



## Chicken liver, pate and *Campylobacter*

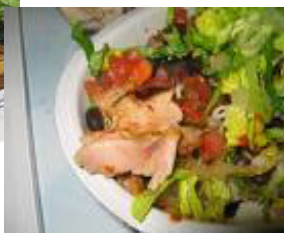
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### *Campylobacter* poses two public health challenges



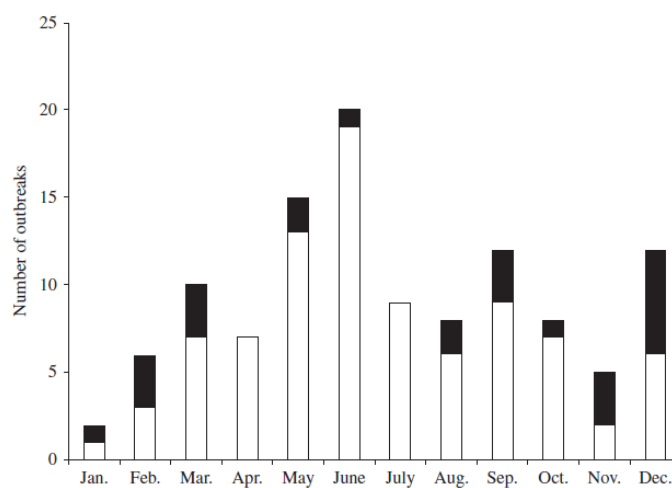
- High level surface contamination ( $10^9$ ):  
A cross-contamination risk
- Contamination of liver and muscle tissues:  
Heightened risk from under-cooking



### *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**
  - Lubber 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**

### Seasonality of foodborne outbreaks of *Campylobacter* in England and Wales 1992-2009

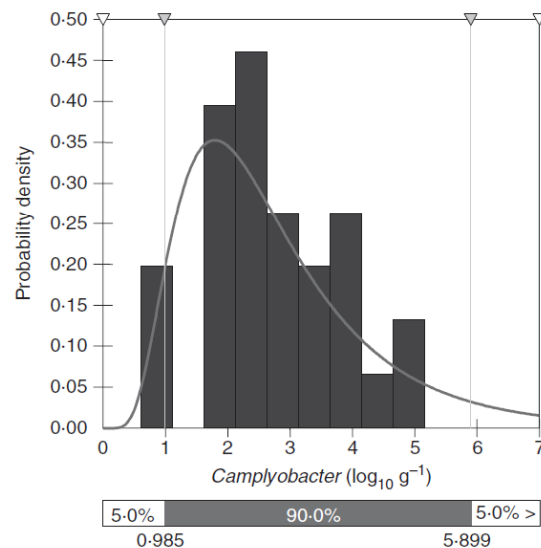


Outbreaks caused by chicken liver pate are shown in black

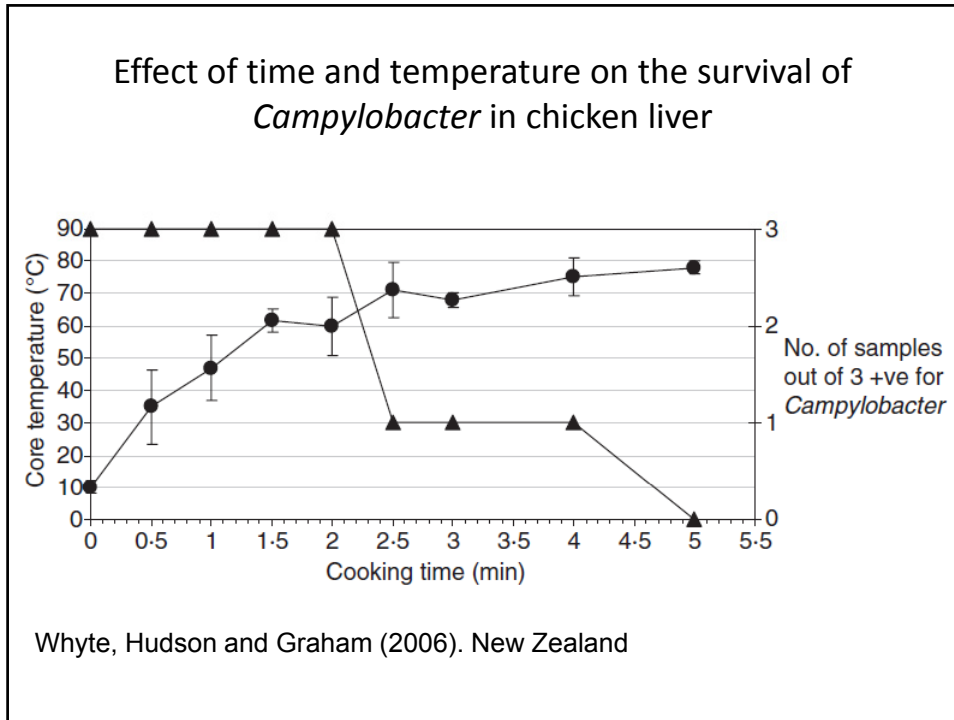
### Quantitative data for *Campylobacter* in chicken livers

- 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*

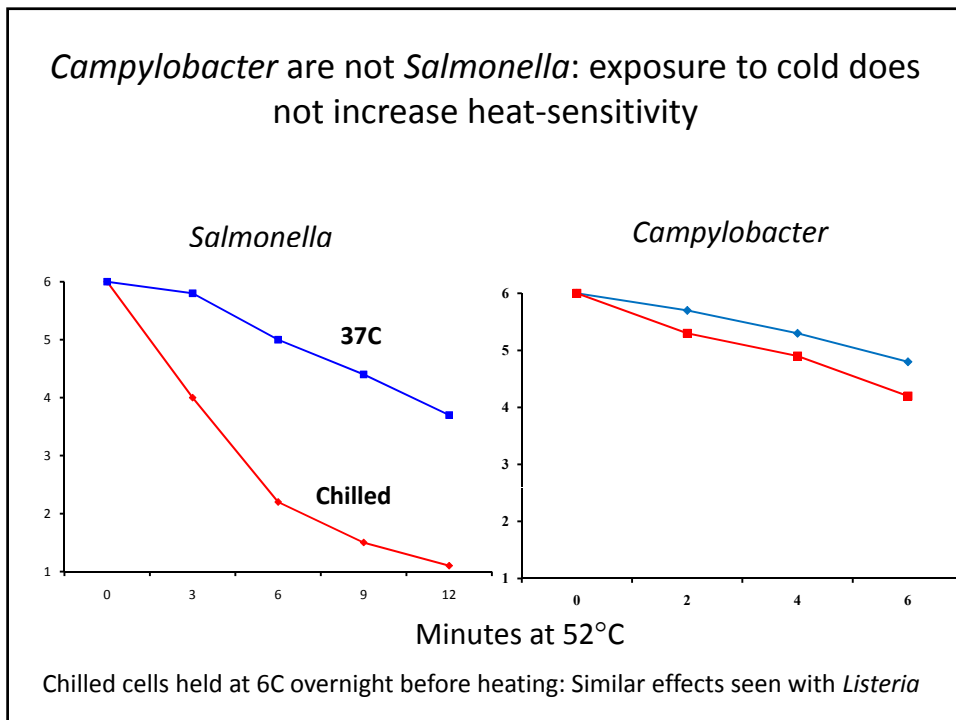
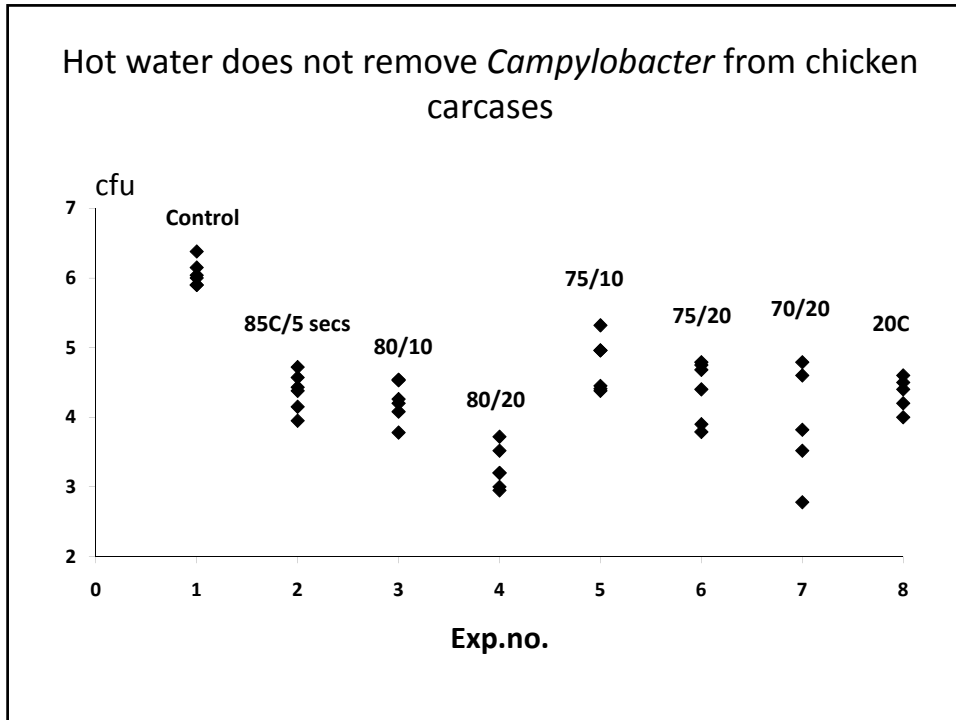
Whyte, Hudson and Graham (2006). New Zealand

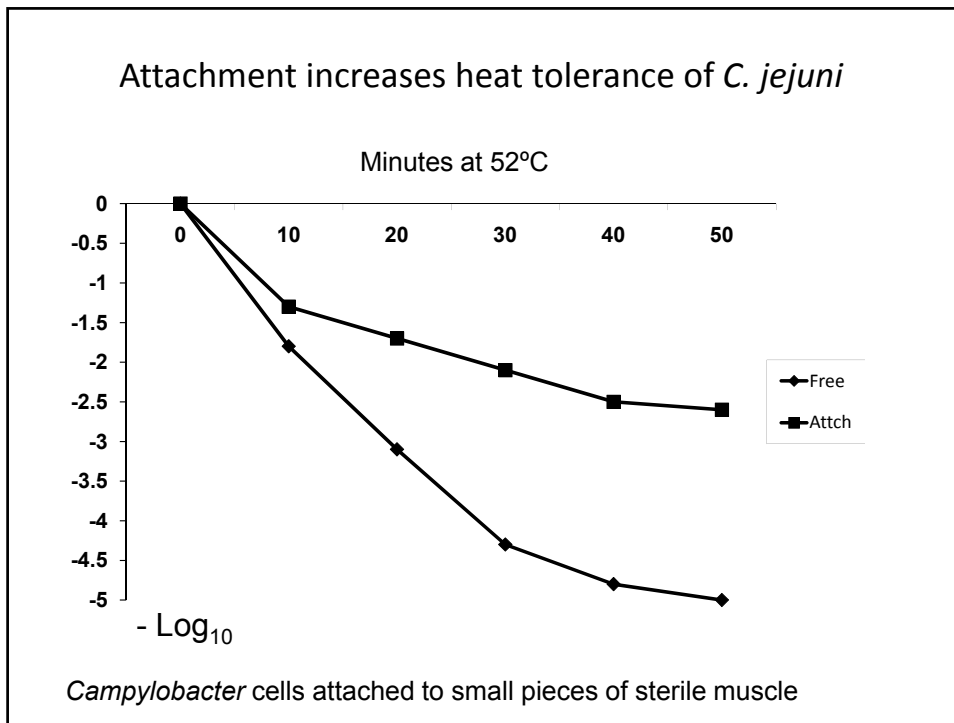


**Figure 1** A lognormal distribution fitted to the estimated number of *Campylobacter* ( $\text{Log}_{10}$ ) on and in chicken livers. The fitting of the distribution (line) to the data (histogram) is based on the Anderson Darling goodness of fit statistic. The fitted curve is lognormal (2.795,1.641).



Studies on the interaction of *Campylobacter jejuni* with its environment





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 vibriotic 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*

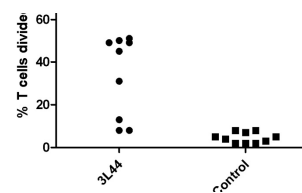
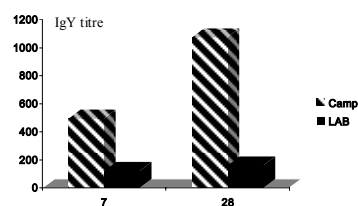


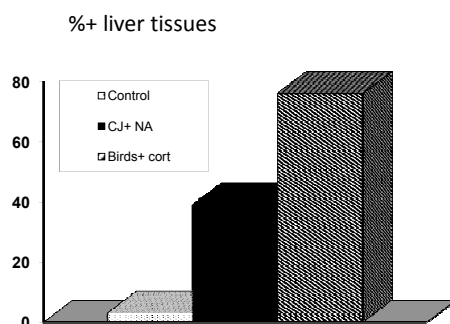
Fig 2. Chickens' immune responses to campylobacter differ from those to other “commensals”



### 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

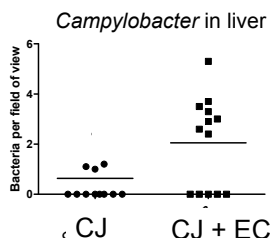


Infection of liver tissues after oral challenge

- 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

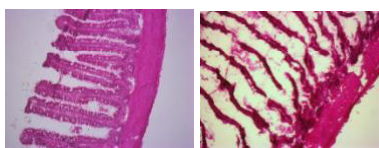


## Endemic APEC infection and *Campylobacter* in broilers



- 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

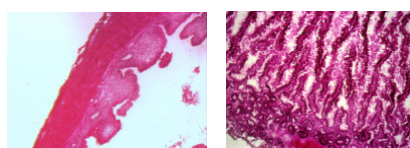
### Jejunum



CJ

CJ + EC

### Caecum



CJ

CJ + EC

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