Emerging Antimicrobial Resistance in the Food Supply: the Role of Integrated Surveillance

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Centers for Disease Control and Prevention

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Outline

- NARMS: The National Antimicrobial Resistance Monitoring System
- Commensal Surveillance
  - Enterococci
- MRSA in Europe: selections from the literature

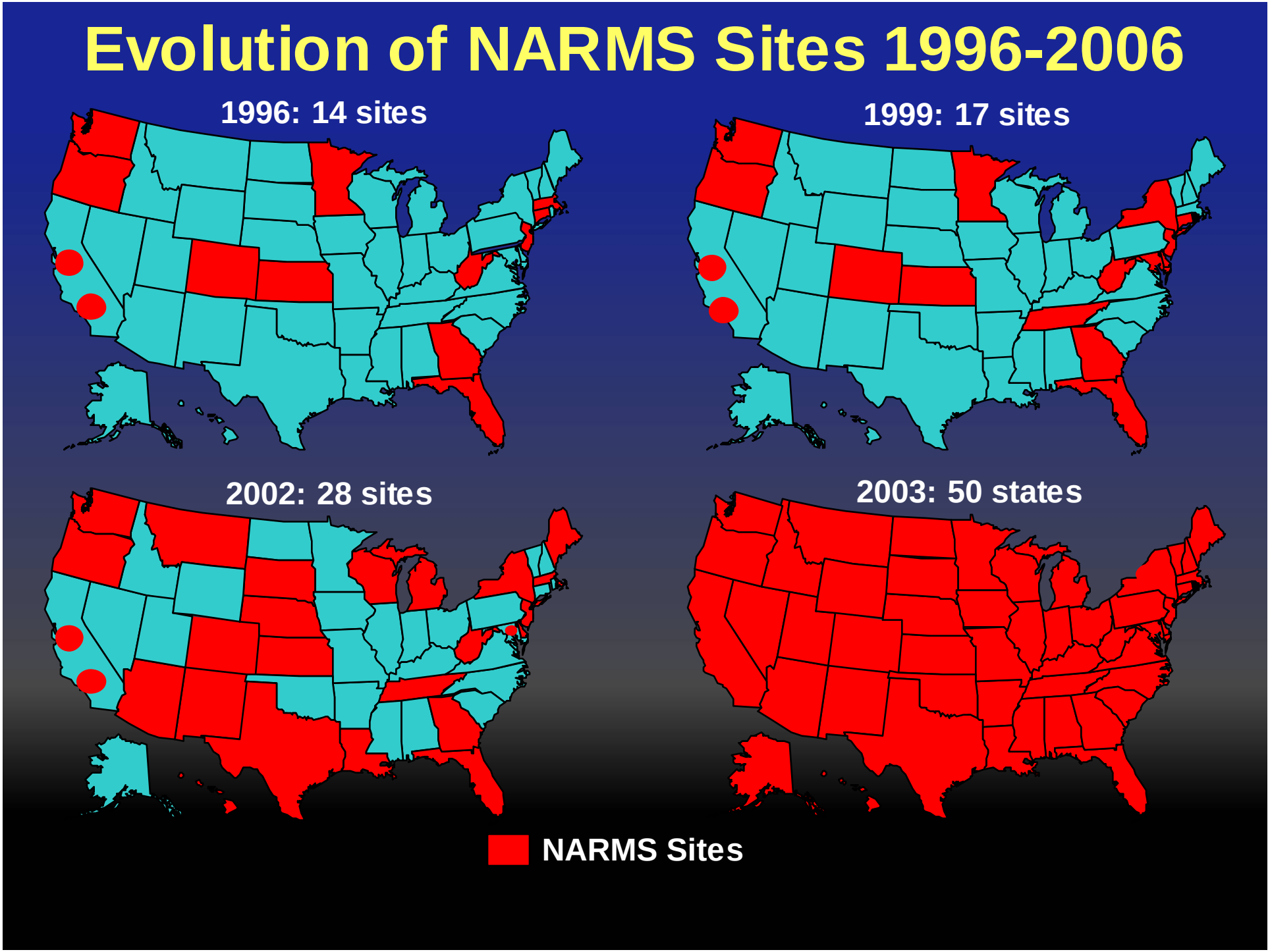
National Antimicrobial Resistance Monitoring System (NARMS)

- FDA Joint Advisory Committee recommended the creation of surveillance system
- Strategy to monitor antimicrobial resistance among foodborne bacteria
  - CDC: Human surveillance
  - FDA-CVM: Retail meat surveillance (2002)
  - USDA: Animal surveillance (On Farm & Slaughter)
  - All 50 state health departments

NARMS

- Monitor the susceptibility of antimicrobial agents among enteric bacteria from humans, foods, and animals
  - Core surveillance
  - Retail Food Surveillance
  - Outbreak Isolates
  - Commensal Organisms

Evolution of NARMS Sites 1996-2006

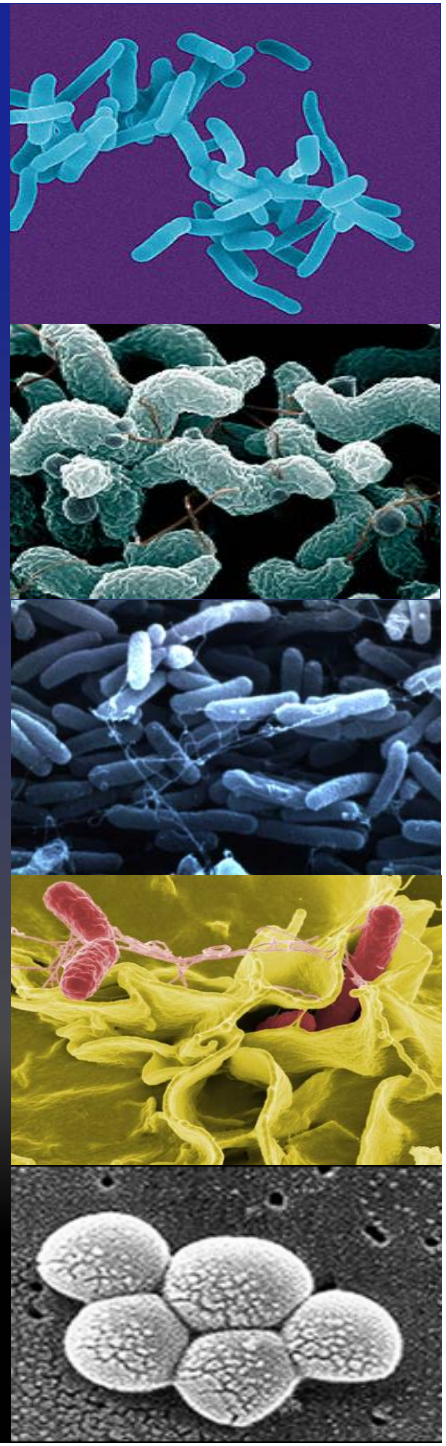


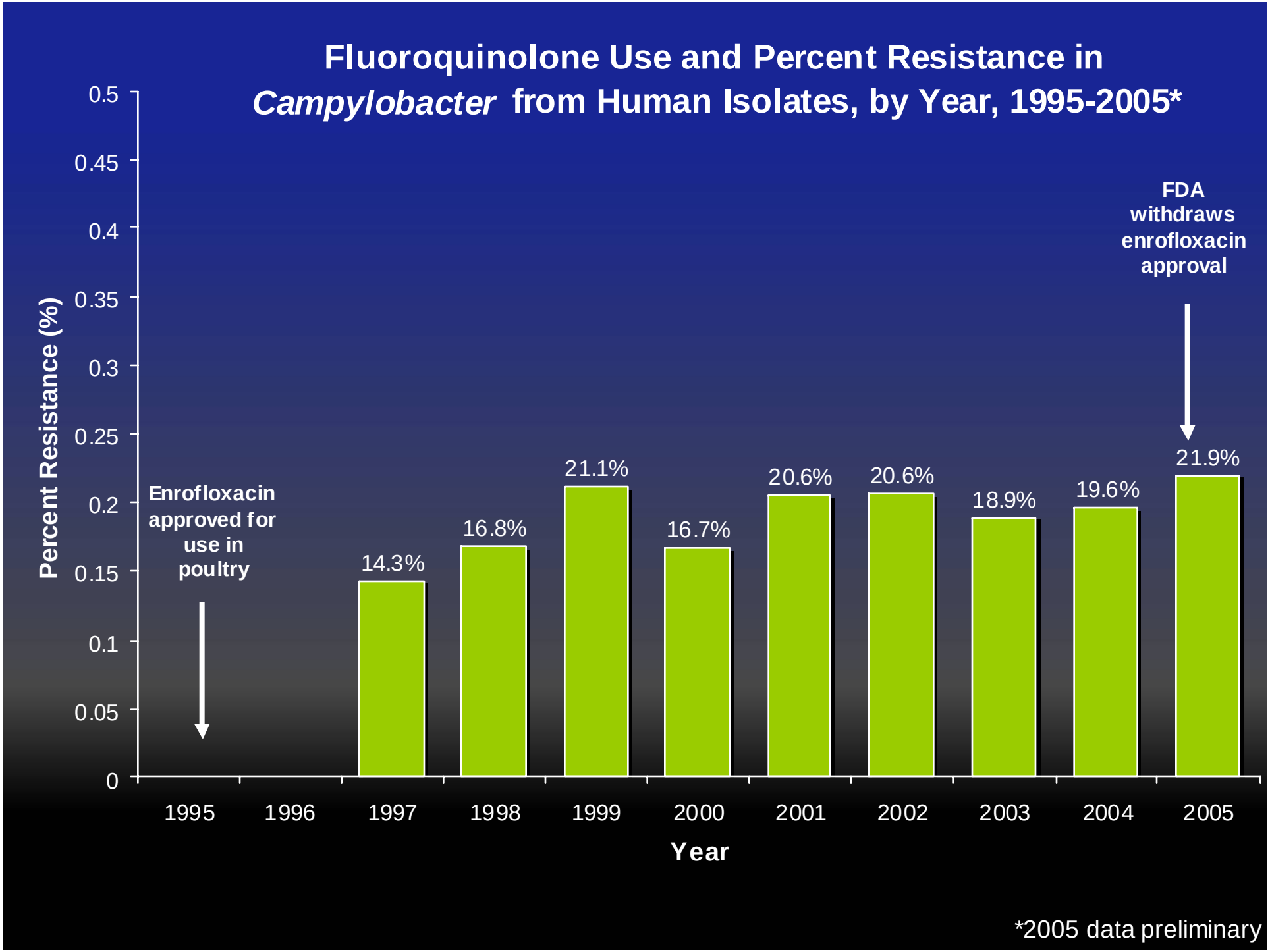
Core and Retail Food Surveillance

- Core surveillance
  - Provide a centralized source of antimicrobial resistance data from major surveillance systems
- Retail food surveillance
  - ground beef
  - ground turkey
  - pork chops
  - chicken breasts

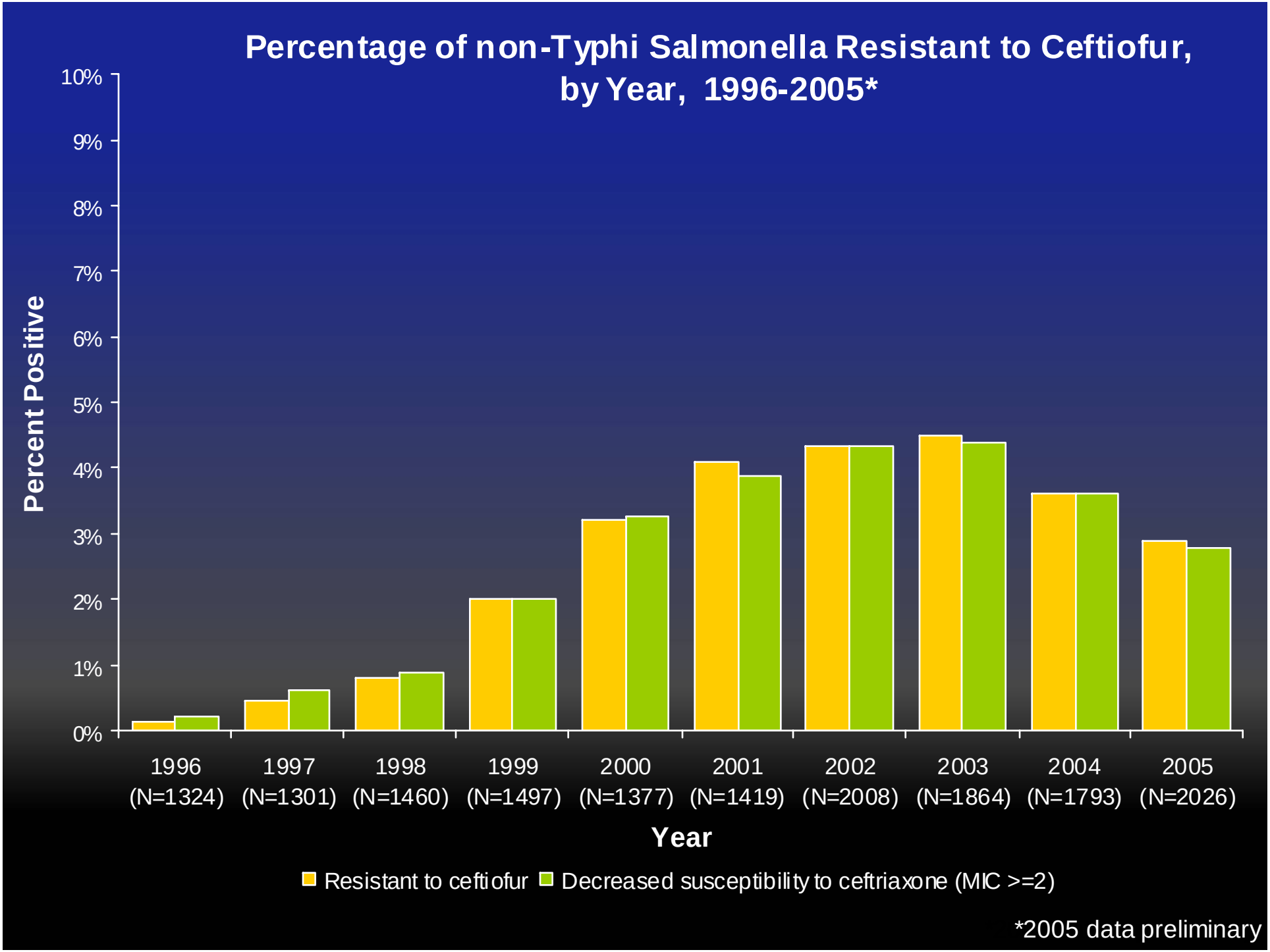
Outbreak and Commensal Surveillance

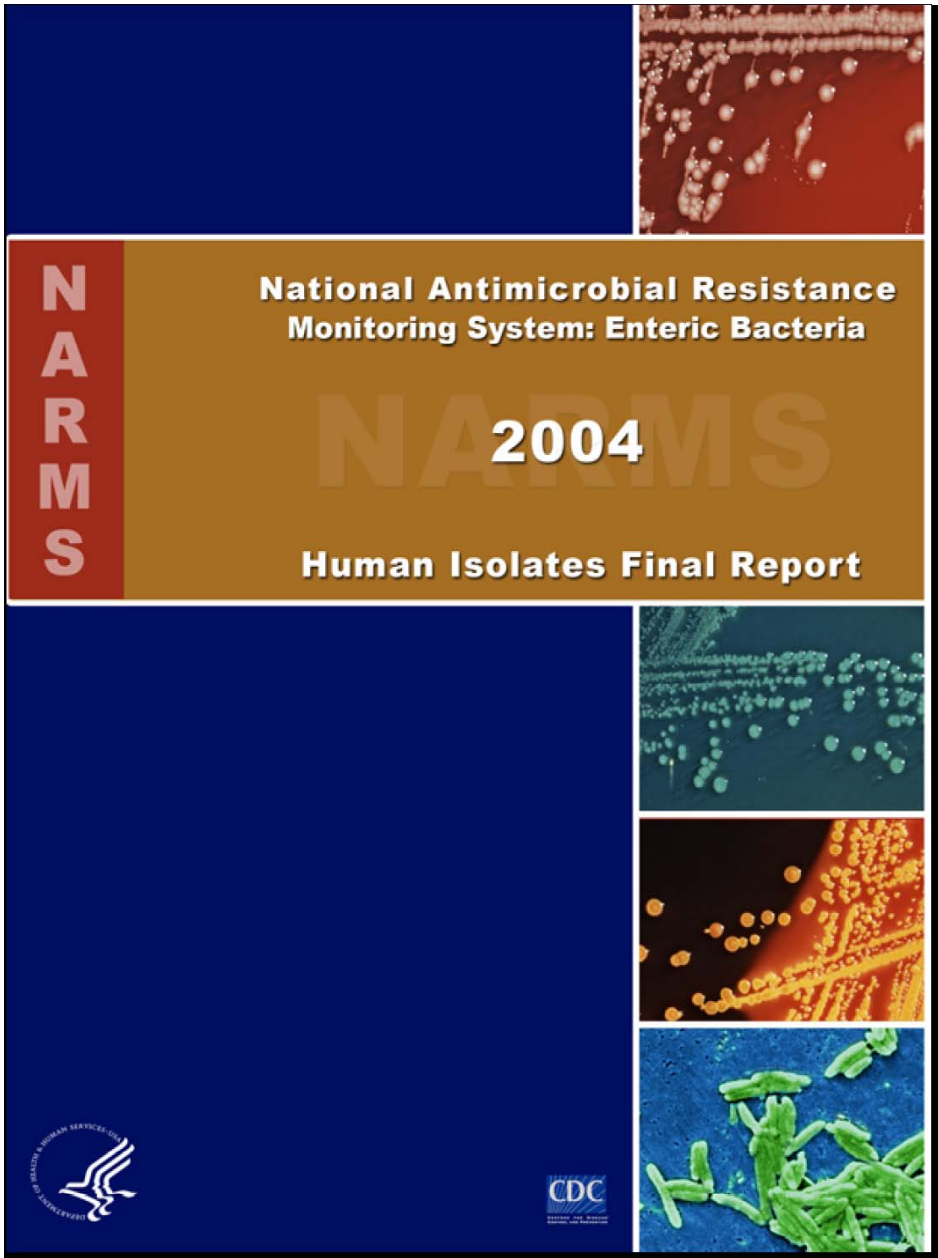
- Outbreak isolates
  - Characterize antimicrobial resistance attributes of bacterial pathogens isolated from foodborne disease outbreaks
- Commensal organisms
  - Ongoing surveillance for antimicrobial resistance among Enterococci and *E. coli*, commensal bacteria

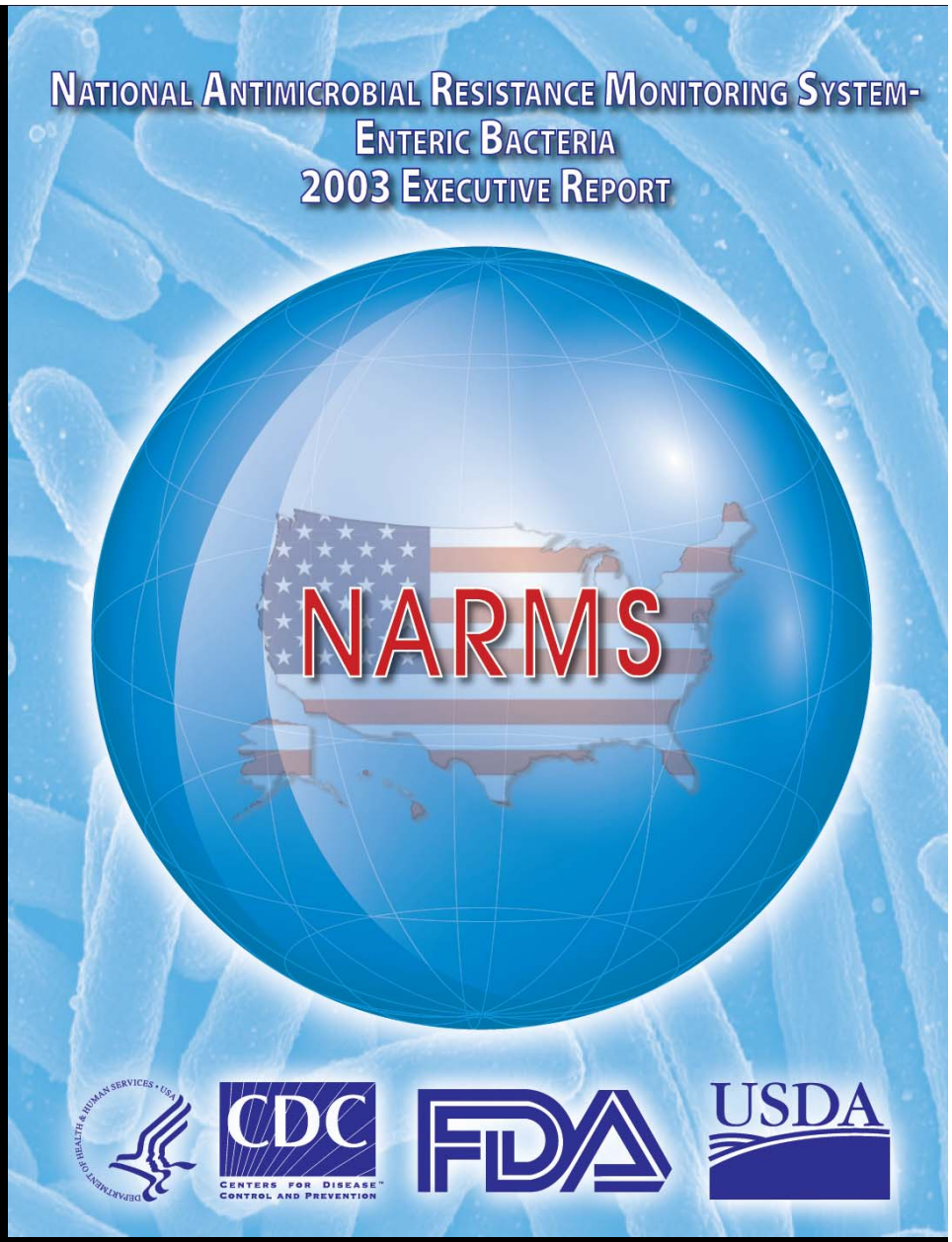




Percentage of non-Typhi Salmonella Resistant to Ceftiofur, by Year, 1996-2005*







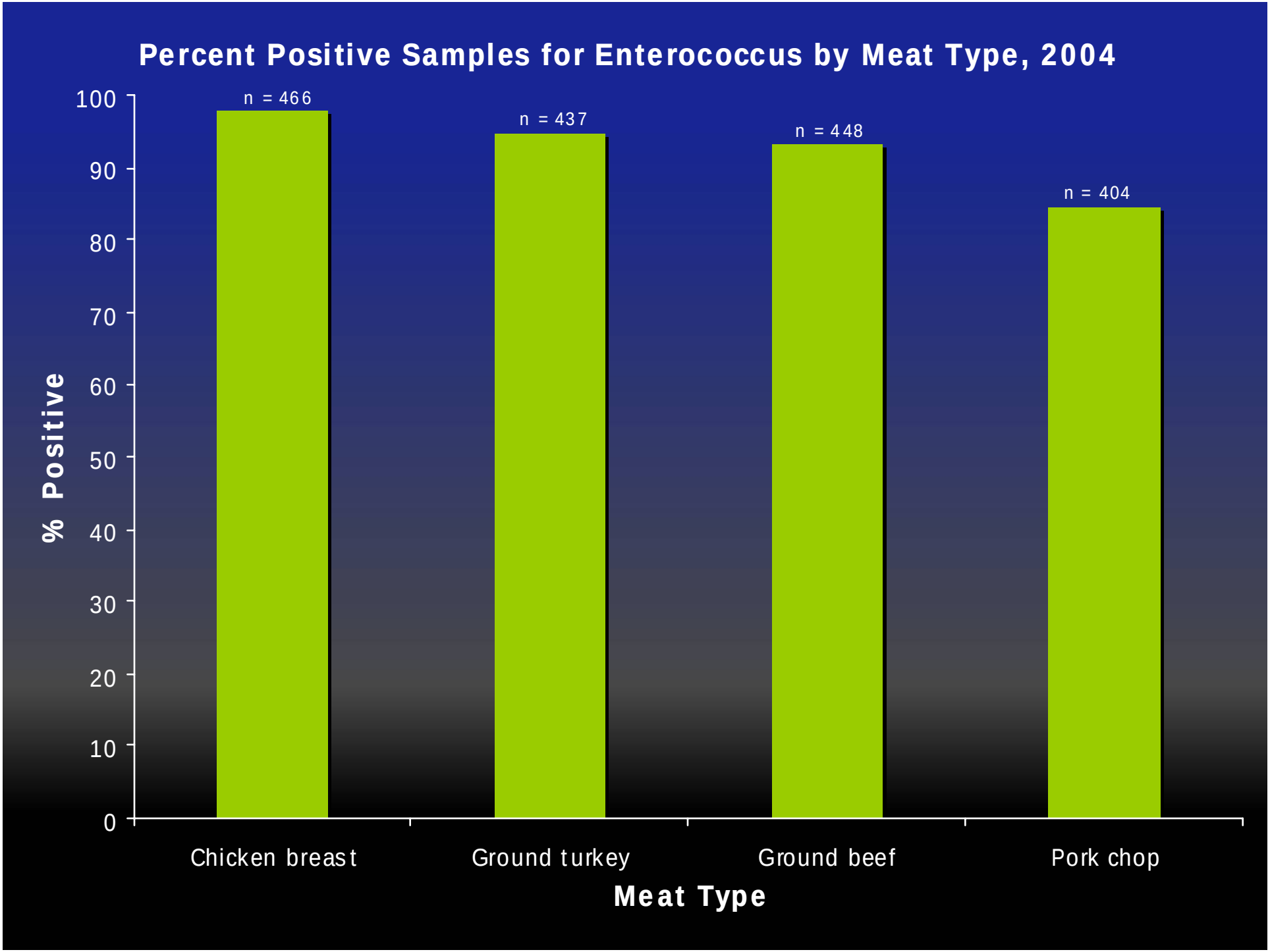
www.cdc.gov/narms

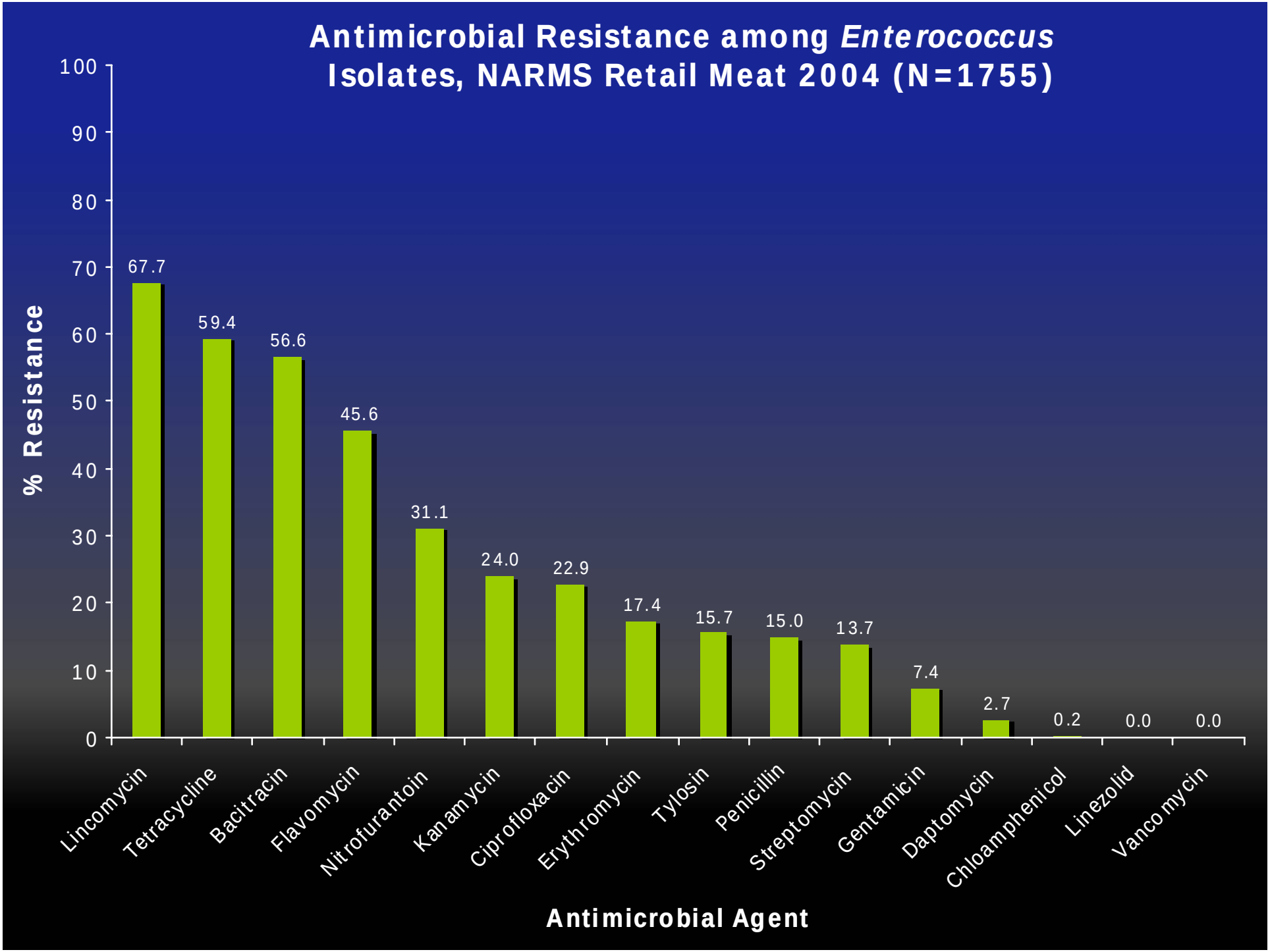
Enterococcal Infections

- Carriage of enterococci resistant to certain antimicrobial agents has been documented among non-hospitalized persons, suggesting a community source of some resistant enterococci
- Specific resistant enterococci have been isolated from meat and poultry in grocery stores, and from the intestinal tracts of farm animals

NARMS Methods

- *Enterococcus*
  - 40 food samples purchased per month per state
  - Susceptibility testing method – **broth microdilution**
  - CLSI interpretive criteria where available





Use of Antimicrobial Agents in Food Animals

- Antimicrobial agents in food animals:
  - **Growth promotion**
  - **Disease prevention**
  - **Therapy**
- Results in the selection of resistant enterococci in the intestinal tracts of animals
- Example:
  - Virginiamycin (an analog of quinipristin/dalfopristin (Q/D)), commonly used in chicken for growth promotion
  - Cross-resistance known between virginiamycin and Q/D

Commensal Bacteria as Reservoirs

- Use of antibiotics selects for resistance genes in humans and farm animals
- Resistance gene reservoir hypothesis
  - Transferable resistance genes are exchanged between commensal bacteria and with bacteria passing through the intestine
- Retail meats are a potential source of exposure
  - NARMS recovered *Enterococci* isolates in 93% (1742/1873) of all retail meat samples in 2003
- Human to human and environmental transfer of commensal bacteria through contact, fomites, fecal-oral pathways

Dissemination of Streptothricin Resistance in *E. coli*, in former East Germany, 1982-1987

Origin	1982	1983	1984	1985	1986	1987
Pigs	-	+	+	+	+	+
Farm Personnel	-	-	+	+	+	+
Farm Families	-	-	+	+	+	+
Community	-	-	-	+	+	+
Community UTI's	-	-	-	+	+	+
S. sonnei	-	-	-	-	-	+

Nourseothricin introduced in animal feed in 1983 in former East Germany

Witte, W. 1997. Antibiotic resistance, Ciba Foundation Symposium 2007

The Food Supply

- Antimicrobial agents are used in food animals
  - Use selects for bacterial resistance to antimicrobial agents
- Food animals constitute an important reservoir of antimicrobial resistance
  - Pathogenic and commensal bacteria may be transmitted to humans through the food supply

Cleanliness

Compromised Skin

Shared Surfaces

Crowding

Frequent Contact

Staphylococcus aureus

- *Staphylococcus aureus*:
  - Gram-positive bacteria that frequently colonizes the nose and skin of healthy persons
  - Sometimes causes infection: skin, other
  - Transmitted by direct or indirect contact
- Methicillin-resistant *Staphylococcus aureus* (MRSA):
  - Resistant to all currently available beta-lactam antibiotics
  - Increasingly important cause of healthcare-associated infections since 1970s

Emergence of MRSA in the Community

- Strains of MRSA distinct from those already established in healthcare settings emerged worldwide as a cause of infection among otherwise healthy adults and children in the community
- Genetic characteristics of these strains suggest they originated in the community

MRSA in Dutch Pork Industry

- van Loo et al. (2007 Emerging Infectious Diseases)
  - Collected 79 raw meat products from 31 shops in The Netherlands (pork, n=64; beef, n=15) from February – May 2006
  - 27 (42.2%) pork samples and 5 (33.3%) beef samples were positive for *S. aureus*
  - 2 isolates from pork (2.5% of total meat samples) were methicillin resistant

MRSA in Dutch Pigs

- van Duijkeren et al. (2007 Veterinary Microbiology)
  - Nasal swabs were collected from 310 randomly selected pigs on 31 farms between August and November 2006 in The Netherlands
  - Swabs were taken from 11 persons on 5 farms
  - Antimicrobial use survey was administered

MRSA in Dutch Pigs (continued)

- Of 10 farms where antimicrobials were administered, 6 (60%) were positive for MRSA
- Of 21 farms where no antimicrobials were administered, 1 (5%) was positive for MRSA
- Pigs were sampled at the 6 farms supplying pigs to the 6 MRSA positive farms, 5 of 6 (83%) farms supplying pigs were also positive for MRSA
- 3 human carriers were found on 2 MRSA positive farms, 1 human carrier was found on 1 MRSA negative farm

MRSA in Dutch Pig Farmers?

- Voss et al. (2005 Emerging Infectious Diseases)
  - Nasal swabs of 10 pigs and perineum swabs of 30 pigs were cultured in southeast of The Netherlands
    - 1/30 (3%) pigs were positive for MRSA
  - Nasal swabs of 26 pig farmers, 3 hospitalized patients
    - 6/26 (23%) farmers were positive for MRSA

3 farmers shared the same *spa*-type (108) with the positive isolate in pigs

MRSA in Swine Different from CA-MRSA Strains

- MRSA isolated from swine farms in The Netherlands, Denmark and Canada
- MRSA strains similar to each other but distinct from the prevalent CA-MRSA strains in Europe and the US
- Evidence of direct swine-to-human transmission shown
- No evidence of MRSA foodborne transmission

Monitoring MRSA in Foods?

- No data on the presence of MRSA in foods
- Studies of MRSA in foods would answer this question
- If MRSA was found in food, it will be important to compare with CA-MRSA strains in people
- No changes in current food handling and hygiene recommendations are warranted

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Thank you for your attention

The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention

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Enterotoxin-producing CA-MRSA

- A report of an outbreak of GI illness caused by CA-MRSA
  - Tennessee (2002 Emerging Infectious Diseases): Staph intoxication outbreak involving a food handler, food specimen, 3 ill patrons
  - all culture positive for the same toxin-producing strain of MRSA