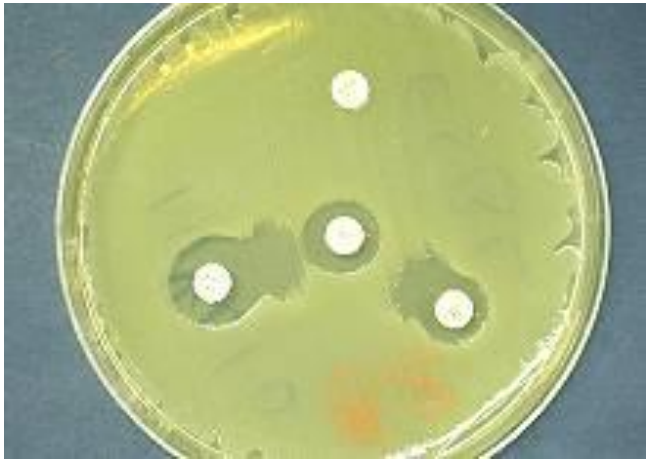
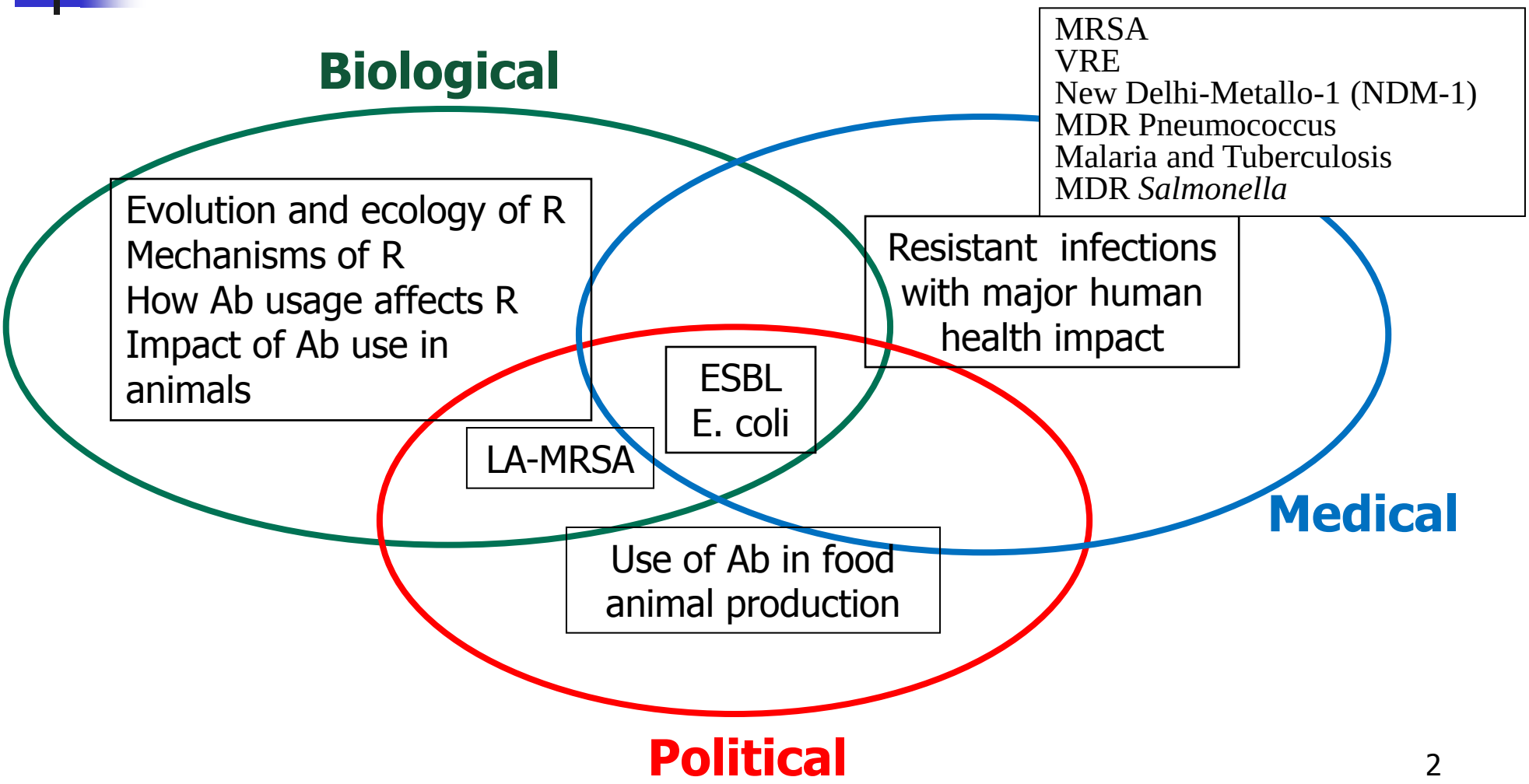
Antimicrobial Resistance and Food Animal Pathogens

What's hot and what's the risk?

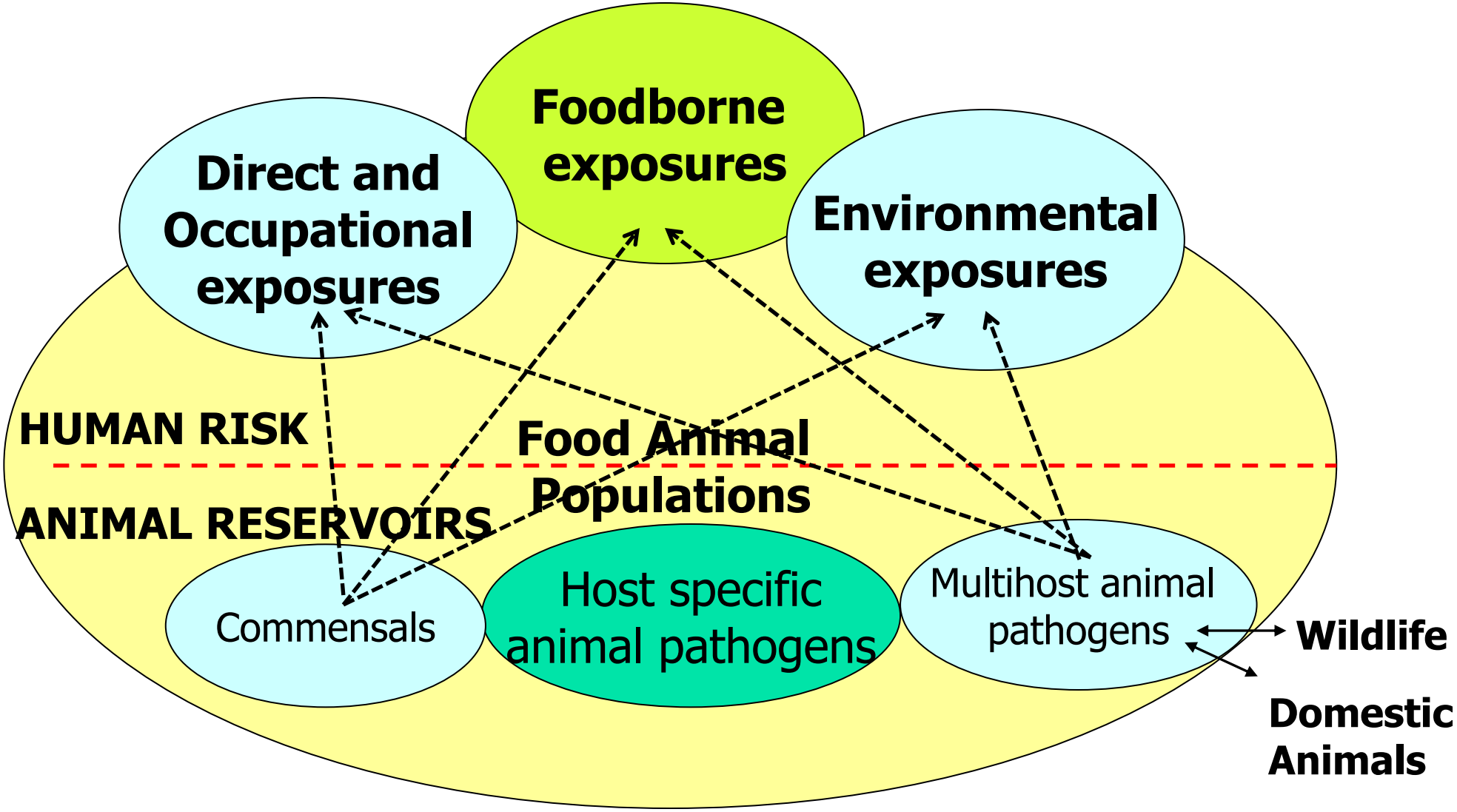


Peter Davies BVSc, PhD
University of Minnesota

Types of heat



Food animals and zoonotic disease

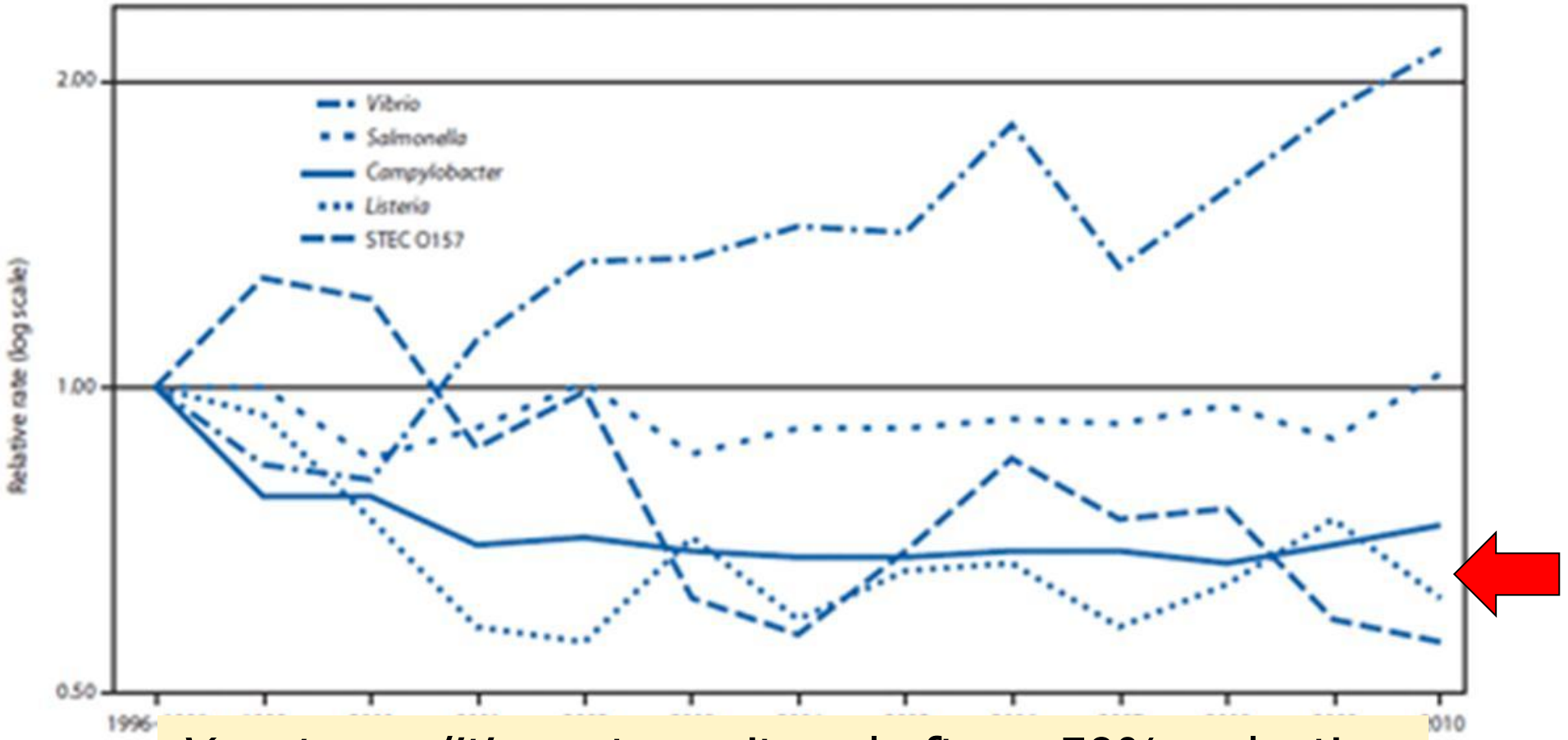


Hazard vs. exposure vs. risk

"Warm to Hot" Hazards: Food animals

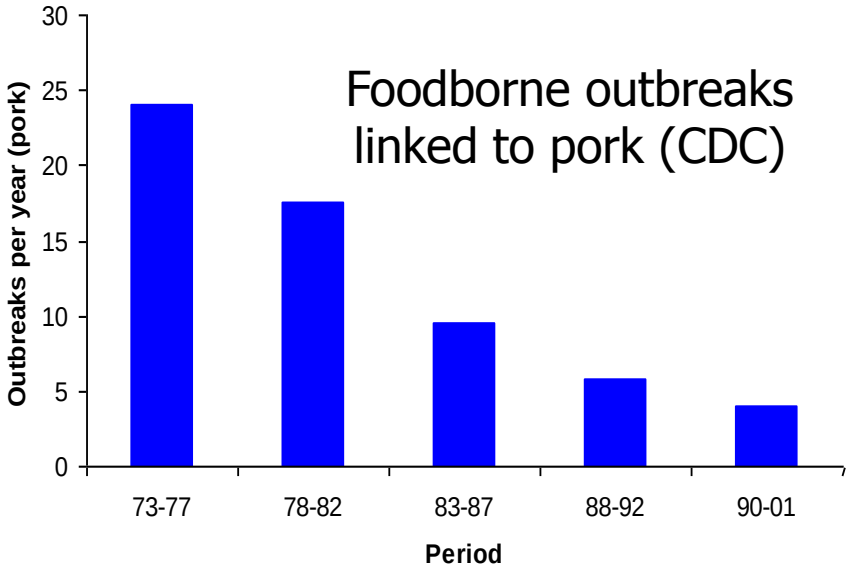
- Foodborne pathogens
  - *Salmonella*
  - *Campylobacter spp.*
  - *Listeria spp.*
  - *E. coli* - STEC
  - *Yersinia enterocolitica*
  - …
- Commensals
  - *E. coli* - ESBL
  - *Enterococcus spp.*
  - *S. aureus - MRSA*
  - *C. difficile*
  - ….

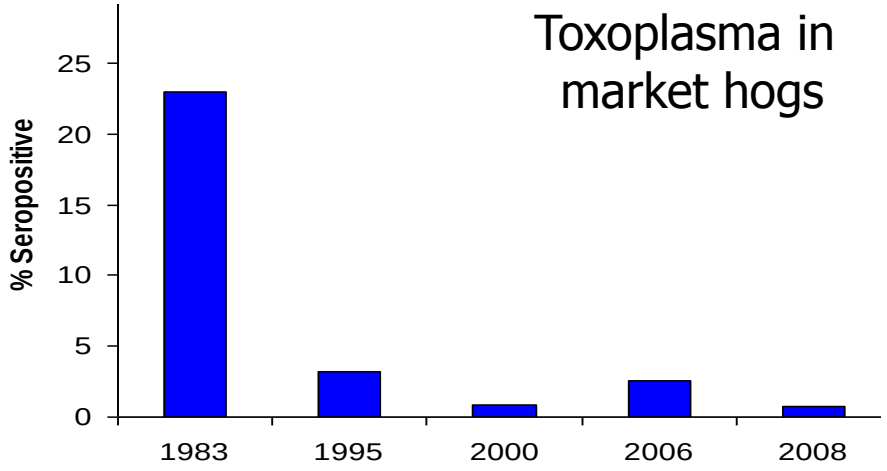
Relative rates of laboratory-confirmed enteric infections in the USA (FoodNet 2010)

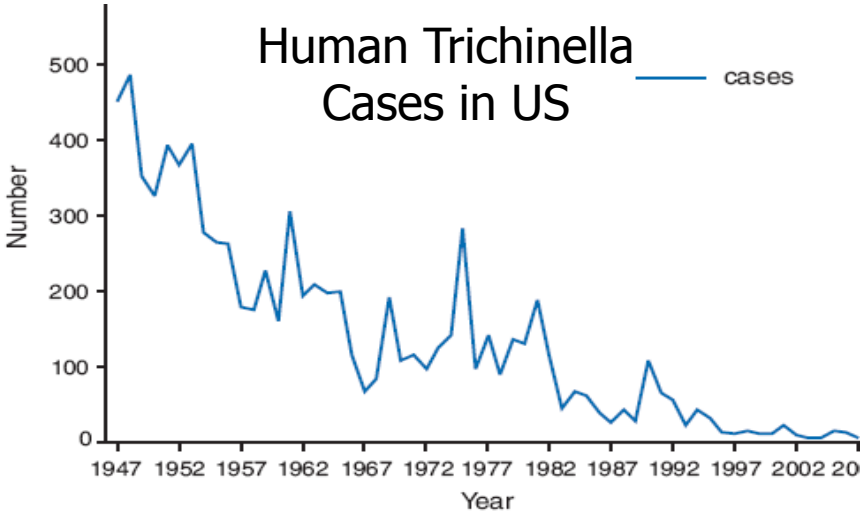


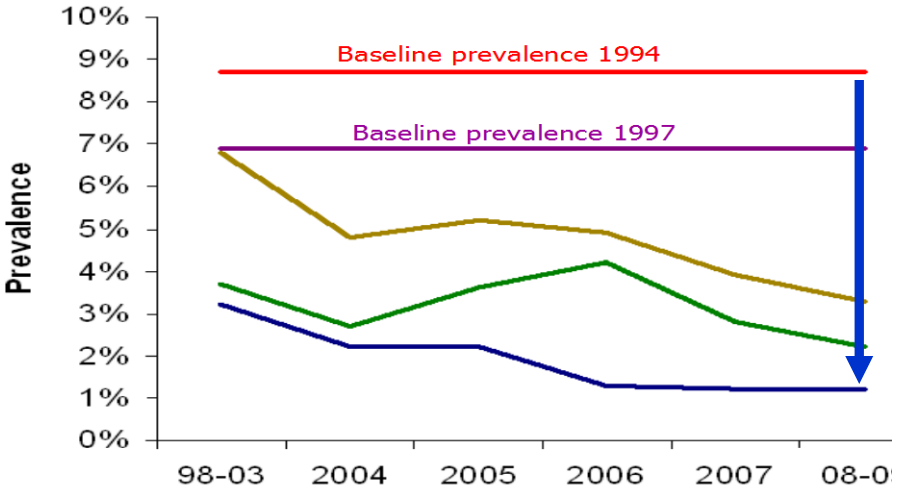
Y. enterocolitica not monitored after >50% reduction

Improved pork safety



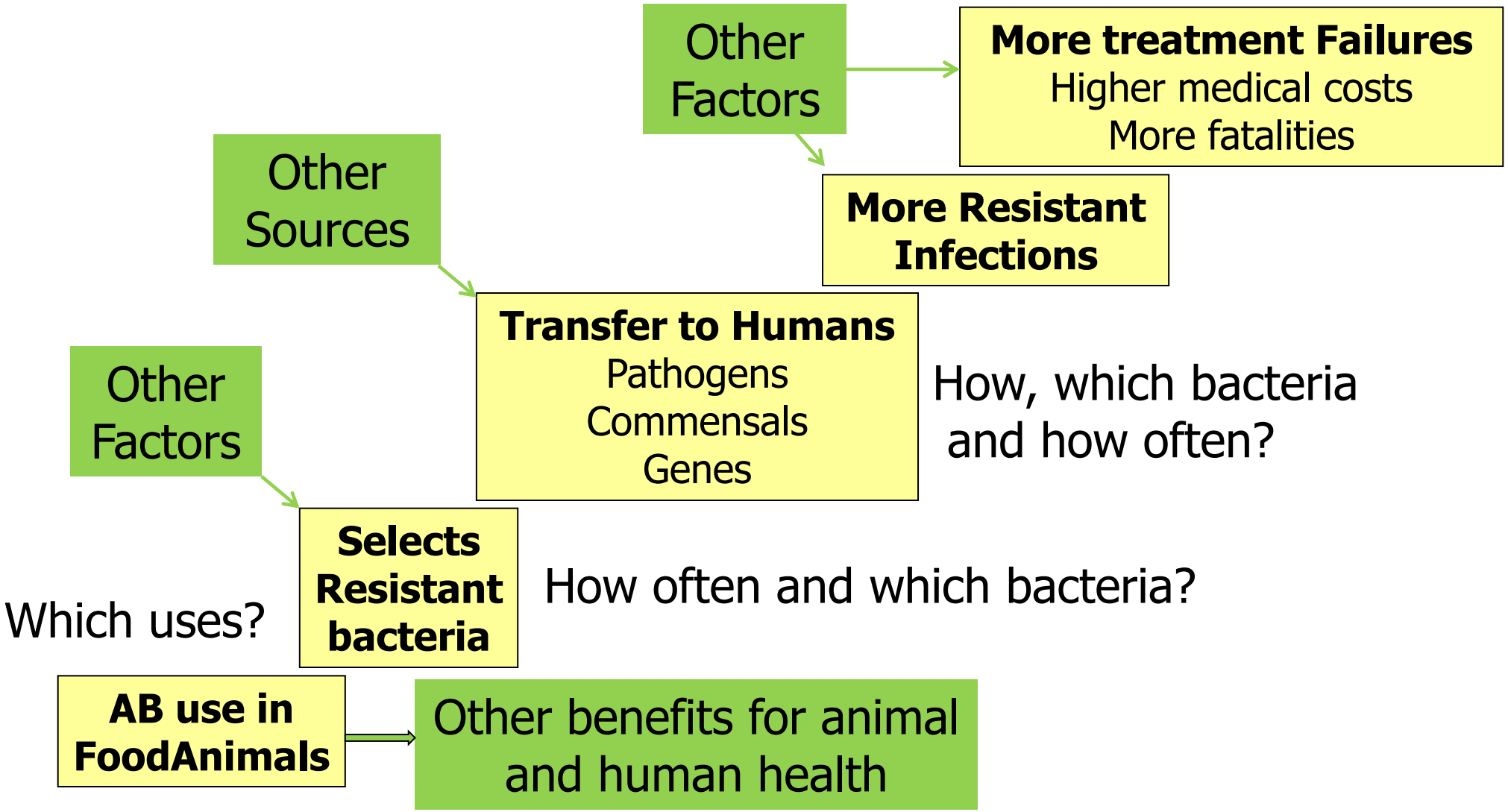






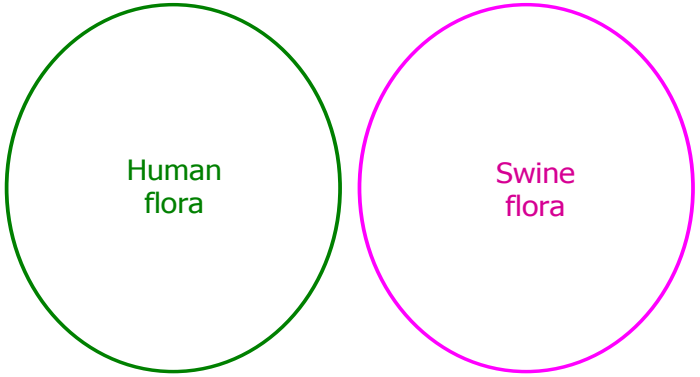
Salmonella on carcasses

The simple model



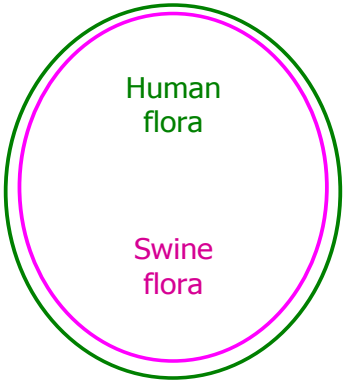
Concepts of Interspecies Transmission

Complete host adaptation



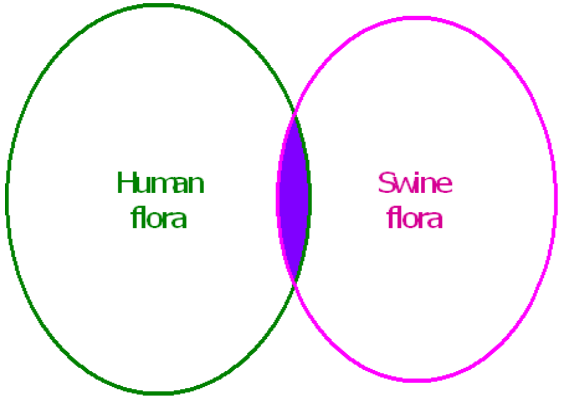
No interspecies transmission

No host adaptation



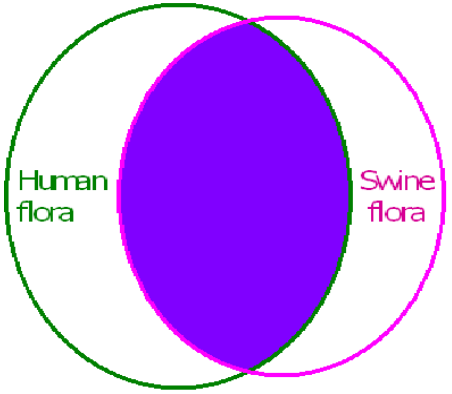
Equal propensity to
colonize both species

Marked host adaptation



Rare interspecies transmisssion

Some host adaptation



Common interspecies transmisssion

Attribution – joining the dots

- Difficult to establish links between cases of resistant infections and treatment failure to exposures originating from food animals
  - Non-zero risk
- Exposure pathways
- Molecular epidemiology
  - When are two bacteria 'identical'?
  - Does finding 'identical' strains mean transmission?
  - Which direction?

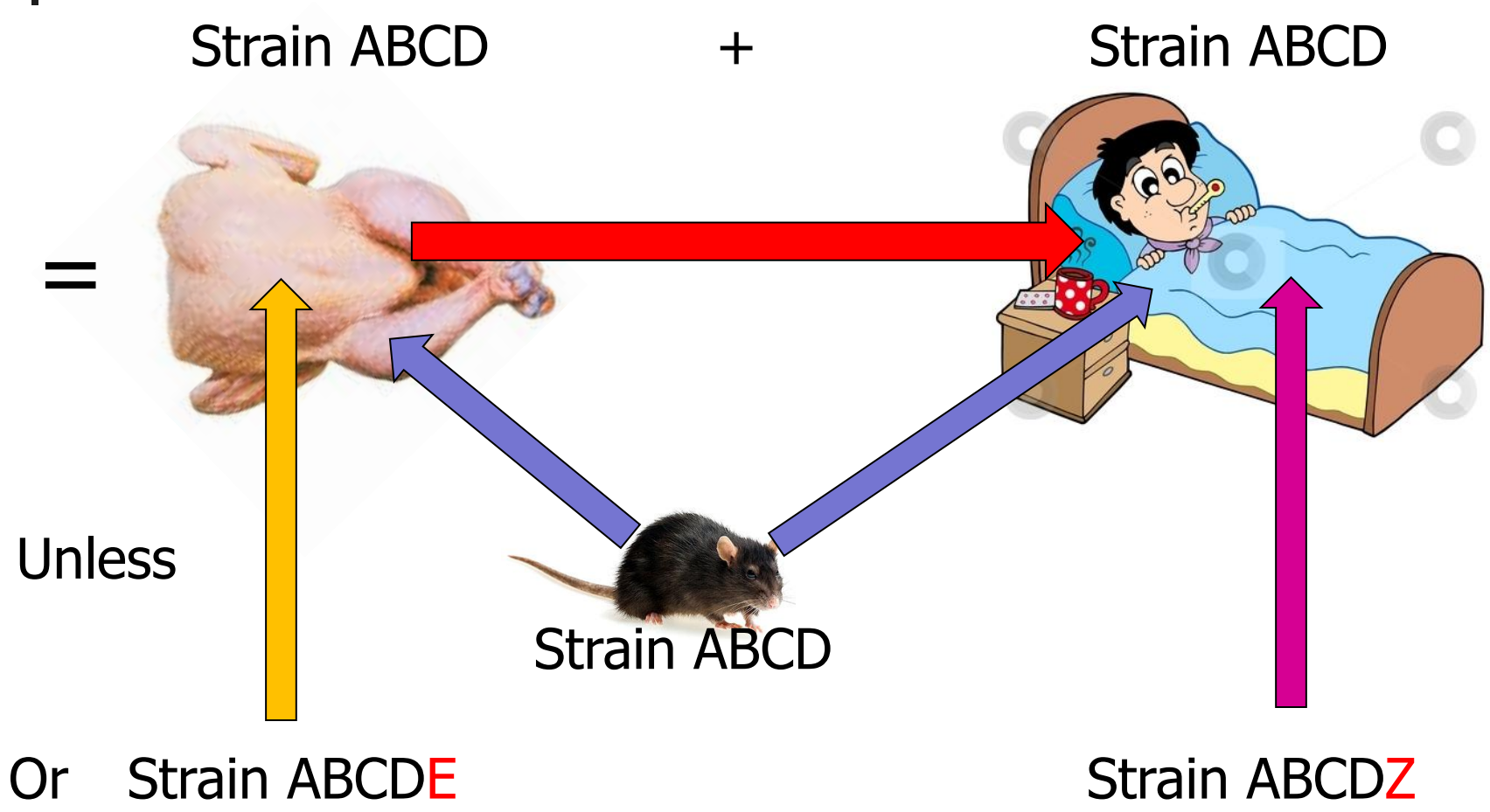
Extended spectrum beta-lactamase resistance in E. coli

- ESBL *E. coli* an emerging problem in human clinical medicine
  - Intestinal commensals
  - Extraintestinal infections - septicemia
  - Urinary tract
- *E. coli* diverse within and across host species
  - MLST and other typing methods
- ESBL resistance involves many different genes
  - TEM, SHV, CTX-M, CMY, NDM….

ESBL in poultry meat and humans in NL
(Overdevest et al, 2011)

- ESBL genes in chicken meat and human rectal swab specimens were identical.
  - also in human blood culture isolates
- Typing showed a high degree of similarity of *E.coli* strains from meat and humans.
- 'Abundant presence of ESBL genes in the food chain may have a profound effect on future treatment options for a wide range of infections caused by gram-negative bacteria'

Causal inference



Ab use in poultry is an important factor in emergence of ESBL-ExPEC?

- Troubling observations?
  - 30 of 33 unrelated ESBL-producing E. coli from healthy poultry lacked virulence genes associated with human-pathogenic strains (Bortolaia, 2011)
  - ESBL strain of highly virulent (mainly human- and avian-restricted ExPEC lineage ST95) in urban rats points to important role in epidemiology of E. coli strains (Ewers et al., 2012)
  - ESBL prevalence similar in organic and conventional poultry (Cohen et al, 2012)

ESBL producing and AmpC producing *E. coli* from livestock and companion animals: putative impact on public health (Ewers et al., 2012)

- MLST and plasmid ESBL/AmpC genes in E. coli present in humans and animals
  - Livestock and Companion animals
- MLST revealed the existence of ESBL-producing isolates thoughout the E. coli population, with no obvious association with any ancestral group.

ESBL producing and AmpC producing E. coli from livestock and companion animals: putative impact on public health (Ewers et al., 2012)

- A similar distribution of major ESBL/AmpC types was apparent only in human isolates, regardless of their geographical origin
- In animals, varied extensively between animal groups and across different geographical areas.
- The opinion that animal ESBL-producing *E. coli* is a major source of human infections is oversimplified, and neglects a highly complex scenario.

The role of antimicrobial use in emergence of Livestock Associated MRSA

- LA-MRSA 'uniformly tetracycline resistant'
  - Emergence due to growth promotant usage
- MRSA emergence in horses
  - Tetracyclines not used
- Role of antimicrobial use in food animals
  - 'Therapeutic' vs. 'non-therapeutic' uses
  - Few growth promotants are beta lactams
  - Newer injectable products
    - Long acting cephalosporins

Other selective pressures? (Aarestrup 2010)

- MSSA in pigs also tetracycline resistant
  - No selective pressure for MRSA
- Zinc
  - 74% of ST398 MRSA in DK had high MIC to zinc
  - All 60 ST398 MSSA strains had low MIC to zinc
- Widespread use of zinc since AGP ban
  - Prevention of enteric disease in weaned pigs
  - Used on most DK swine herds
- Law of unintended consequences?

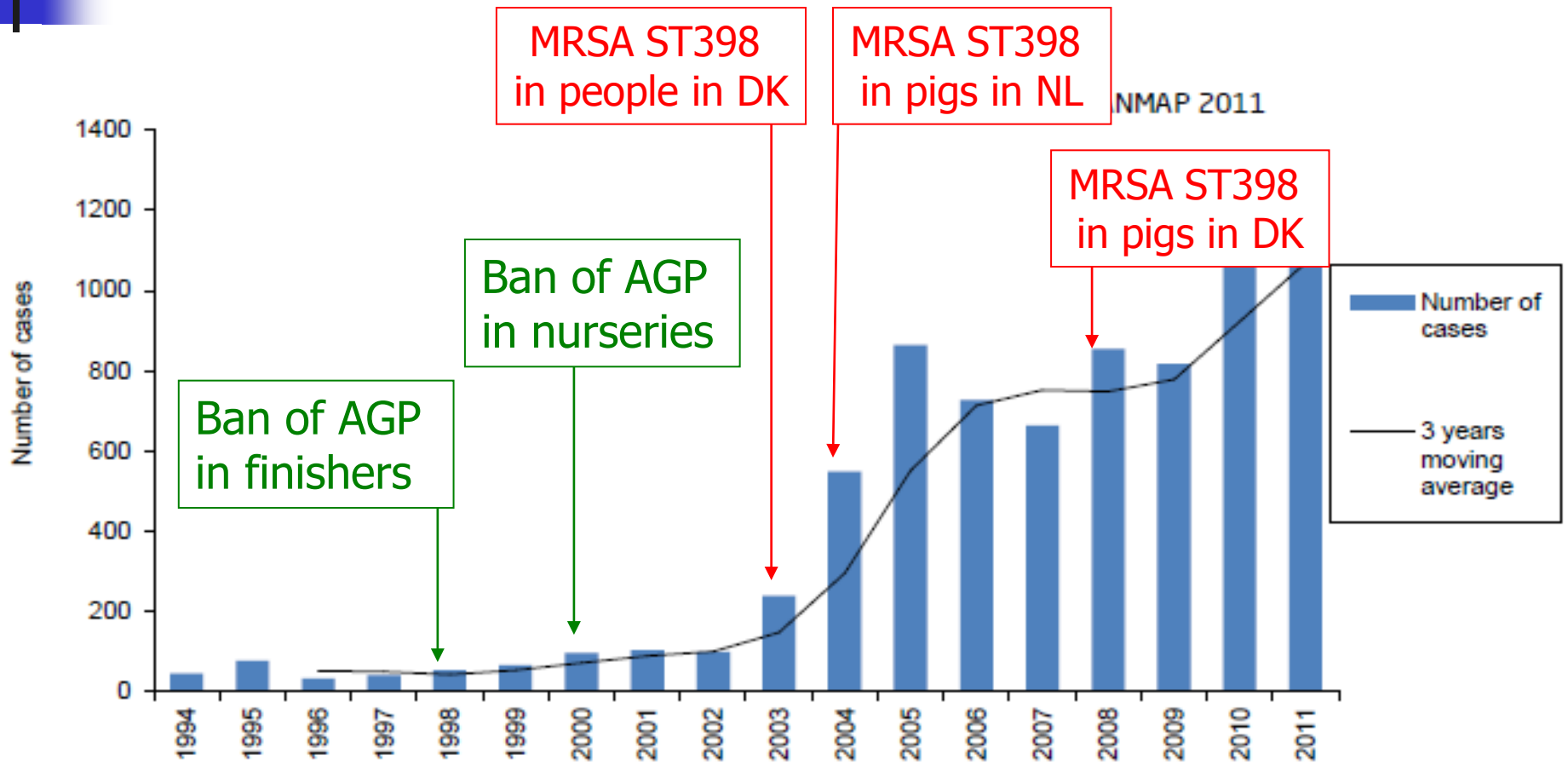
Zinc resistance of *Staphylococcus aureus* of animal origin is strongly associated with methicillin resistance

Lina M. Cavaco [1,*], Henrik Hasman [1], Frank M. Aarestrup [1]

- Global strain collection
  - MRSA and MSSA
  - Swine and veal isolates
- Study showed that zinc resistance widespread among ST398 LA-MRSA
- Use of zinc in feed might have contributed to the emergence of LA-MRSA

Growth promotants as the evil?

MRSA cases in Denmark (all types)



Summary

- Interspecies transmission of bacteria and resistance genes is complex
- Simple, single-factor cause and effect relationhips are rare at best
- 'Name, blame, and shame' approach to food animal industries is not constructive
- Time and effort required to understand the risks associated with apparently novel agents