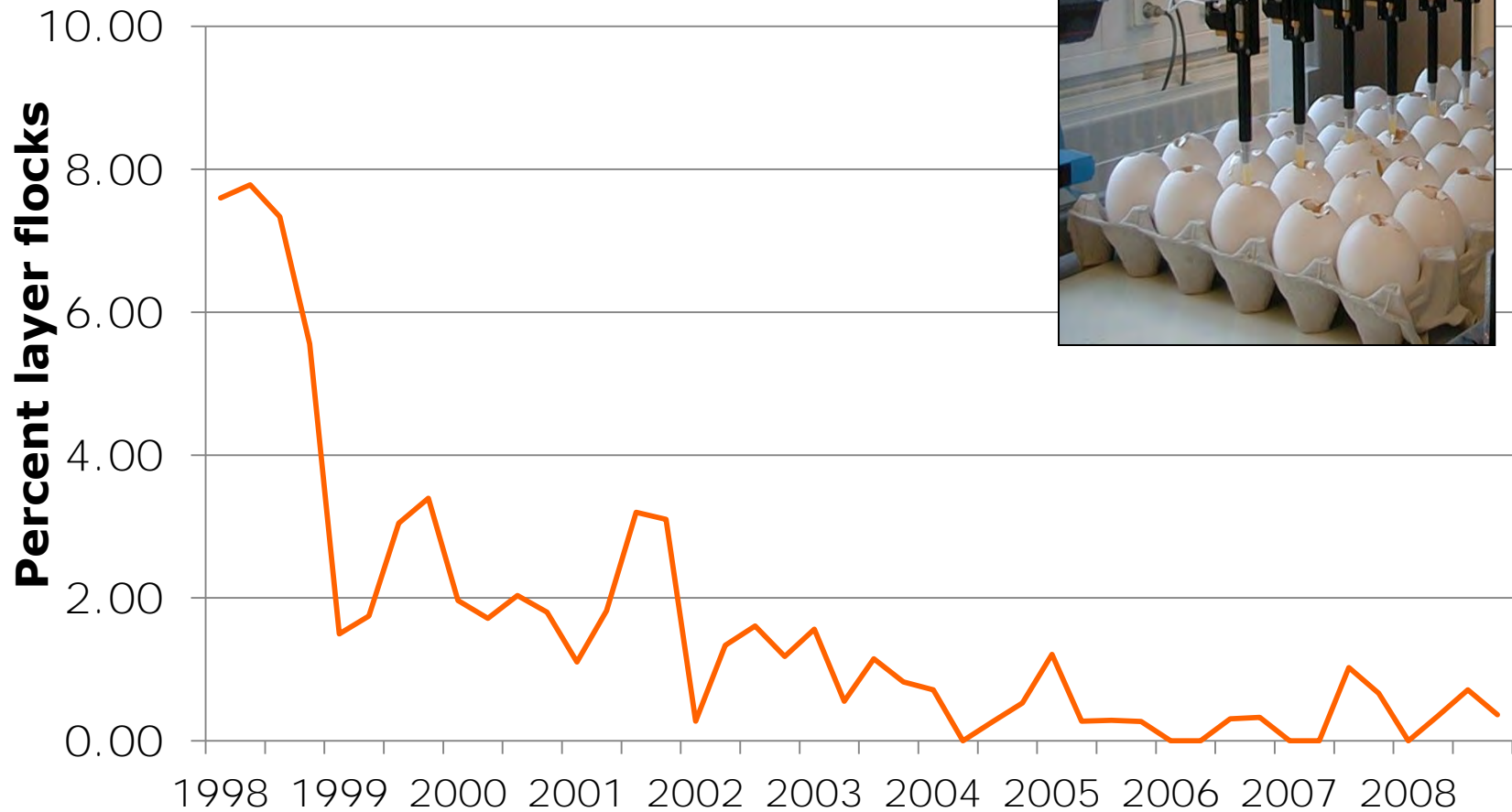
- ❑ Massive SE outbreak in 2010 is putting added focus on egg safety
 - eggs implicated
 - egg farm had major hygiene issues
- ❑ **FDA's egg rule may result in fewer egg-associated SE illnesses**
 - implemented July 2010
- ❑ **However, SE has other sources**

Is Control Possible?

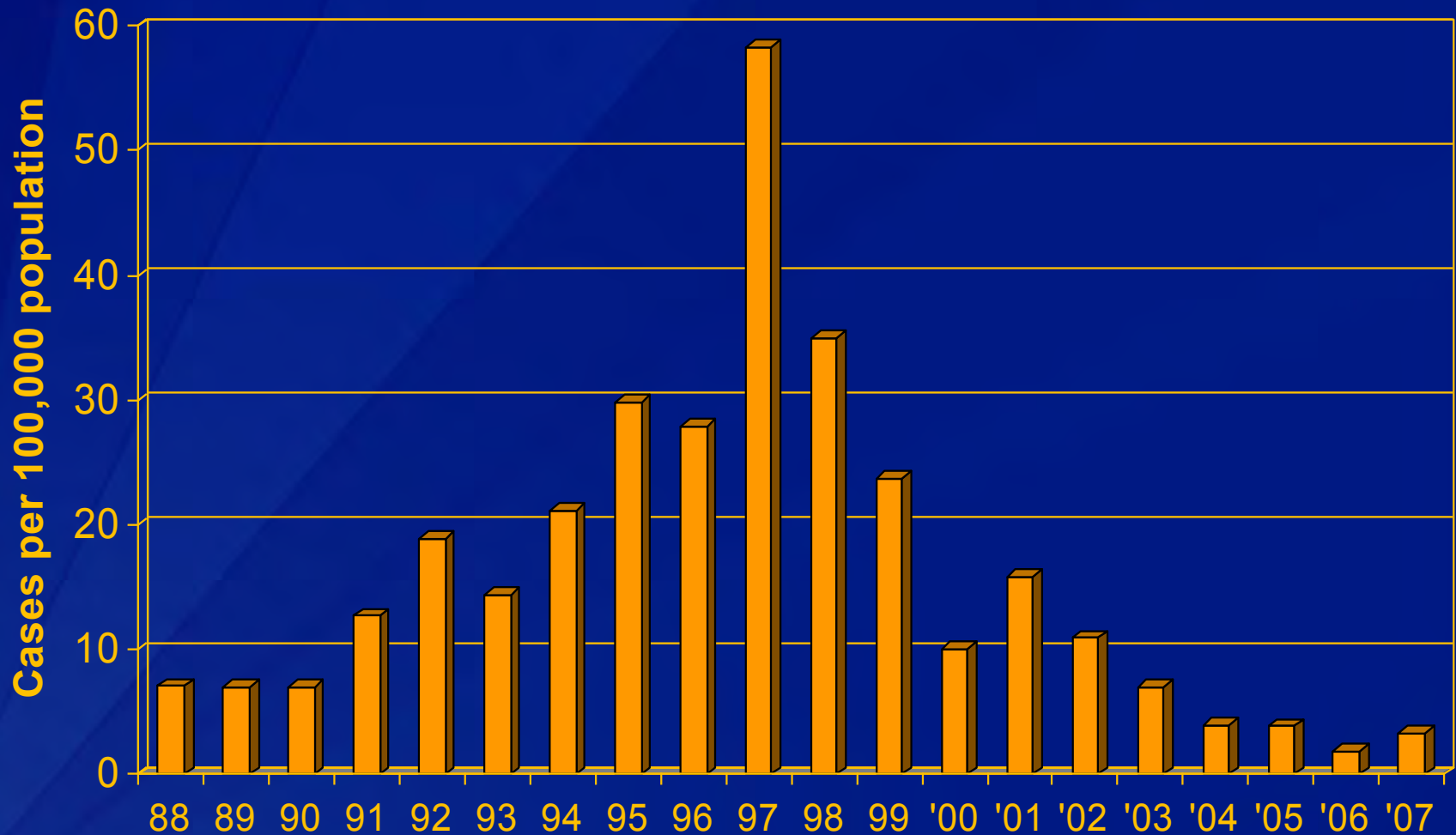
- ❑ **UK used same control methods as EQAP, plus they vaccinated egg and broiler breeder flocks**
 - recently had a dramatic decrease in human incidence of SE
- ❑ **Denmark has also had a successful control program**

EQAP = Egg Quality Assurance Program

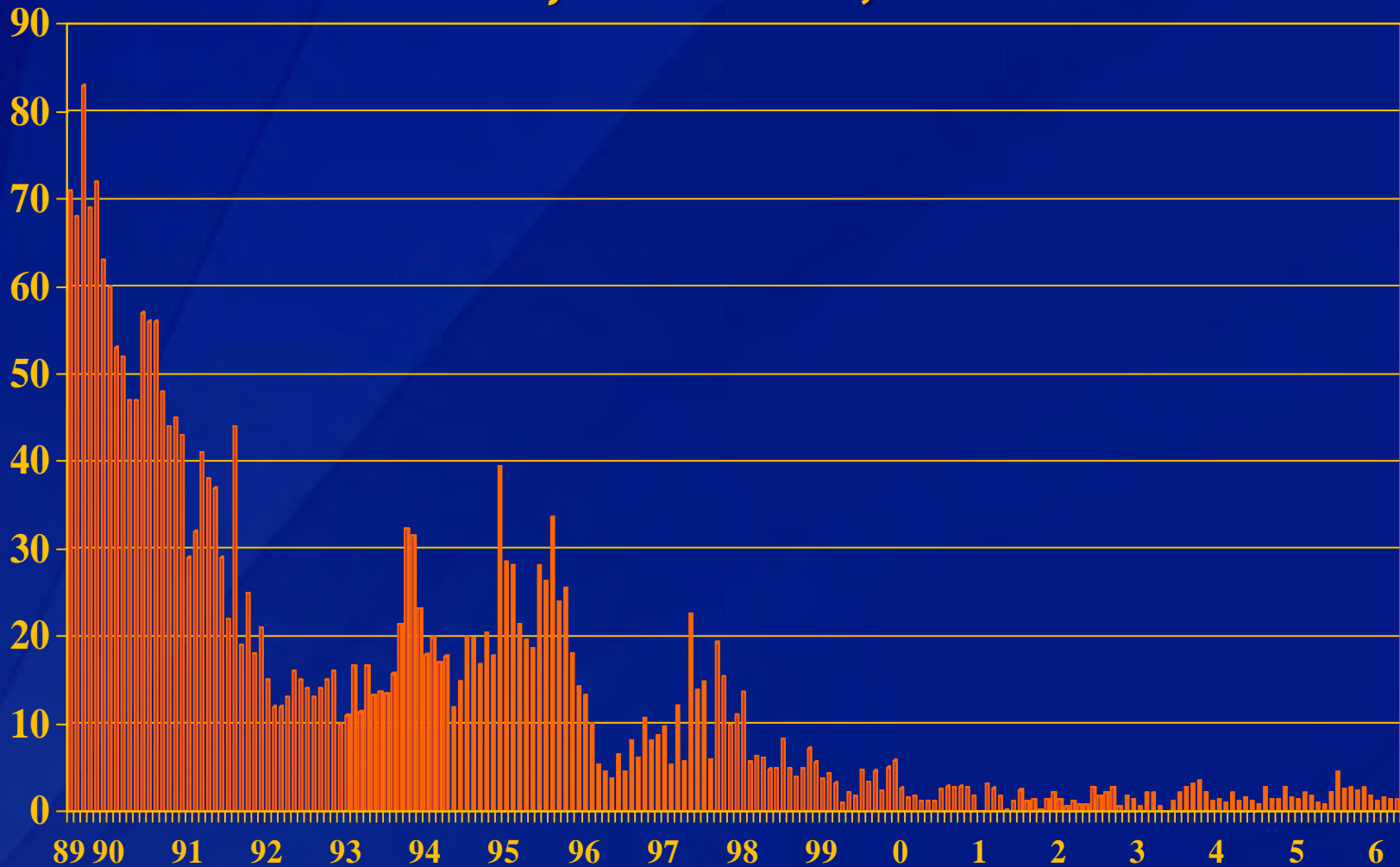
Percent of Egg Layer Flocks Infected with *Salmonella*, Denmark, 1998-2008



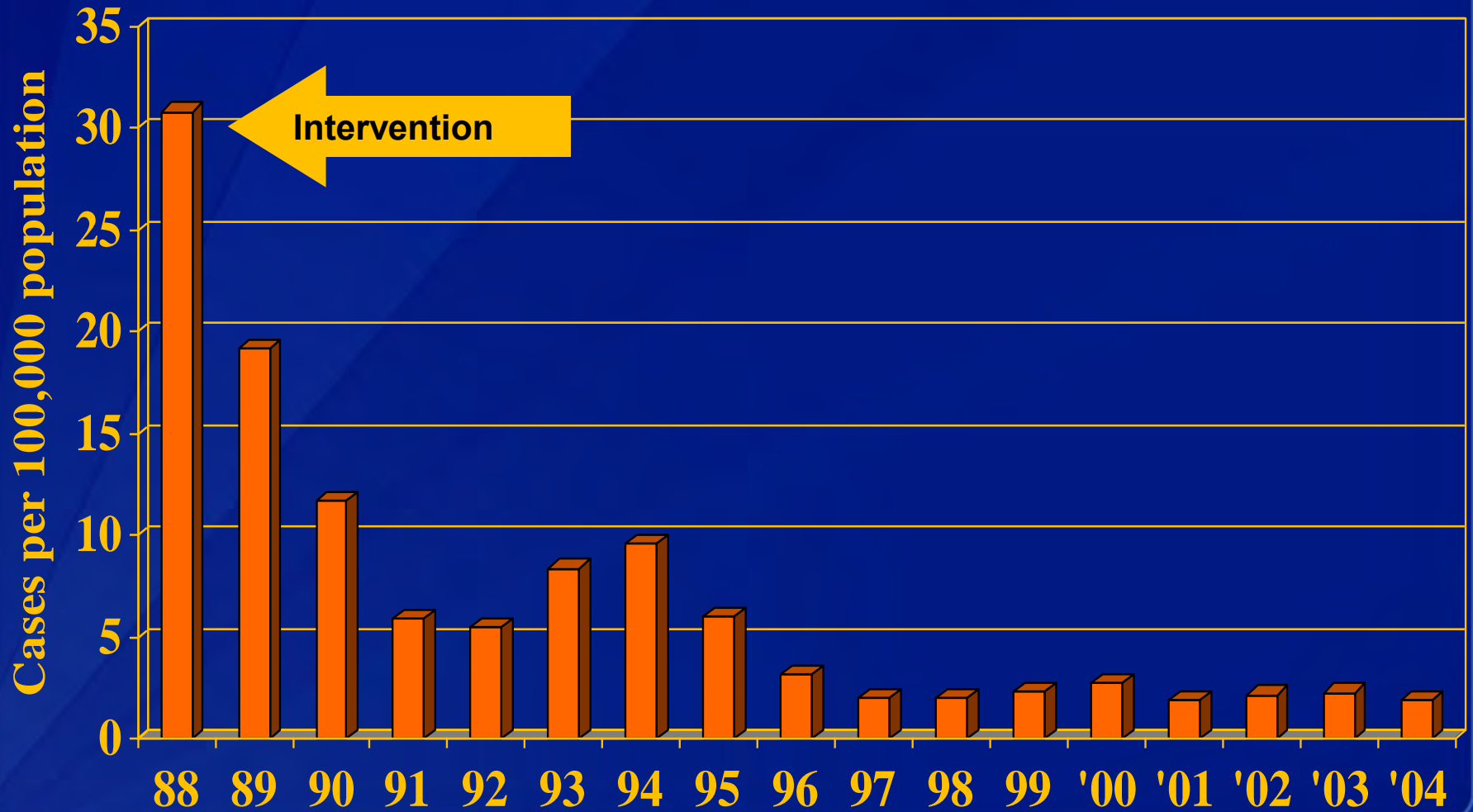
Incidence of Human Salmonellosis Attributed to Eggs, Denmark, 1988-2009



Percent of Broiler Flocks Infected with *Salmonella*, Denmark, 1989-2006



Incidence of Human Salmonellosis Attributed to Eating Chicken, Denmark, 1988-2004



What Tools Are We Using to Track This Problem?

- ❑ National Molecular Subtyping Network for Foodborne Disease Surveillance (**PulseNet**)
- ❑ Laboratory-based Enteric Disease Surveillance (LEDS)
- ❑ Foodborne Diseases Active Surveillance Network (FoodNet)
- ❑ National Antimicrobial Resistance Monitoring System (NARMS)
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CDC Enteric Disease Surveillance



PulseNet



FoodNet



LEDS



NARMS



FDOSS

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CDC Enteric Disease Surveillance



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LEDS



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PulseNet



FoodNet



LEDS



NARMS



FDOSS

Surveillance Gives Us the Current Picture of SE Infections

- ❑ **Incidence** (lab-confirmed infections per 100,000 population)
 - most recent 12 months (through June 2011): 3.3
 - previous 12 months (ending June 2010): 3.0
- ❑ **Food vehicles** (% of outbreaks with known vehicle, 2005-2009)
 - 28% eggs
 - 11% poultry
 - 61% other commodities and complex foods
 - many contained eggs or poultry

More Surveillance Data is Needed

- Data on contamination of eggs with SE and other *Salmonella*

Summary

- ❑ **The rise and fall and rise of SE shows the importance of many components of the foodborne disease surveillance system in**
 - determining trends
 - detecting outbreaks
 - evaluating the effectiveness of control measures
- ❑ **Data from other countries show**
 - the value of data on isolations from food and animals
 - that control is possible



PulseNet



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LEDS



NARMS



FDOSS

Acknowledgments

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- ❑ FDA
- ❑ Current and former members of Enteric Diseases Epi and Lab Branches, and Outbreak Branch

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention

Egg Rule in Brief

- ❑ **Raise hens under SE-monitored conditions**
 - Chicks must meet “US S. Enteritidis Clean” standards
 - Test environment for SE when hens 14-16 weeks old and if positive, test eggs and clean environment
- ❑ **Control introduction or transfer of SE among poultry houses**
 - Limit visitors and prevent stray animals from entering poultry houses
 - Prevent cross contamination of equipment or persons among poultry houses
- ❑ **Control rodents, flies, and other pests**

Egg Rule in Brief

- ❑ Clean and disinfect poultry houses, but only if environmental or egg testing positive
- ❑ Refrigerate eggs within 36 hours after they are laid
- ❑ Document compliance with rule
- ❑ Register with the FDA
- ❑ Rule defines environmental sampling and testing methods and frequency
- ❑ Rule defines egg sampling and testing methods and frequency; testing only required if environmental sample testing is positive

Pennsylvania SE Pilot Project

- ❑ **Begun in early 1990s**
 - with US Department of Agriculture's Animal and Plant Health Inspection Service
- ❑ **Provided knowledge of on-farm ecology of SE**
 - how to sample a farm for SE
 - how to prevent and reduce contamination on farms
- ❑ **Led to general strategy of**
 - testing farm environment and
 - diverting eggs to pasteurization if environment positive for SE



SE Control Measures

- ❑ **National Poultry Improvement Plan**
 - established standards for SE-free breeder flocks
- ❑ **US Dept of Agriculture**
 - Breeder flock testing for interstate commerce
 - Refrigeration and labeling of eggs
- ❑ **Food and Drug Administration**
 - Refrigeration at retail
 - Egg carton label changes