Chicken liver, pate and *Campylobacter*

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*Campylobacter* poses two public health challenges

- High level surface contamination \((10^9)\):  
  A cross-contamination risk
- Contamination of liver and muscle tissues:  
  Heightened risk from under-cooking
Campylobacter spp in chicken muscle and liver tissues

• Muscle:
  - Humphrey (1991) 5% UK
  - Berndtson et al (1992) 5% Sweden
  - Scherer et al (2006) 27% USA
  - Luber and Bartlett (2007) 20% Germany

• Liver
  - Barot et al (1983) 4% USA
  - Boukraa et al. (1991) 21% diseased; 12% normal Canada
  - Wieliczko (1994) 63% (diseased) Germany
  - Cox et al (2006) 9% USA
  - Whyte et al. (2006) 36% Ireland
  - Cox et al (2009) 17% USA


Outbreaks caused by chicken liver pate are shown in black
Quantitative data for *Campylobacter* in chicken livers

- 30 samples examined and all positive on the exterior surfaces
- 9 had surface counts of >1100/100 grams
- 27 livers (90%) had internal contamination
- 2 had internal counts of >1100/100 grams
- Of 171 isolates examined, 168 were *C. jejuni*

Whyte, Hudson and Graham (2006). New Zealand
Effect of time and temperature on the survival of *Campylobacter* in chicken liver

Whyte, Hudson and Graham (2006). New Zealand

Studies on the interaction of *Campylobacter jejuni* with its environment
Hot water does not remove *Campylobacter* from chicken carcases

![Graph showing the effect of hot water on Campylobacter and Salmonella](image)

**Campylobacter are not Salmonella:** exposure to cold does not increase heat-sensitivity

![Graph showing the effect of cold on Campylobacter and Salmonella](image)

Chilled cells held at 6°C overnight before heating: Similar effects seen with *Listeria*
Attachment increases heat tolerance of *C. jejuni*

![Graph showing heat tolerance of Campylobacter cells attached to muscle](image)

_Campylobacter_ cells attached to small pieces of sterile muscle

How does chicken liver become contaminated with _Campylobacter_?
Does liver become positive during slaughter?

Liver surfaces may become contaminated during evisceration.

Research in USA has shown that bacteria in scald tank water can contaminate edible tissues, including liver.

Campylobacter: a poorly controlled chicken commensal?

- Some strains invasive in “well” chickens
- Others invade in compromised host
- Host responds as if Campylobacter is “pathogenic”
- Immune responses confine Campylobacter to gut
- C. jejuni isolated from liver and can cause vibrionic hepatitis (+ other factors)
- Association with bird health and welfare suggests an opportunistic pathogen

Liver T cells of infected birds proliferate on stimulation by C. jejuni.

Fig 2. Chickens’ immune responses to campylobacter differ from those to other “commensals”.
Infection of edible tissues more likely:

- If birds are suffering from acute stress
  - Catching, thinning and transport
  - *Campylobacter* virulence enhanced by noradrenaline
- If birds are in a poor production environment
  - Chronic stress and immunosuppression
- If birds are co-infected with endemic pathogens
  - APEC particularly important
  - Damages mucosa and allows *Campylobacter* through
  
  If the gut microbiota disturbed by antibiotic treatment
- If they grow rapidly
  - **The key to *Campylobacter* control is biosecurity and good gut health**

Welfare has a direct impact on extra-gut spread of *Campylobacter* in broilers

- Immunosuppression with corticosterone (chronic stress)
- Much extra-intestinal spread
- Acute diarrhoea in some birds
- *C. jejuni* highly invasive when grown with noradrenaline (acute stress)
- Highly invasive in birds given NA
- Enhanced virulence mainly iron-mediated
Endemic APEC infection and *Campylobacter* in broilers

- Link between *E. coli* and *Campylobacter* in field
- High % of *Campylobacter*+ livers in EC+ flocks
- Mucosal damage and extra-intestinal spread in lab studies when CJ and EC together
- No effect when CJ or EC given singly
- Crosstalk?
- Link between NE and *C. jejuni* in Norway

High levels in mucosal damage in co-infected birds

Concluding remarks

- *Campylobacter* in chicken poses two health threats: surface contamination and infection of edible tissues
- There is a need to better understand risk factors and mechanisms for the extra-intestinal spread of *Campylobacter*
  - Role of stress and poor welfare
  - Importance of endemic disease
  - Importance of production systems
- There is a need to properly examine the resistance of *Campylobacter* to heat and other stressors
  - Responses to food chain stresses
  - Does the food chain select more ‘virulent’ *Campylobacter*?
  - Survival and virulence of attached cells