ESR Science for Communities

New Zealand Food Safety
Ministry for Primary Industries
Manatū Ahu Matua

CAMPYLOBACTER SPP.

THE ORGANISM/TOXIN

- *Campylobacter* spp. are Gram-negative, mostly motile, spiral-to-curved rods (1).
- *Campylobacter* spp. live as commensal organisms in the gastrointestinal tract of many domestic mammals and wild birds (2).
- The genus *Campylobacter* consists of 26 species and 9 subspecies (as of 2014) (2).
- *Campylobacter* spp. are a major cause of gastroenteritis worldwide and the most commonly-reported gastrointestinal disease within New Zealand (2, 3, 4, 5).
- *Campylobacter jejuni* (*C. jejuni*) and *C. coli* are responsible for over 90% of human campylobacteriosis cases (4). *C. concisus, C. upsaliensis,* and *C. lari,* have also been associated with human gastrointestinal infections (2).
- *Campylobacter* spp. produce several different cytotoxins but none are produced in foods (4).

GROWTH AND ITS CONTROL

Unless otherwise stated, the information below was derived from the following references (6, 7).

Growth:

	Minimum	Optimum	Maximum
Temperature*	30.5°C	42°C	45°C
	Slow growth (generation time approximately 1 hour)		
Water activity	0.987	0.997	
pH	4.9	6.5 - 7.5	9
Atmosphere	3-5% oxygen and 2-10% carbon dioxide.		
	• Some species require at least 3% hydrogen. • Correlation between strain differences in oxygen tolerance and resistance to the antibiotic metronidazole (8).		

*for *C. jejuni and C. coli* (4).

Survival:

Temperature	• Better survival in food under refrigeration than at room temperature (up to 15 times as long at 2°C compared with 20°C). • 1 $\log_{10}$ CFU reduction at normal freezing temperatures then slow decline (9).
Atmosphere	• Survives well in modified atmosphere and vacuum packaging. • Survives poorly at atmospheric oxygen concentrations.
Biofilm production	• Can form biofilms and survive for long periods of time in drinking water distribution networks (10).
VBNC	• Transition to the Viable but Non-Culturable (VBNC) state under stress conditions (pH stress, nutrient starvation and low temperatures) (11).

Inactivation:

Temperature	• Rapidly inactivated by temperatures ≥ 55°C. • Insufficient data to derive *D* values for *C. coli* and *C. jejuni* in meat (12). • *Campylobacter* is more sensitive to heat than *Salmonella* spp., *L. monocytogenes* and *E. coli.* Therefore, heat inactivation processes for these pathogens will provide at least the same $\log_{10}$ reduction for *C. jejuni* or *C. coli* (12) (refer to other individual data sheets).
Drying	• Very sensitive to drying, particularly at ambient temperatures.
pH	• Rapid death in foods at pH <4.0 particularly at non-refrigeration temperatures.
Sanitisers /disinfectants	• > 6 $\log_{10}$ reduction in 1 minute with a large range of commercial formulations (13).
Radiation	• Killed by ionising radiation. Rate of killing is dependent on the temperature and type of food being irradiated (14). • *Campylobacter* spp. reduced by Ultraviolet (UV) light, high intensity light pulses (HILP) and high intensity near ultraviolet/visible (NUV-vis) on raw chicken and other meats (15).
Preservatives	• Natural antimicrobials, including plant-based derivatives such as essential oils and stilbenes (16, 17). • Bacteriocins, bacteriophages and probiotics for reducing intestinal colonisation (of broiler chickens in particular) (2).

THE ILLNESS

Incubation: 1 to 10 days (average between 2 and 5 days) (18).

Symptoms:

- Muscle pain, headache and fever followed by self-limiting watery or bloody diarrhoea, abdominal pain and nausea (2, 18).
- Symptoms typically last between 3-7 days (2, 18).
- Precursor to more serious illnesses in a minority of individuals (2, 3).
- Infection with strains other than *C. jejuni* or *C. coli* often lead to milder symptoms however, diarrhoea lasts for 14 days or more in 80% of patients infected with *C. concisus* (19).

Condition: Campylobacteriosis.

At Risk Groups:

- Gastrointestinal illness can occur in any age group.
- Highest incidence reported among children (<5 years old), young adults (15-24 years) and people >60 (2, 18).
- Extraintestinal infections are more common in the elderly, immunocompromised patients and pregnant women (18).
- Risk factors include international travel; consumption of contaminated meat, milk or water; environmental exposure and direct contact with farm animals (2).

Long-term effects:

- Gastro-intestinal manifestations including periodontal disease, inflammatory bowel disease (IBD), Barrett's oesophagus and colorectal cancer (2).
- Extragastrointestinal manifestations including bacteraemia, hepatitis, miscarriage, meningitis reactive arthritis (Reiter's syndrome), autoimmune neurological/respiratory disorders (Guillain-Barré Syndrome) (GBS), Miller Fisher syndrome and cardiovascular complications (2, 3).

Dose: For *C. jejuni,* the infective dose can be as low as 350-800 colony forming units (20, 21).

Incidence:

- Most frequently reported foodborne illness in developed countries including New Zealand (5).
- New Zealand incidence rate of 158.9/100,000 (2016) (5). A large decrease in cases was observed during 2006-2008, compared with the preceding decade, after successful intervention strategies from the poultry sector were implemented. Since 2008 the rates have remained relatively stable between 168/100,000 and 135.3/100,000.
  Updates can be found on the ESR website: *https://surv.esr.cri.nz/surveillance/annual_surveillance.php*
- New Zealand incidence rates are higher than the EU ((65.5/100,000) (2015)) (22), USA ((17.1/100,000 from 10 States) (2015)) (23) and Australia ((124.9/100,000) (2014)) (24).
- Globally, case-fatality rates for campylobacteriosis range from <0.01% to 8.8% and are typically confined to young, elderly or immunocompromised patients (25).
- Seasonal trend in notifications, with most cases occurring during the spring and summer months (5, 17).

Treatment:

- Treatment rarely required, supportive therapy may be given (maintenance of hydration and electrolyte balance) (2).
- For severe cases, Fluoroquinolones are the antibiotic of choice however; *Campylobacter* strains are becoming increasingly resistant to this family of antibiotics (2, 17).
- Gentamicin or kanamycin (aminoglycosides) used for severe systemic infections (2, 17).

SOURCES

Human:

- Person-to-person transmission, via stools (2, 3).
- Responsible for 4% of campylobacteriosis cases in New Zealand (26) and similar estimates in the Netherlands (27) and Australia (28).

Animal:

- Wild or domesticated animals, birds and insects are common reservoirs of infection for humans (2, 3, 4, 17, 29).
- Prevalence higher in younger ruminants compared with older animals (2).
- Biosecurity failures may contribute to higher rates in the farm environment (17, 30).

Food:

- Consumption of contaminated raw meats (poultry and red meat), unpasteurised milk, inadequately cooked meats (especially poultry), contaminated raw fruit and vegetables or cross-contaminated ready-to-eat foods (2, 3, 17).
- Poultry is recognised as a primary source of food-related *Campylobacter* transmission to humans (2, 31).
- Previous very high rates of campylobacteriosis in New Zealand (>300/100,000) have been attributed to high carriage rate within broiler chickens (26, 31, 32).

Environment/Water:

Worldwide:

- Consumption of contaminated water responsible for a number of outbreaks globally (2, 17).
- Contamination of water from sewage outflow systems, waste runoff from grazed pasture and excreta from wild birds (33).

New Zealand:

- Contamination of 55-85% of river water samples in the South Canterbury region (26).
- Exposure to contaminated recreational water responsible for 3-10% of infections (26, 33).

Transmission Routes: Consumption of contaminated food and water, environmental exposure, direct contact with domesticated animals, person-to-person transmission (17).

OUTBREAKS AND INCIDENTS

Outbreaks:

Most campylobacteriosis cases are sporadic and outbreaks are rarely reported (17).

New Zealand

- Between 2007 and 2016 (excluding 2014), the number of reported foodborne outbreaks of campylobacteriosis ranged from between 7 and 16 each year with between 28 and 77 annual outbreak-associated cases. The increased number of cases in 2014 was due to three outbreaks with high numbers of associated cases (34).
- In 2016, 8 (53%) of the outbreaks caused by *Campylobacter* spp. and 28 of the associated cases (2.8%) were reported as foodborne with only a minority of foodborne outbreaks having a source identified. Implicated foods included raw milk and chicken liver pate (34).
- In 2016 *Campylobacter* was the primary infectious agent responsible for a large outbreak of gastroenteritis in Havelock North associated with contamination of local drinking water supplies (35).

New Zealand

Notable foodborne/water outbreaks in recent years are included below*.

Year	Foodborne outbreaks (cases)	Suspected foods (outbreaks) percentage
2006	32 (137)	No identifiable source
2007	12 (35)	Poultry (5) 42%
2008	8 (36)	Poultry (2) 25% Dairy (1) 12.5% Eggs (1) 12.5% Meat (1) 12.5% Fresh produce (1) 12.5%
2009	7 (39)	Poultry (4) 57% Dairy (2) 29% Pork (1) 14% Beef (1) 14% Lamb (2) 28% Root vegetables (1) 14%
2010	14 (62)	Poultry (6) 43%, Shellfish (1) 7% Dairy (3) 21% Rice (1) 7% Grains/Beans (1) 7% Oils/Sugars (1) 7% Lamb (1) 7%
2011	11 (53)	Poultry (2) 18%, Dairy (2) 18% Lamb (2) 18%
2012	11 (51)	Poultry (2) 18%, Dairy (3) 27%
2013	16 (77)	Poultry (4) 25% Dairy (3) 19% Oils/sugar (1) 6% Beef (1) 6% Root vegetables (1) 6%
2014	18 (158)	Poultry (7) 39% Dairy (5) 28% Lamb (1) 5.5%
2015	11 (46)	Poultry (2) 18% Dairy (2) 18% Leafy vegetables (1) 9%
2016	8 (28)	Chicken liver pate (3) 37.5% Raw milk (4) 50%
2016	1333/5500	Contaminated drinking water supply (Havelock North) (35)

*More than one source may be implicated in some outbreaks

Worldwide

Notable foodborne/water outbreaks in recent years are included below.

Year	Cases confirmed/individuals affected	Suspected foods	Country	Control measure failure
2007	105/1500	Drinking water	Norway	Multiple faults including pressure fall, significant leakage problems and outdated materials used for piping (36)
2007	16	Raw milk	The Netherlands	Poor hygienic practices on farm (37)
2011	57	Duck liver parfait	Australia	Inadequate cooking of duck livers (38)
2012	148	Raw milk	Multistate USA	Poor hygienic practices and on-farm biosecurity failures (39)
2014	59/99	Raw milk/Mexican-style soft cheese	Utah	Poor hygienic practices on farm (40)

LIST OF AVAILABLE RISK PROFILES

Matrix	Date	Link
Offals (mammalian and poultry)	January 2007	*Campylobacter jejuni/coli* in mammalian and poultry offals
Red meat	January 2007	*Campylobacter jejuni/coli* in red meat
Poultry	March 2007	*Campylobacter jejuni/coli* in poultry (whole and pieces)
	August 2013	*Campylobacter jejuni/coli* in poultry (whole and pieces) (update)
	January 2016	The emergence of *Campylobacter jejuni* ST 6964 in poultry in New Zealand and its associated antimicrobial resistance
Broiler chickens	June 2007	*Campylobacter* species in broiler (young) chickens
Raw milk	May 2014	*Campylobacter jejuni/coli* in raw milk

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