Sources, Seasonality, Transmission and Control:
Campylobacter and human behaviour in a changing environment

Sarah J O'Brien[1], Peter Diggle[2], Tom Humphrey[1], Paul Hunter[3], Dan Rigby[4], Steve Rushton[5] on behalf of the Scientific Steering Group

INTRODUCTION

Campylobacter is the most common bacterial cause of diarrhoeal disease in the developed world. There were approximately 700,000 cases in the UK in 2010 with around 200 deaths.

The current annual UK cost of acute *Campylobacter* infection is around £600 million, exceeding that from *Salmonella*, *Listeria* and *E. coli* O157 combined.

The transmission pathways for ~50% of human cases are unknown. Around 40% of cases occur during the 'spring peak'. Yet the relative roles of environmental and food pathways, and their interaction, in this seasonal emergence are poorly understood, if at all.

To reach a breakthrough we face two important challenges.

1. to develop innovative methods that incorporate environmental and social systems to understand how they interact with *Campylobacter*.
2. to ensure these new methods capture the behaviours of both humans and *Campylobacter* over different temporal and spatial scales.

AIMS

- Identify the key reservoirs, environmental and social drivers of *Campylobacter* that affect human disease;
- Analyse seasonal variations in pathogen load and their impacts on exposure and disease;
- Understand the relative roles of the transmission pathways and thus points of control;
- Generate future projections of disease risk and its control.

OBJECTIVES

- Identify how *Campylobacters* persist in the natural environment and how environmental exposure influences their virulence; analyse the interaction between *Campylobacter* populations and their environment; estimate the direct and indirect contribution of environment and human behaviour on the risk of human *Campylobacter* infection (Aim 1).
- Analyse spatial and temporal variation in *Campylobacter* load in contrasting rural environments to quantify seasonal variation in human exposure to *Campylobacter* (Aim 2).
- Analyse the relative importance of different transmission pathways (recreation, water, food, etc.) to humans; analyse risk perceptions of rural environment users; analyse effectiveness, acceptability, costs and benefits of interventions to reduce burden by estimating the current costs of *Campylobacter* disease; analyse interventions and assess their acceptability (Aim 3).
- Predict changes in disease burden due to environmental and/or social change; predict how future changes in climate, land use, countryside visits, food production and consumption will affect disease patterns and costs (Aim 4).

STUDY 1: Ecological analysis of patterns of risk using historical data

- Spatio-temporal variation in the incidence of human *Campylobacter* cases is determined by interaction between seasonal patterns of livestock husbandry and weather that increases environmental contamination and exposure;
- Seasonal variation in the incidence of *Campylobacter* depends on the seasonal pattern of contaminated chicken consumption, socio-economic status of consumers and colonisation of chicken by *Campylobacter*.

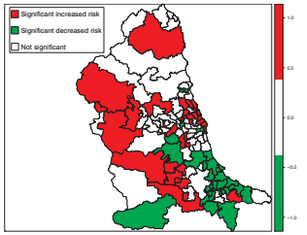

Figure 1: Relative risk for *Campylobacter* infection in populations delineated by outgoing postcode sectors in NE England, winter months 2004-2008.

STUDY 2: The ecology of *Campylobacter* infection on farms

- Animal production acts as a multiplier of *Campylobacter* and livestock are a source of contamination for the surrounding natural environment, which is then the source of further livestock infection;
- Microbial communities in the environment are important in the ecology of *Campylobacter*;
- Ruminant *Campylobacter* strains are more common in the environment and more widespread than ones from intensively reared chickens.

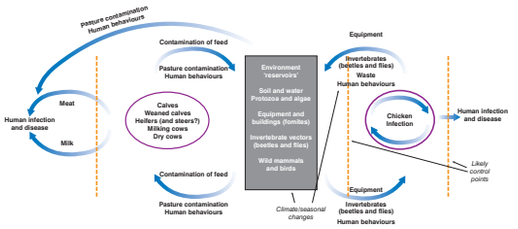

Figure 2: *Campylobacter* transmission cycles

STUDY 3: Landscape as a direct source of human exposure

- Seasonal patterns in human *Campylobacter* cases arise from variation in patterns of human exposure in the landscape, coinciding with seasonal variation in pathogen load arising from variations in land use and weather;
- Members of the public do not perceive health hazards associated with countryside use;
- Throughout the year, children in rural areas are more frequently infected with *Campylobacter* from the environment because they have more frequent contact with soils and water than do children in urban areas;
- During the seasonal peak a higher proportion of human disease is caused by genotypes found in the environment because of greater environmental exposure and higher levels excreted by sources in the countryside.

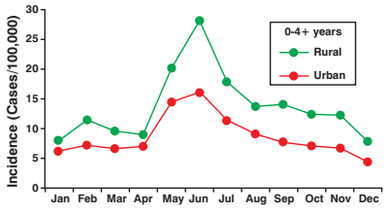

Figure 3: Seasonality of *Campylobacter* cases in the under 5s, urban and rural populations, Scotland (2000 – 2006)

Environmental sampling: pilot study

The research team carried out a pilot study of environmental sampling using boot socks in February 2011. The boot socks withstood 2 hours of fell-walking.
From subsequent microbiological analysis of the boot socks 3 out of 7 were positive for *C. jejuni*.




STUDY 4: The economic costs of *Campylobacter* and assessment of interventions to reduce it

- What are the economic costs of *Campylobacter* infection in the UK?
- What role could technical interventions in the food chain play in reducing *Campylobacter* loads?
- What is the relationship between the effectiveness of control measures and their acceptability to producers and consumers?
- What is the extent of pathogen risk increasing behaviours in the food chain, and how can their prevalence be gauged?

STUDY 5: Alternative Risk Futures

- Synthesise the outputs of all prior studies to produce a unified model of both indirect (food chain) and direct (environment) *Campylobacter* transmission to people.
- Develop a risk progression model encapsulating all risk factors associated with the environment and dietary exposure to identify those features of the transmission pathway most amenable to intervention.
- Identify the extent to which changes in the environment that might arise because of global climate and land use change affect disease prevalence and our ability to control disease.
- Consider appropriate policy responses.

AUTHOR AFFILIATIONS

1 Institute of Infection and Global Health, and National Centre for Zoonosis Research University of Liverpool, UK

2 School of Health and Medicine, Lancaster University, Lancaster, UK

3 The Norwich School of Medicine, University of East Anglia, Norwich, UK

4 Dept of Economics, School of Social Sciences, The University of Manchester, Manchester, UK

5 School of Biology, Newcastle University, Newcastle upon Tyne, UK

Co-investigators are:

Malcolm Bennett and Craig Winstanley, University of Liverpool

Ken Forbes and Norval Strachan, University of Aberdeen

Rachel Griffith, University of Manchester

Iain Lake and Kevin Hiscock, University of East Anglia

David Howard, Centre for Ecology and Hydrology, Lancaster

Brendan Wren, London School of Hygiene and Tropical Medicine

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