

# Control of Emerging Foodborne Pathogens (An Industry Perspective)

**ILSI-ICMSF Symposium  
New Delhi  
21-22 October 2008**



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**Four steps lead from detection  
to control of emerging pathogens**

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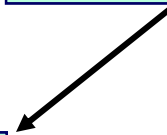
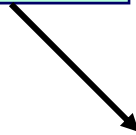
**1. Detection**

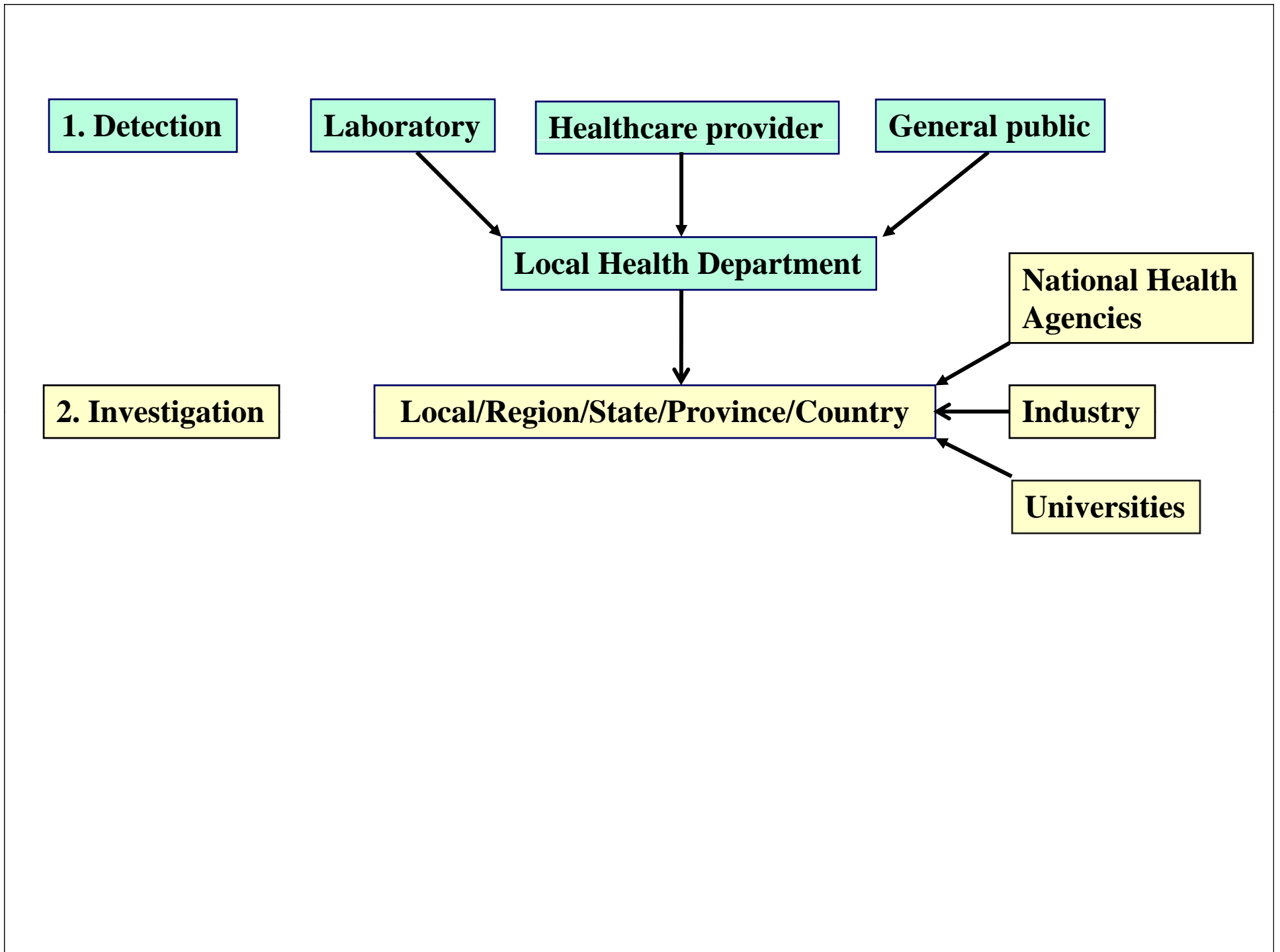
**Laboratory**

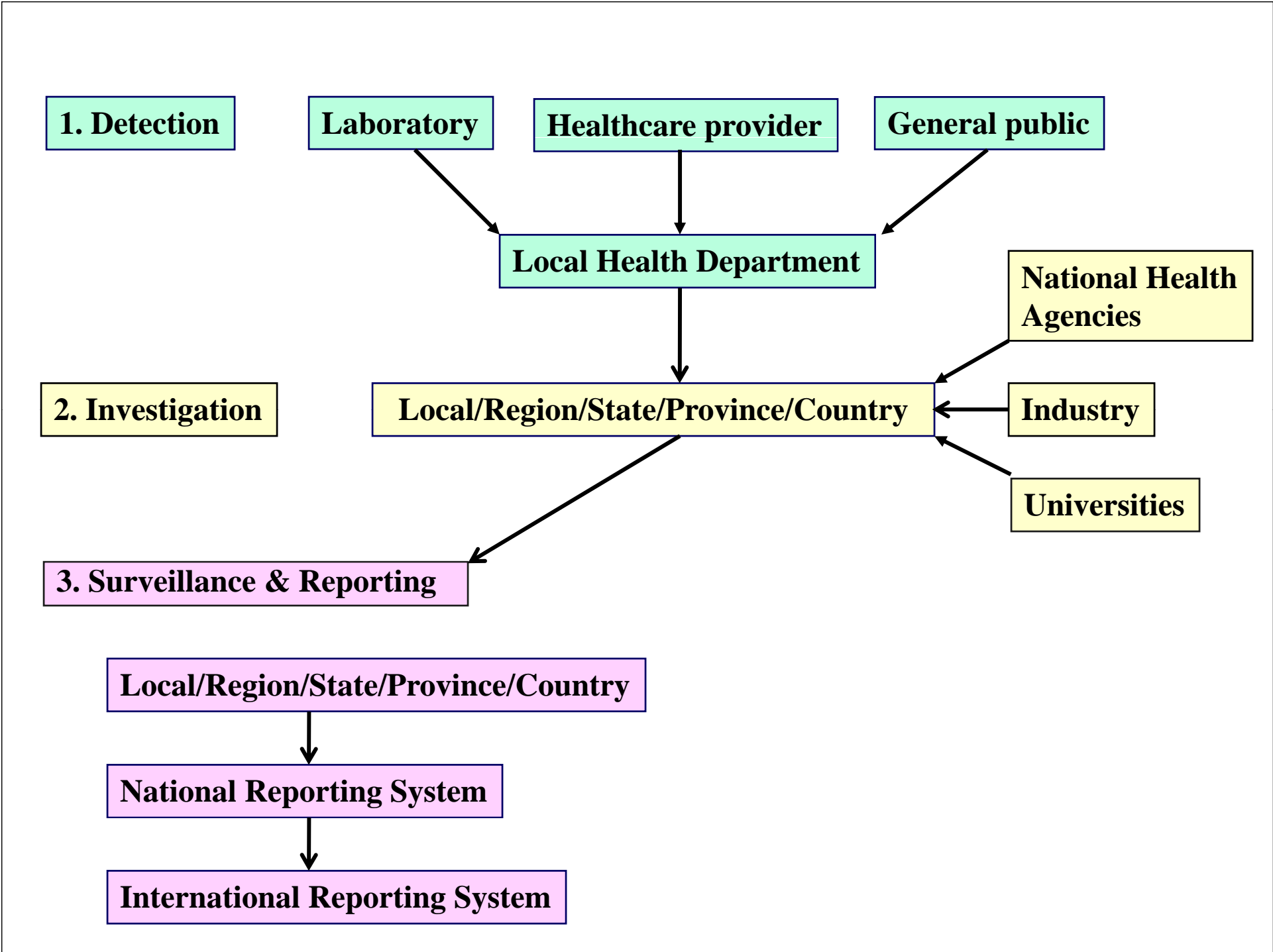
**Healthcare provider**

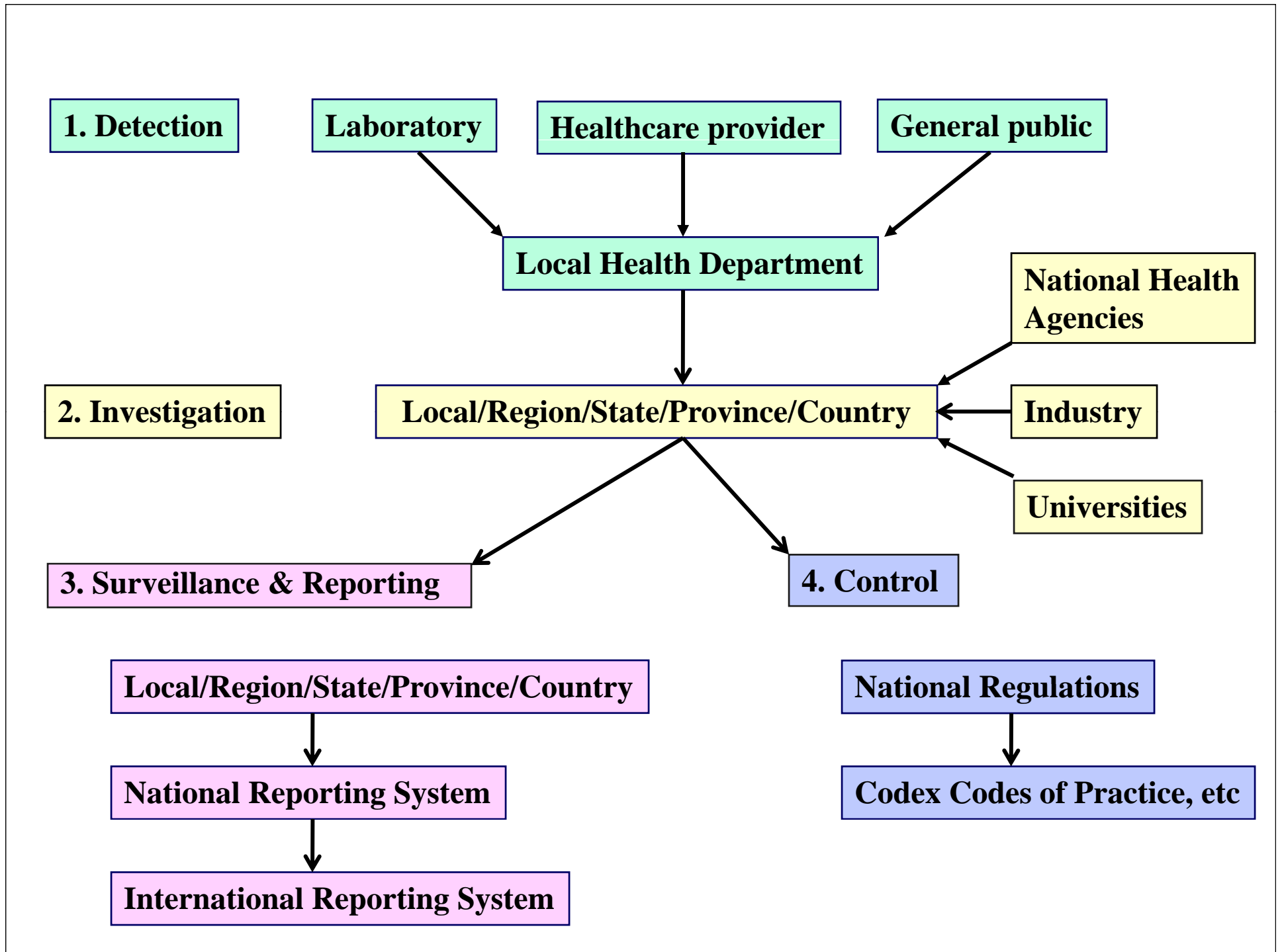
**General public**

**Local Health Department**












# 1. Detection

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# Detecting “new” foodborne pathogens

<1900	<i>V. cholera, T. spiralis, C. botulinum, Salmonella, Shigella</i>
1900-10	<i>B. melitensis</i>
1910-20	<i>S. aureus, foodborne polio</i>
1920-30	
1930-40	<i>S. aureus, hepatitis A</i>
1940-50	<i>B. cereus, C. perfringens, V. parahemolyticus</i>





## Detecting “new” foodborne pathogens

1950-60	<i>L. monocytogenes</i> , <i>C. perfringens</i> , <i>V. parahemolyticus</i> , <i>Anisakidae</i>
1960-70	<i>B. cereus</i> , <i>V. parahemolyticus</i> , <i>V. vulnificus</i> , aflatoxin and other mycotoxins
1970-80	<i>C. jejuni</i> , <i>Y. enterocolitica</i> , Norwalk virus, <i>Giardia</i> , vomitoxin
1980-90	<i>L. monocytogenes</i> , <i>E. coli</i> O157:H7, <i>E. sakazakii</i>
1990-00	<i>Cyclospora</i> , <i>Cryptosporidium</i> , nvCJD
2000-10	



## 2. Investigation

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# Investigation

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- **Case definition**
- **Symptoms and severity of disease**
- **How disease occurs - infection, toxin, virulence factors, etc**
- **Methods to detect and quantify**
- **Sources and how humans are exposed**
- **Effect of temperature, pH,  $a_w$ , etc. on growth and survival**
- **Where is control possible in the food chain**
- **How to control the pathogen (GHP, HACCP)**
- **Degree of control (prevent, eliminate, reduce)**



## 3. Surveillance and reporting





## **Some benefits of surveillance**

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- **Trends in the incidence of disease can be measured**
- **The steps in the food chain that must be controlled can be identified**
- **The impact of public health policies and industry efforts can be measured**
- **The role of specific foods can be estimated**

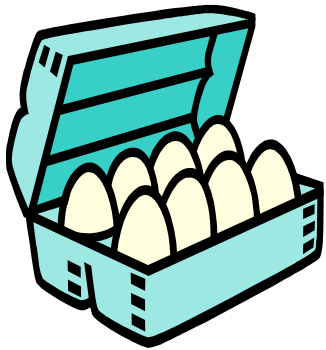


## **Surveillance can lead to control strategies**

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# Targeting specific foods for control





## Examples of targeting foods

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***Y. enterocolitica***

**Raw pork, fermented meats with pork**

***L. monocytogenes***

**RTE foods in which growth can occur**

***E. sakazakii***

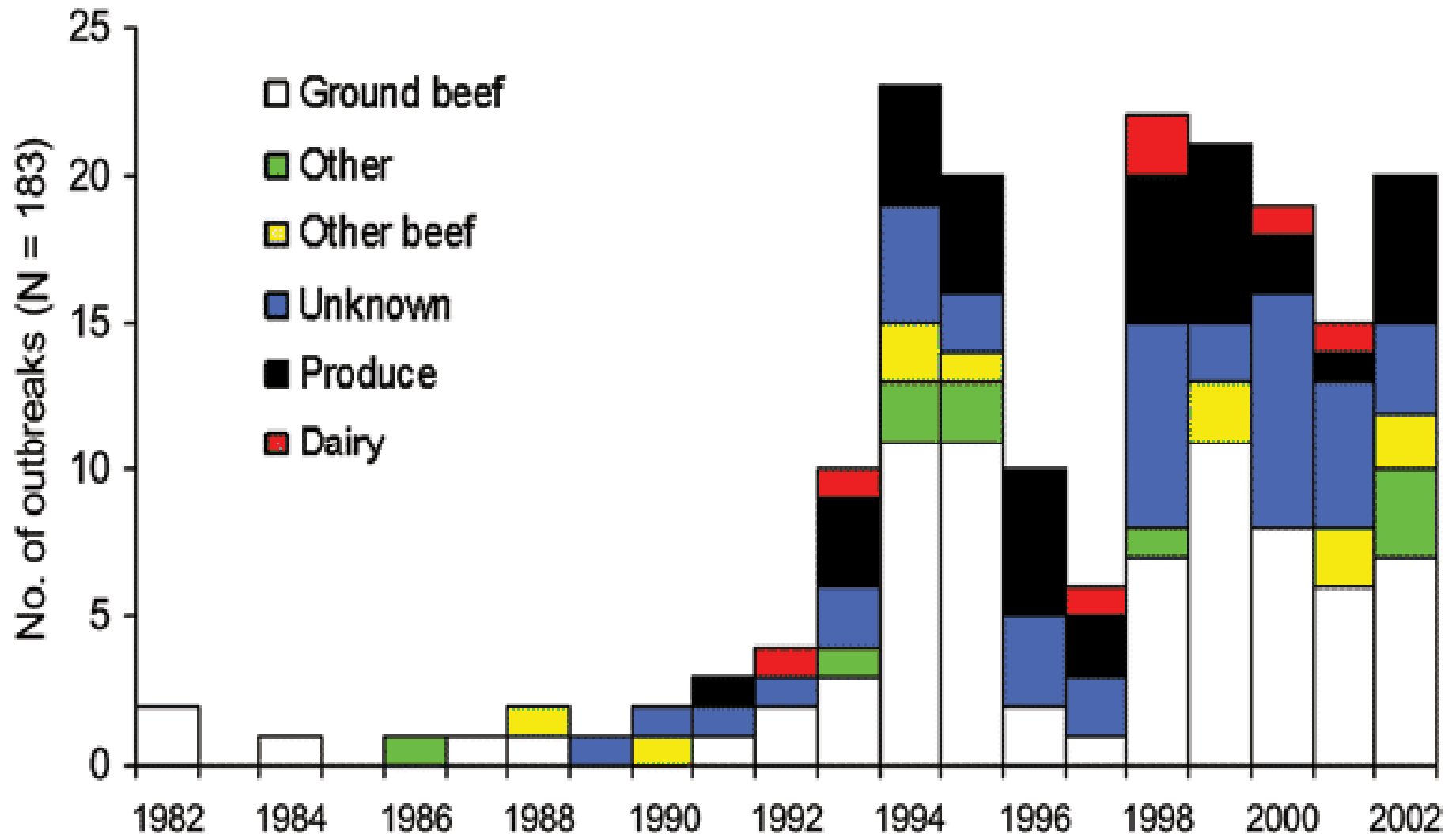
**Powdered infant formula**

***E. coli* O157:H7**

**Ground beef, leafy greens**



## Vehicles of foodborne *E. coli* O157 outbreaks in the USA, 1982-2002





# Surveillance systems

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## Enteric pathogens

- **Passive systems (e.g., physician reports)**
- **Active systems**
  - **CaliciNet**
  - **European network for Norovirus**
  - **FoodNet**
  - **PulseNet**
  - **Enter-net**
  - **Global Salm-Surv**

WHO Global Salm-Surv Centers of Excellence are designated by the WHO Global Salm-Surv Steering Committee to serve several countries in a region.

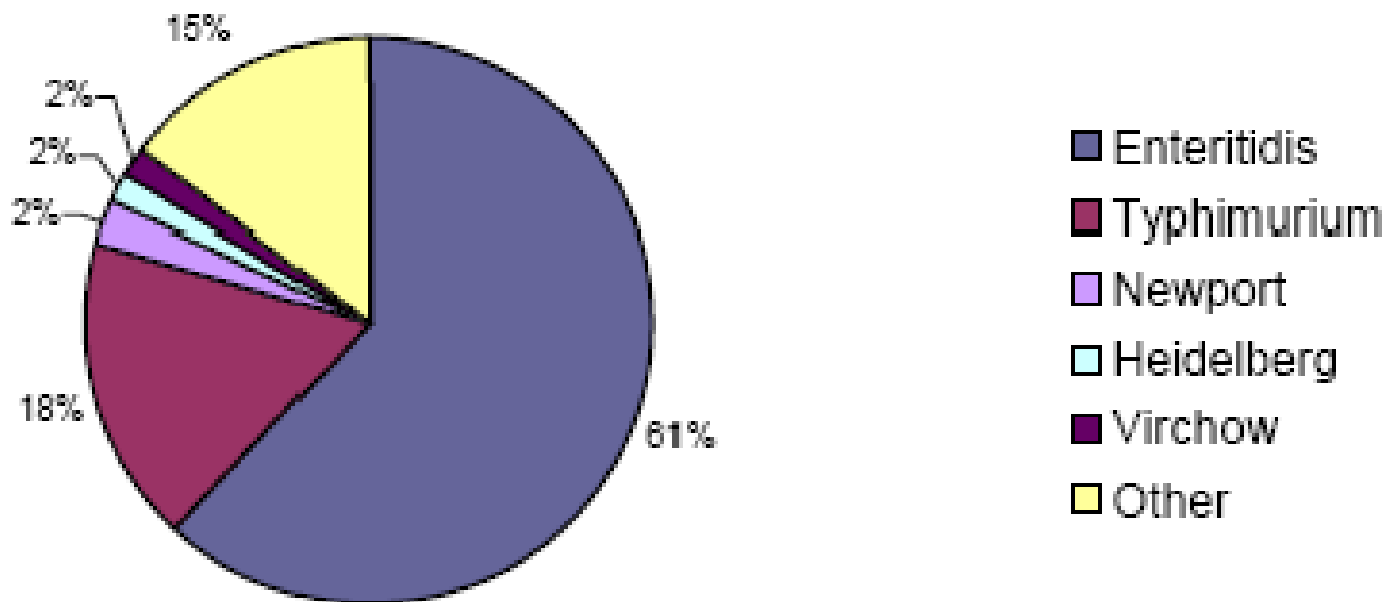


Fig 22



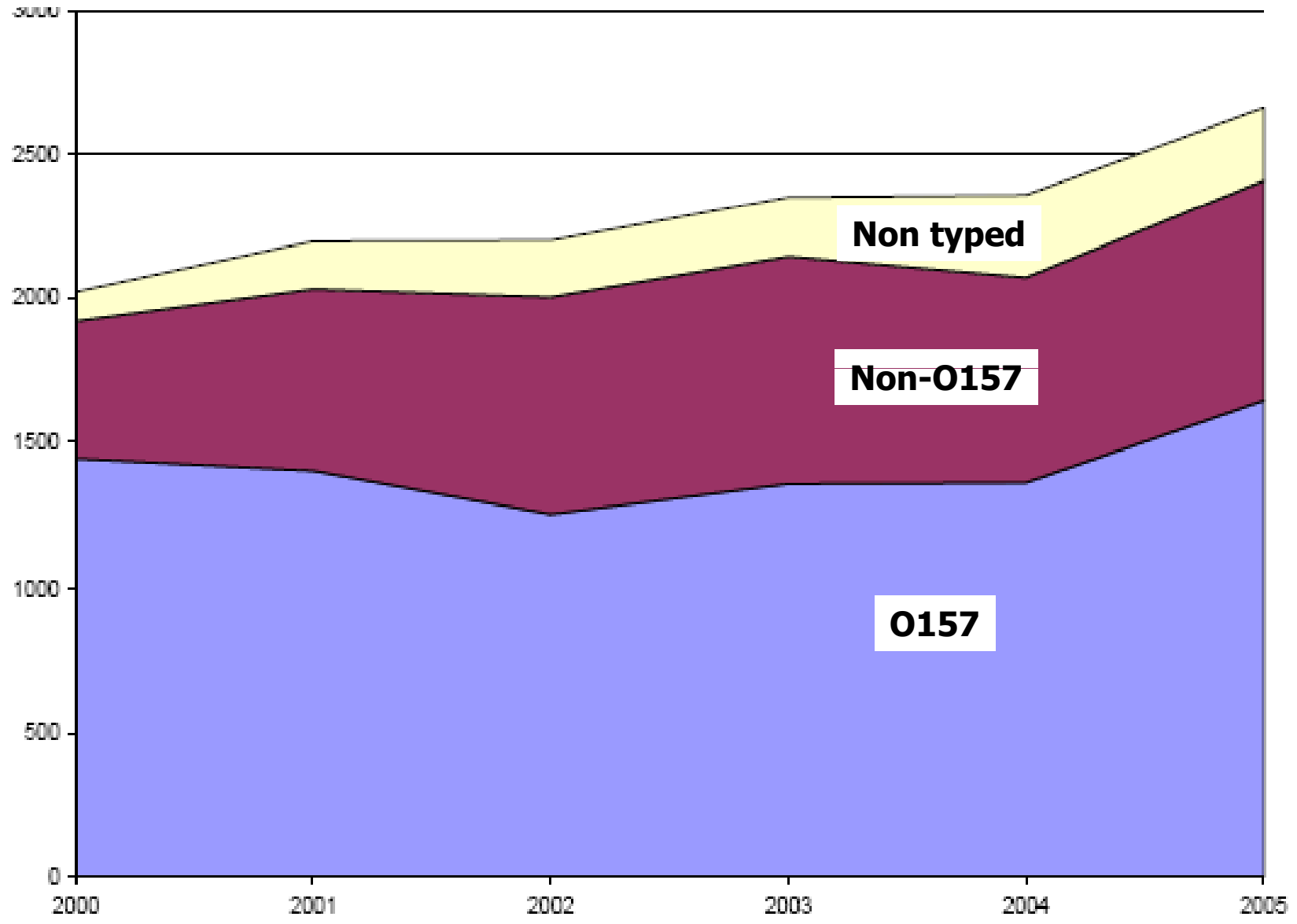
# Salmonella serotypes 2000-2004

Human



Source: WHO Global Salm-Surv Report 2005

# Trends of VTEC 2000-05 (Data from 21 countries)

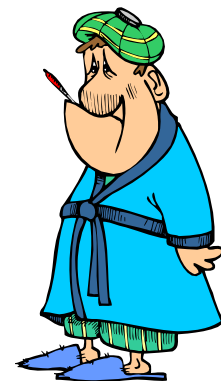


Anon. 2007. Enter-Net Annual Report for 2005

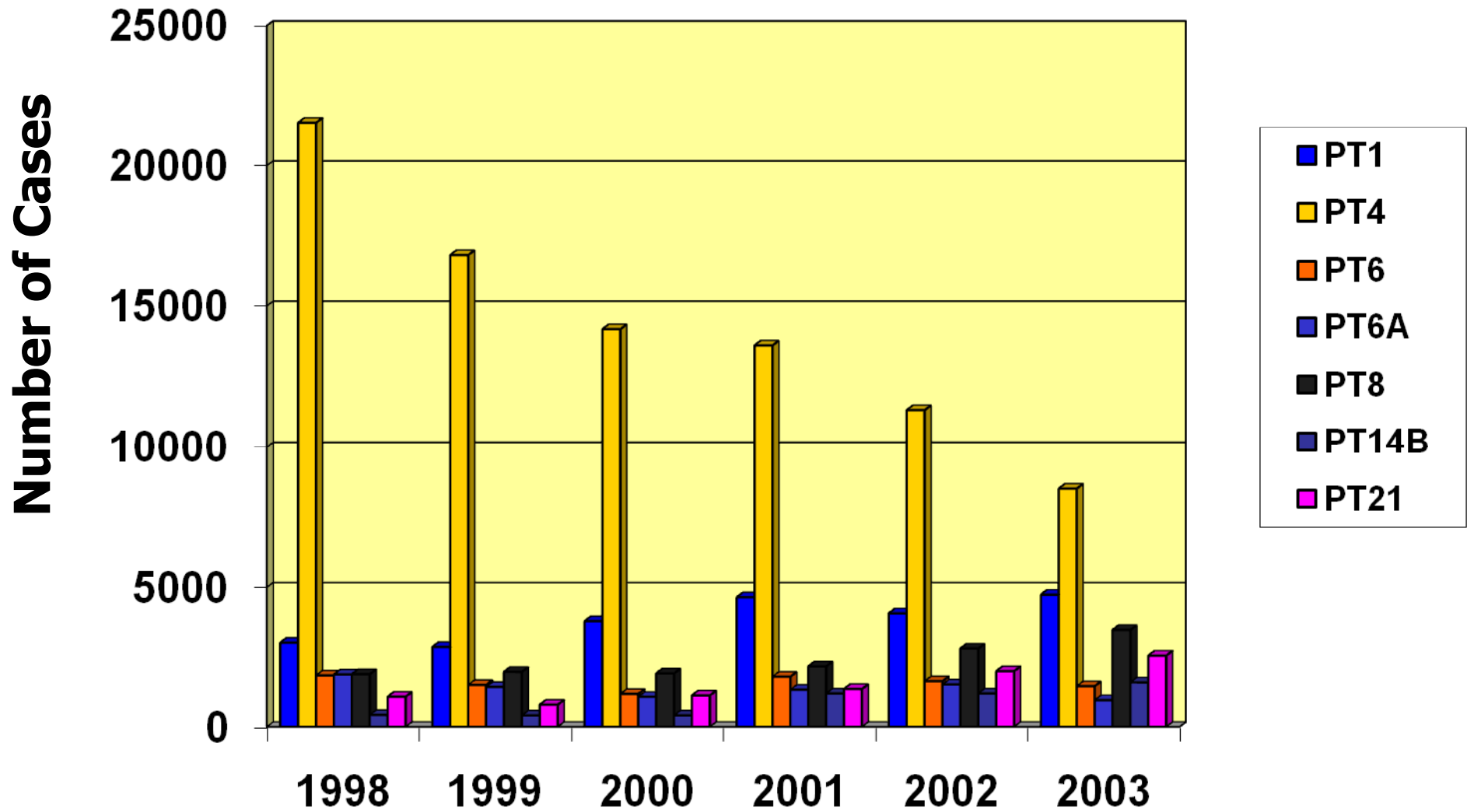
# Examples of targeting pathogens

**Which strains are more likely to be involved in human disease?**

- ***Y. enterocolitica* serotypes 0:3; 0:5,27; 0:8; 0:9**
- **Certain epidemic clones of *L. monocytogenes***
- **Monophasic *S. Enterica* serovar 4, [5],12:1:-**
- **Certain phage types of *S. Enteritidis***



# Trends of *S. Enteritidis* phage types in nine European countries



Fisher. 2004. Eurosurv. Monthly 9:7-8



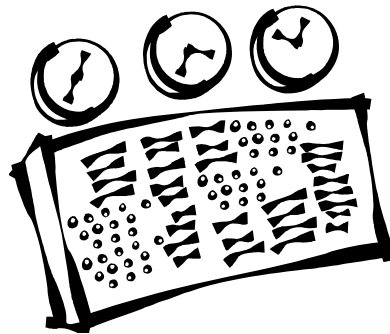
# Historically

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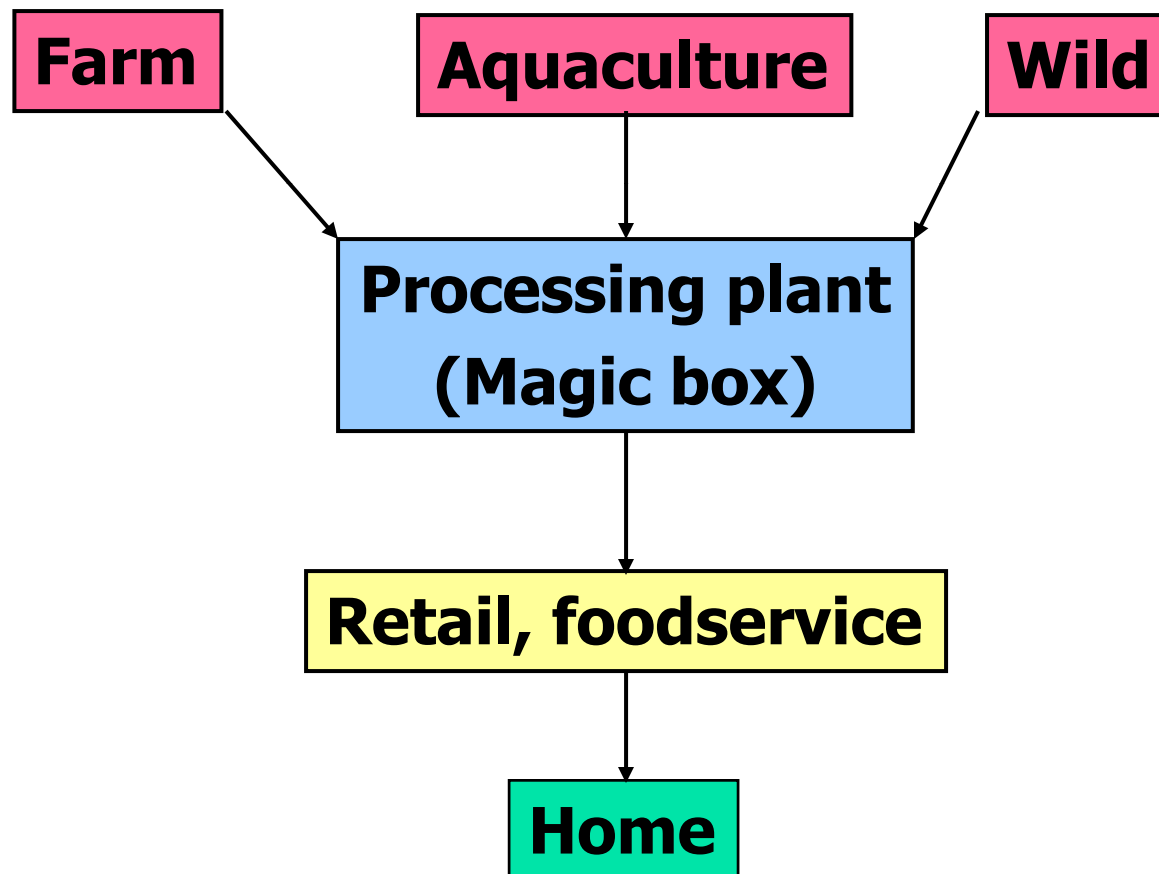
- **Problems expand as they become more widely known.**
- **Pathogens with newly acquired virulence factors will spread.**



# 4. Control



# Where in the food chain can a pathogen best be controlled?





## **Commercial issues of emerging pathogens**

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- **Transmission of disease by employees.**
  - **Noroviruses, Hepatitis A**



## Commercial issues of emerging pathogens

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- **Transmission of disease by employees.**
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- **Consumer perceptions about the safety of food.**
  - **Beef/BSE**
  - **Poultry/avian influenza**
  - **Spinach/ *E. coli* O157:H7**
  - **Tomatoes, peppers/ *Salmonella***
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  - **Tomatoes, peppers/ *Salmonella***
  - **Peanut butter/ *Salmonella***
- **Major customers' (e.g., retailers) reaction.**
  - **More testing!**



# Commercial issues of emerging pathogens

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- **Is it possible to:**
  - **lessen the impact on your business?**
  - **shorten the investigational phase?**
  - **identify and implement controls more quickly?**



# **Industry can improve its management of emerging pathogens**

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## **Example: *L. monocytogenes* in RTE meat and poultry products**

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- **Sampled products and environment beginning in 1987**
- **Shared data with trade association and competitors**
- **Shared data with USDA from 1990 to 2003**
- **Developed control measures, shared with competitors and USDA**
- **Created videos and published best-practice guides**
- **Held 5 annual workshops for suppliers, customers, co-packers; USDA, FDA, CDC participated**
- **Shared information with consumer groups**





## **Some control measures that helped**

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- **Validated kill steps (e.g., cooking, fermenting/drying)**
- **Weekly equipment & environmental sampling program**
- **Covered & steamed critical equipment (e.g., collators, slicers & packaging equipment)**
- **Added citric acid to brine chill systems ( $\text{pH} \leq 3.5$ )**



## **Some control measures that helped**

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- **Prevented recontamination after the kill step by detecting and eliminating harborage sites**
- **Improved equipment design for cleanability**
- **Added inhibitors to products (e.g., lactate, diacetate)**
- **Pasteurized packaged product (steam, hot water, UHP)**

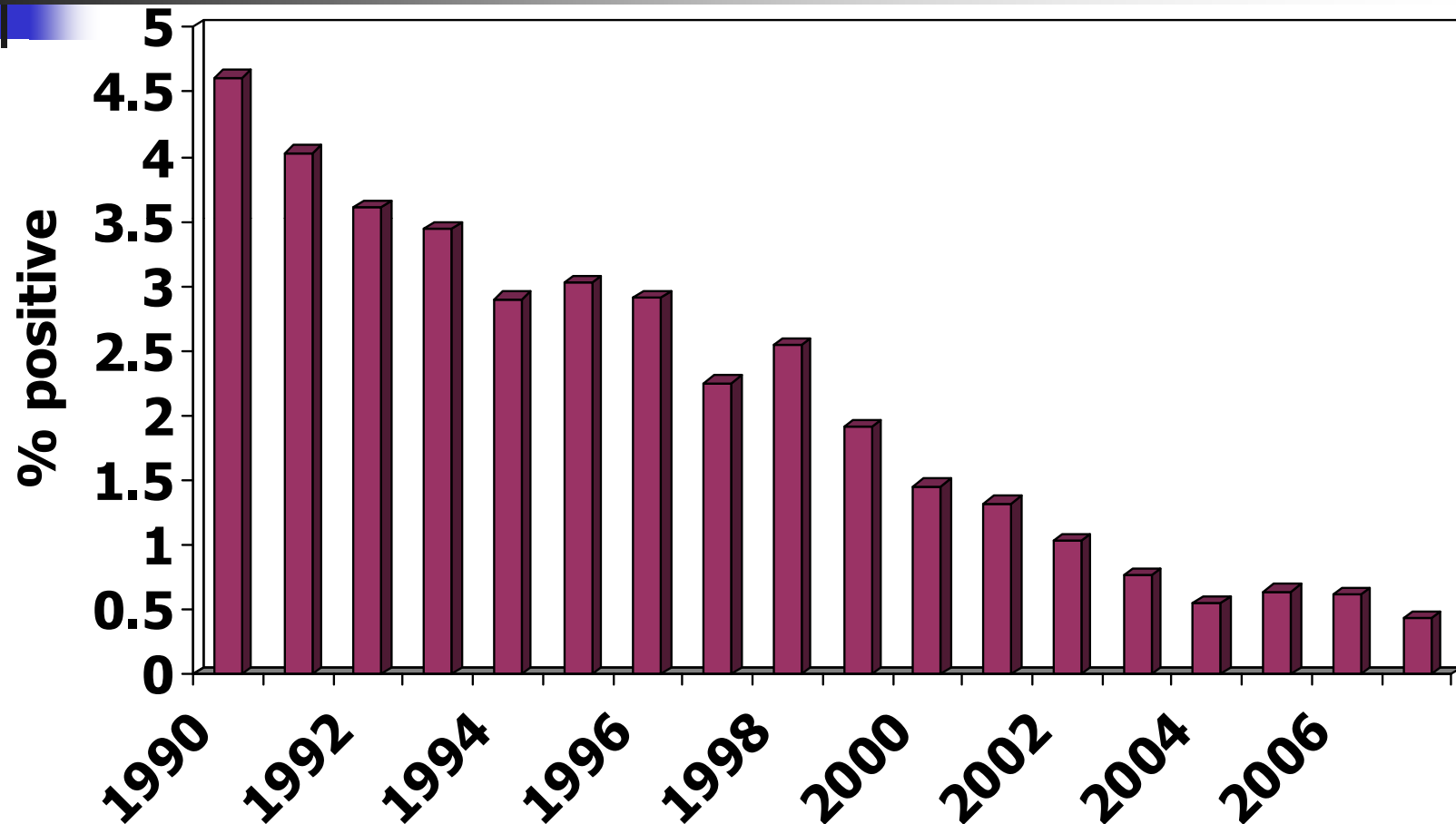


## Benefits of the *Listeria* control program

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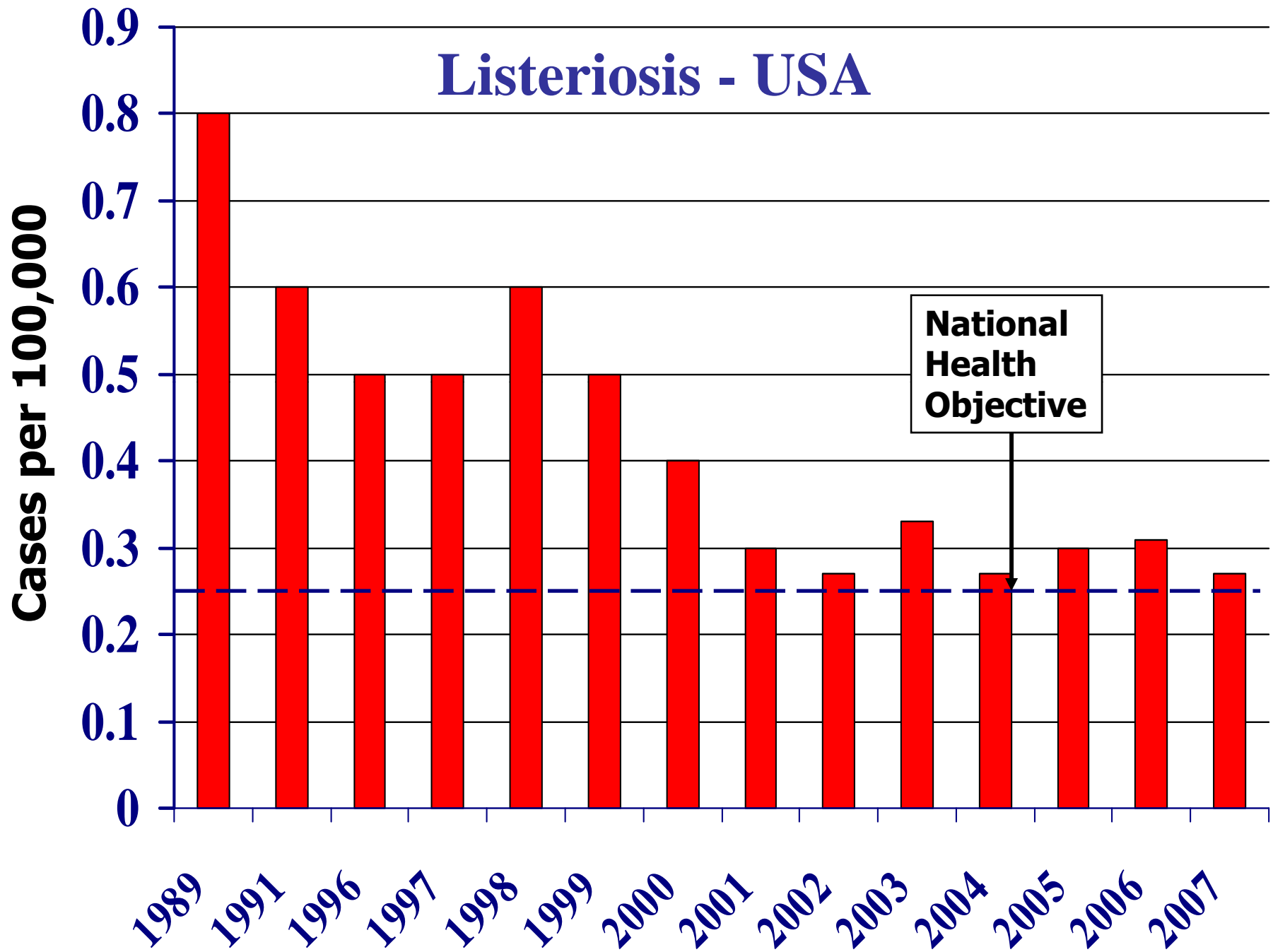
- **Consumer protection**
- **Regulatory compliance**
- **Business protection**
- **Refrigerated products have consistently longer shelf lives**

## USDA results for *Lm* in RTE meat and poultry products



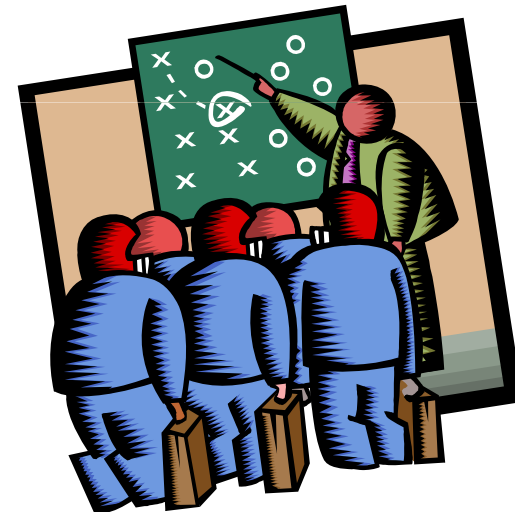
Source: Scott and Huffman. 2007. ISOPOL XVI (Updated with 2007 results)

# Listeriosis - USA

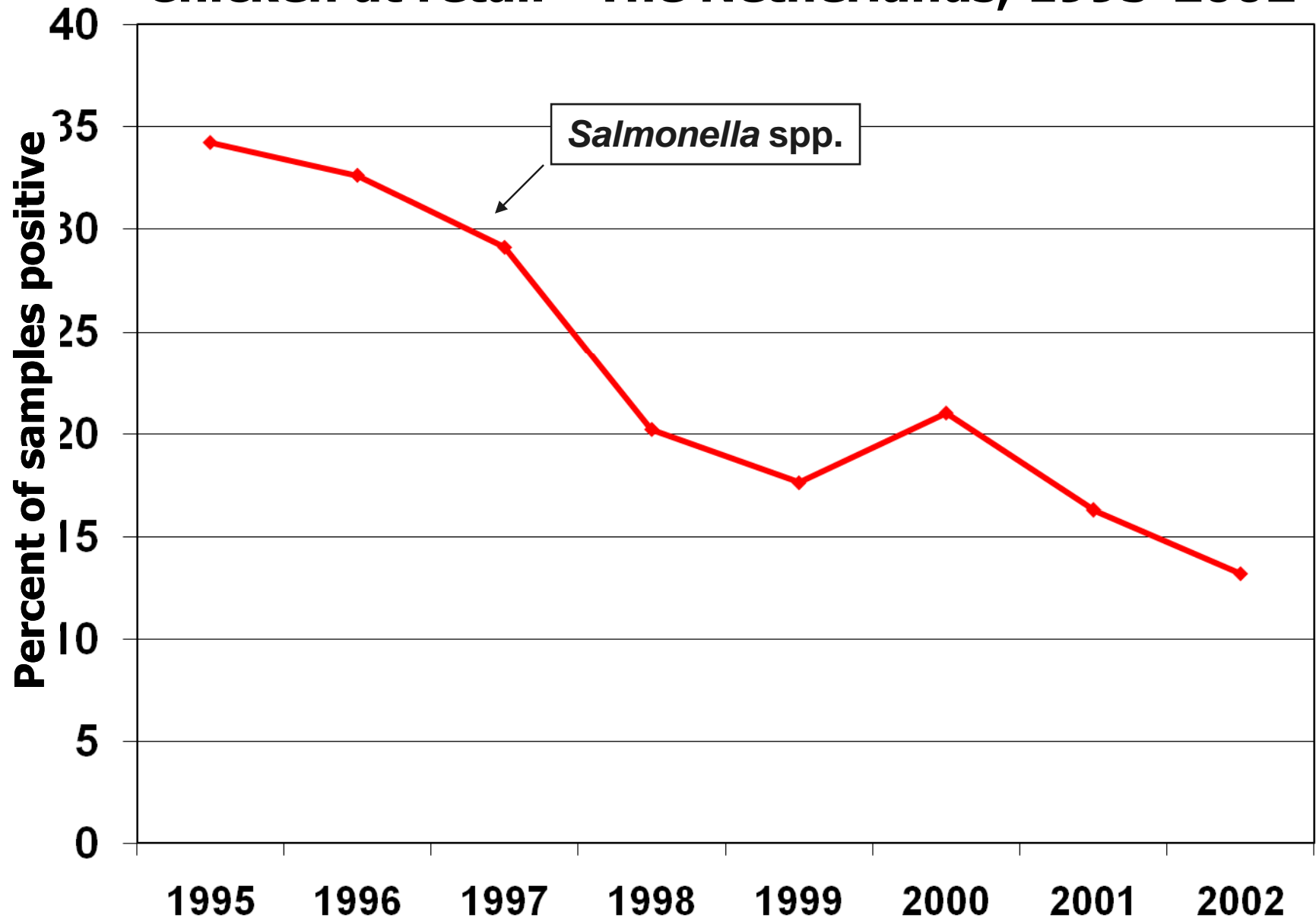


# Other examples of success in pathogen control

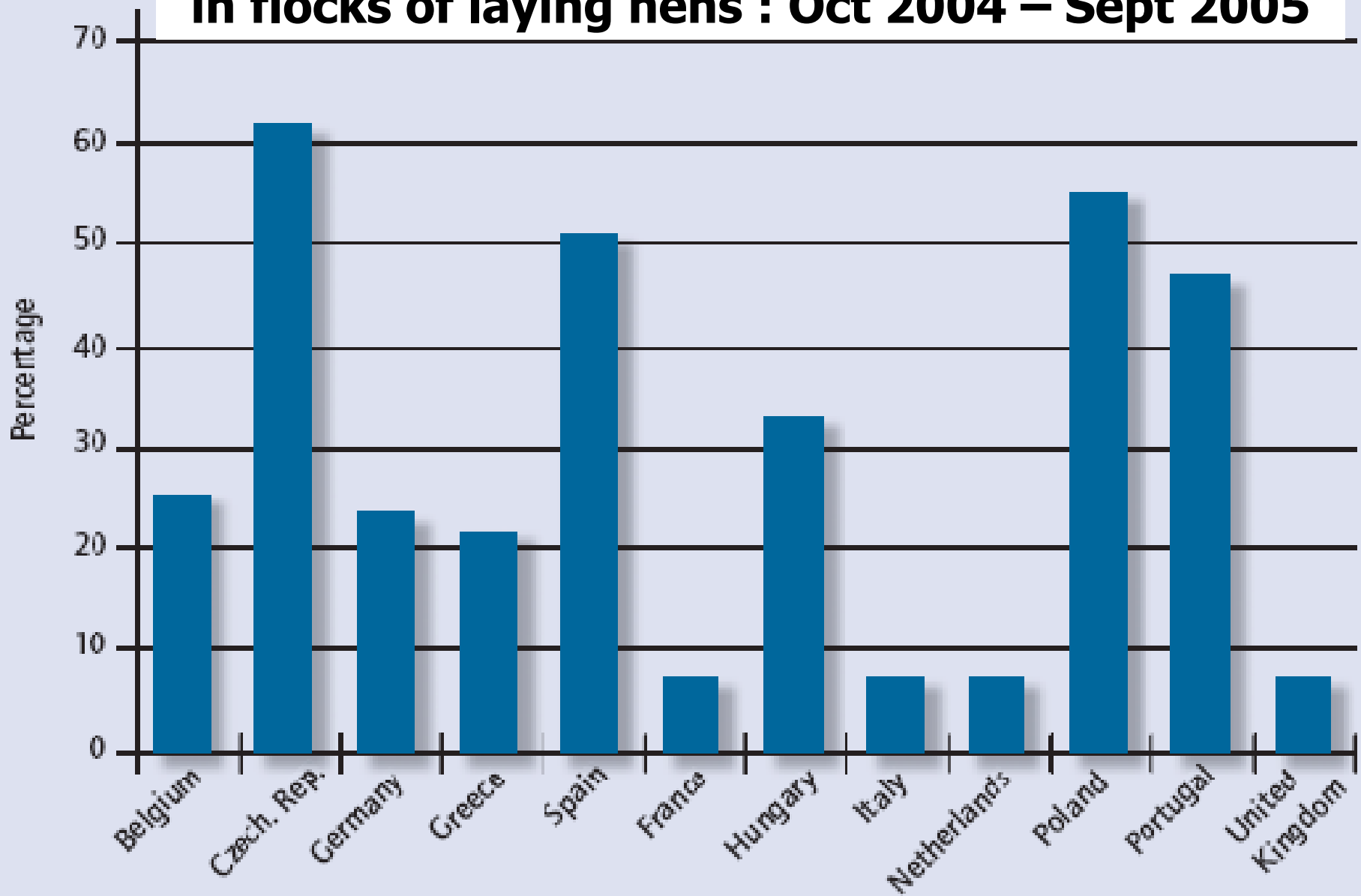
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# Chicken at retail - The Netherlands, 1995-2002



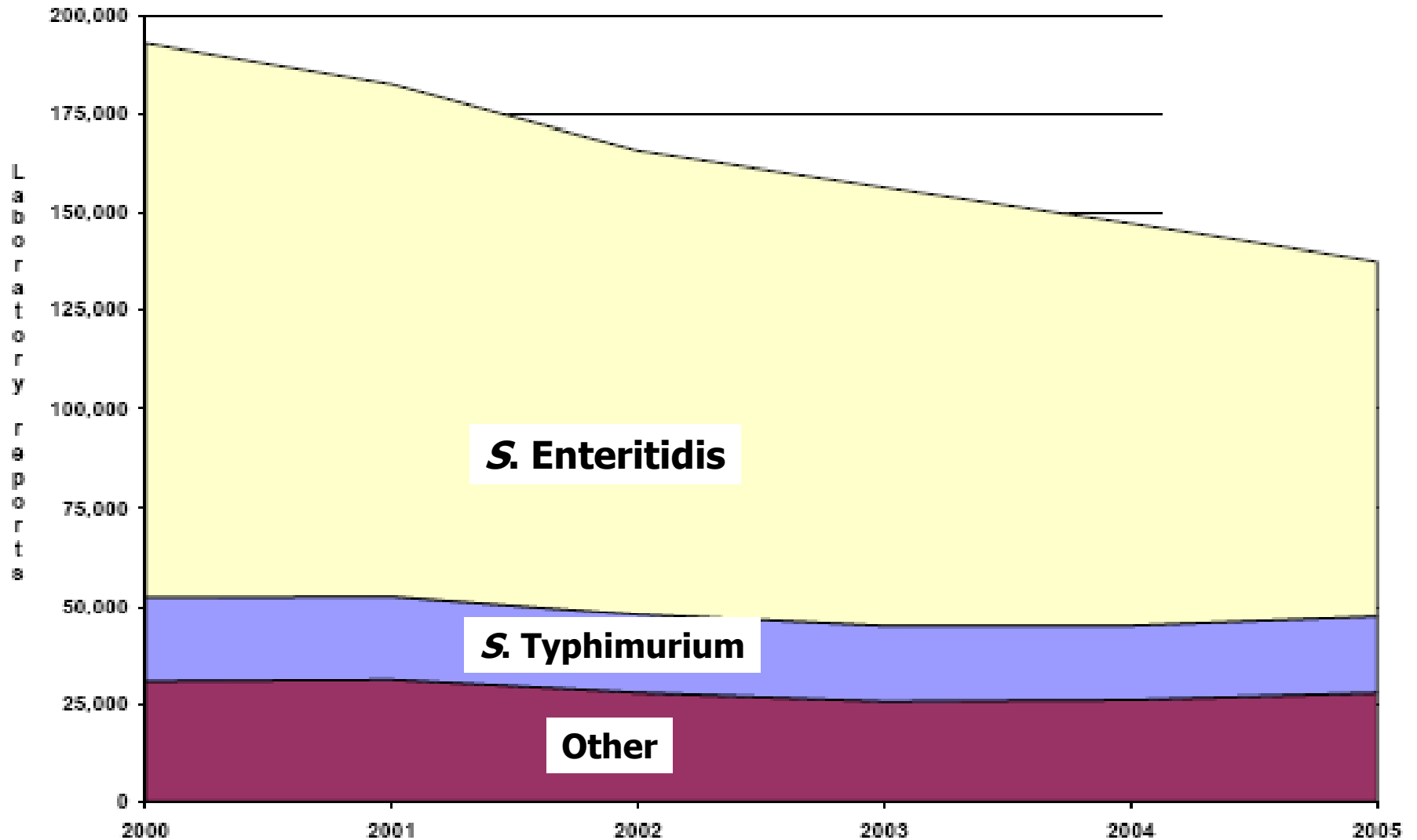
## Prevalence of *S. Enteritidis* and *S. Typhimurium* in flocks of laying hens : Oct 2004 – Sept 2005



Source: Sheehan and van Oort. 2006. World Poultry 22(9):2-4

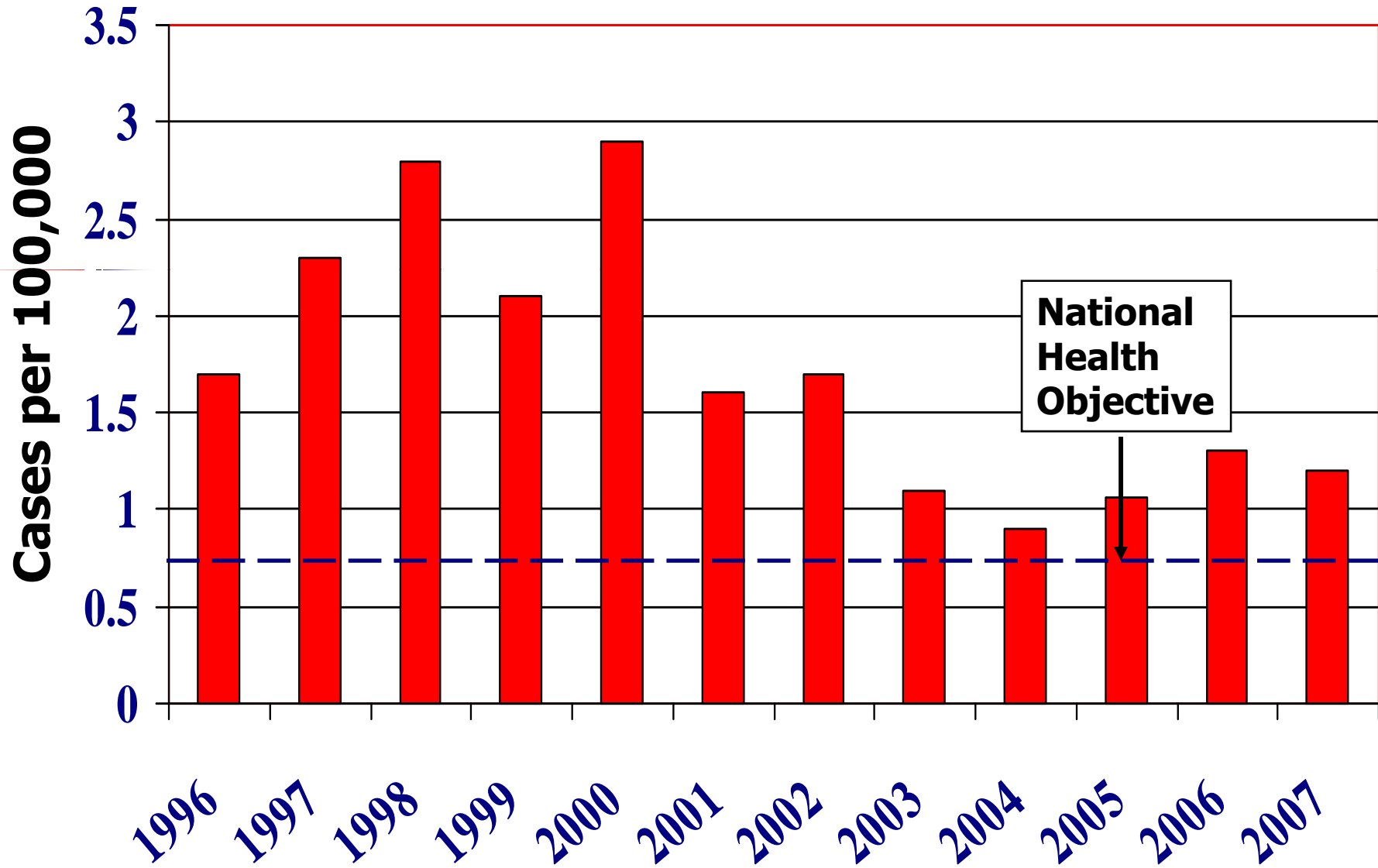


# Total human salmonellosis 2000-05 (data from 26 countries)



Anon. 2007. Enter-Net Annual Report for 2005

# Illness due to *E. coli* O157:H7 - USA





## What about the future?

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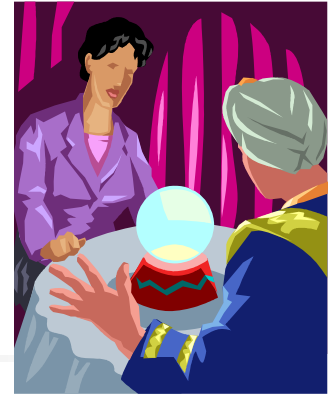
- **Improved surveillance systems and methodologies**

# What about the future?



- Improved surveillance systems and methodologies
- New technologies will be used for control
  - *L. monocytogenes*
    - In-pack pasteurization (e.g., hot water, UHP)
    - Additives to inhibit growth
  - *Salmonella, Campylobacter, VTEC*
    - Vaccination, probiotics, etc will be used to reduce human enteric pathogens in animals
    - Improved decontamination of carcasses

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    - Improved decontamination of carcasses
- The significance of viruses will be clarified and strategies for improved control will be developed



# Viruses

	% of total foodborne disease		
	<u>Cases</u>	<u>Hospitalizations</u>	<u>Deaths</u>
<b>Norwalk-like</b>	<b>66.6</b>	<b>32.9</b>	<b>6.9</b>
<b>Rotavirus</b>	<b>0.3</b>	<b>0.8</b>	<b>0.0</b>
<b>Astrovirus</b>	<b>0.3</b>	<b>0.2</b>	<b>0.0</b>
<b>Hepatitis A</b>	<b>0.0</b>	<b>0.9</b>	<b>0.2</b>

Mead, et al. 1999. *Emerg. Infect. Dis.* 5:607-625



# Viruses

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- **Data from 6 states in the USA:**
  - **~50% of all foodborne outbreaks were due to noroviruses**
  - **salads, sandwiches and fresh produce accounted for >56% of those outbreaks.**



# Conclusions

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- **Almost 125 years have passed since Koch's investigation of *V. cholerae*.**
- **Many new microbial hazards have been discovered.**
- **Tremendous changes have occurred in the food chain.**
- **Improved epidemiologic and surveillance systems have expanded our knowledge.**
- **Industry's food safety systems can and will continue to evolve to meet the challenges of new emerging pathogens.**