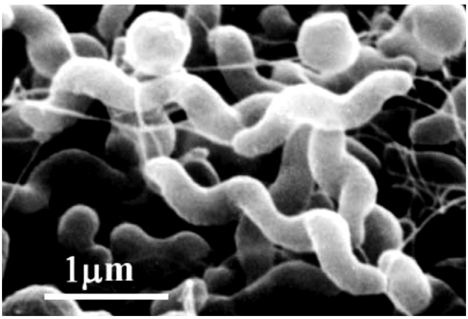
The Society of Food Hygiene and Technology

Food Microbiology

What is *Campylobacter* ?

Campylobacter species cause more reported cases of food-borne diarrhoea in the UK and Europe than any other bacteria, including *Salmonella*. Whilst numbers of *salmonella* infections in England and Wales have been falling steadily in recent years, numbers of *campylobacter* cases have risen every year since 2004, reaching 62,684 in 2010. There are about 15 different species, but only two species are responsible for almost all the reported infections in the UK. *C. jejuni* causes about 95% and *C. coli* about 5 %.



The name '*Campylobacter*' means bent rod. When viewed under the microscope they are small, twisted and rod-shaped. They can move rapidly due to having a whip-like flagellum at one end which acts like a ship's propeller.

Why have so few people heard about *Campylobacter*?

Firstly, although undoubtedly a cause of diarrhoea, they were only 'discovered' in the late 1970s. The reasons for this are two-fold:-

1. There was no convenient method of detecting them – e.g. a selective agar medium that could be used routinely and easily to examine faeces from sick people.

2. It was not realised that campylobacters are microaerophilic - they need an atmosphere high in carbon dioxide and low in oxygen - e.g. 10% CO_2, 5% O_2, balance N_2.

As soon as a selective medium was available and a suitable atmosphere used, clinical laboratories all round the world started to identify *Campylobacter* as a major cause of human diarrhoea.

Another reason why they were ‘missed’ (and why many people, even now, have not even heard of them) is mostly likely because, unlike *Salmonella*, they seldom cause big outbreaks of disease – most cases seem to be ‘sporadic’ - occurring in ones and twos, with person-to-person transmission being rare. However, outbreaks do occur from time to time - e.g. from consumption of raw milk or untreated drinking water, and most recently from undercooked chicken livers (‘pan-fried’).

How do they infect people?

Campylobacters do not seem to be able to multiply outside a warm-blooded animal or bird host, not least because *C. jejuni* and *C. coli* have a minimum growth temperature above 31°C, and so are often called ‘thermophilic’. They do not survive for very long in the environment either, especially in dry and relatively warm environments, and are also quite sensitive to freezing and easily killed by heat during cooking. Counter intuitively, they survive poorly at room temperature and for longer in the fridge.

Characteristics of the disease

The incubation period is usually 2 - 7 days, and the duration of illness varies depending on the age and state of health of the person, from about 10 days up to several weeks. The symptoms include bloody diarrhoea, preceded by fever, abdominal pain and nausea. In a small number of cases recovery from the diarrhoea is followed by some very unpleasant autoimmune complaints, including reactive arthritis and Guillain Barré syndrome. The latter causes descending paralysis, which can be fatal, although most victims make a full recovery.

So why do they cause such a problem?

Well, when they infect birds, especially chickens (perhaps 'colonise' is a better word, as the chickens do not become ill) they multiply to many millions per gram of gut contents. Very high numbers have also commonly been found in the intestines of cattle, sheep and pigs at slaughter. During slaughter and dressing some of these *campylobacters* inevitably contaminate the meat.

Numbers surviving on red meat such as beef and pork after chilling are relatively low, so these meats are considered to cause fewer human infections than chicken and other poultry meat, although offal such as liver is more highly contaminated. Higher numbers of *campylobacters* are usually found on chicken than red meat, probably because chickens are processed more rapidly and using machines which sometimes break the intestines, as well as because the skin, where most *campylobacters* are found, is not removed. Additionally, the surface of red meat carcasses becomes relatively dry during chilling, whilst poultry carcasses remain moist, which allows more *campylobacters* to survive.

The infectious dose is thought to be quite low for susceptible individuals, and humans are infected in various ways - probably directly hand-to-mouth when preparing meals, also by transferring *campylobacters* from raw meat to other food which is ready to eat (cross-contamination), and less frequently due to undercooking.

Cross-contamination can be direct or indirect. Direct contamination is caused by the many consumers who like to wash raw chicken before cooking it. This is a habit to be discouraged, as it causes an aerosol of campylobacter to be spread over a wide area from the sink. Indirect cross-contamination occurs through use of knives and chopping surfaces for both raw and ready-to-eat foods without cleaning between.

While vaccination of humans does not seem to be a viable option, some people acquire immunity. A good example of this is those who work in poultry processing plants (poultry abattoirs). It is well-known in the industry that most new employees suffer a bout of *campylobacter* diarrhoea within a few weeks of starting work, and thereafter remain well. Similarly farmers' families who regularly drink raw milk rarely suffer ill effects.

A significant proportion of *campylobacter* infections in humans are thought to be acquired from environmental sources. These include surface water, or even the sea, polluted from pasture run-off, sewage from poultry farms and abattoirs or human sewage. Infections peak in the summer when more people are out-and-about, walking, drinking from streams, swimming and sailing. A higher proportion of broiler flocks is also infected in the summer.

What is to be done?

Health protection authorities in many countries are trying to deal with the problem. The UK Food Standards Agency and the EU (advised by the European Food Safety Authority) are both active in this field. The poultry industry is considered to be the main source of *campylobacter*.

Measures to educate caterers and domestic consumers have not been very successful, and the emphasis has moved back to controls in poultry farms and abattoirs. If we could prevent poultry being colonised by *campylobacter* this would be ideal, because we would reduce the amount of contaminated raw meat going to the consumer, as well as the environmental contamination from the farm and abattoir effluent. Indeed, broiler chickens do not normally become colonised until they are about 3 weeks old.

However, in spite of many biosecurity precautions, including restricted access, vermin control, boot-disinfection and clothes-changing, the prevalence of campylobacter-colonised flocks has changed little. Extra measures such as the use of fly-screens in the summer, when more flocks are colonised, might be more effective. Meanwhile attention has moved to treatments that can be applied during or after processing. Several studies have shown that the likelihood of human infection is directly related to the number of campylobacters on carcasses.

A likely development in the EU is therefore for poultry processing companies be obliged to check numbers of *campylobacters* on their finished carcasses and, if necessary, to modify their process in order to minimise numbers. In some countries carcasses from colonised flocks must be treated before sale - e.g. in Iceland they are frozen for 3 weeks, in Norway they are heat-treated. Freezing reduces numbers of campylobacter by about two log cycles (e.g. from 10,000 to 100 per g of skin), whilst proper cooking would completely eliminate them.

Other possible treatments include the use of chemicals such as lactic acid or acidified sodium chlorite on chicken carcasses. However, currently the EU does not permit the use of these chemicals, although lactic acid might be authorised, and neither chemical removes campylobacter completely. Reductions of 1-2 log cycles in campylobacter numbers can be achieved by the use of brief steam or hot water treatments, and is more likely to be permitted.

Irradiation is as effective as cooking. It has the added advantages that it can be used on packaged product, would extend shelf-life and also preserve the appearance of the raw meat. Irradiation of raw chicken is permitted in many EU countries including the UK if declared on the label, but there is considerable consumer resistance and hence retailers will not use it. X-rays or accelerated electrons could be used instead of gamma radiation with the added advantage that each abattoir could have its own machine that could be switched on and off as needed.

Testing for Campylobacter

Various media have been developed for the routine testing of food and surfaces for the presence of *Campylobacter species*. The most popular selective medium is mCCD (modified Charcoal Cefoperazone Deoxycholate) agar. If examining raw poultry products, human faeces or animal intestinal contents direct plating can be used. Surface-inoculated mCCD agar plates are incubated at 41.5° C in microaerobic atmosphere using anaerobic jars or an anaerobic cabinet, both without catalyst.

Sachets are available commercially which generate a microaerobic atmosphere. When looking for low numbers of *campylobacters* such as on surfaces and in foods other than raw poultry, it is necessary to use a selective liquid enrichment medium (e.g. Bolton or Preston broth) prior to plating on a solid medium such as mCCD agar. *Campylobacter* colonies are not always easy to recognise, but a useful attribute is that they are oxidase positive and do not grow in aerobic atmosphere.

Latex agglutination test kits can be used to confirm the identity of any isolates as *Campylobacter* species. Rapid PCR-based detection methods are available, but are rarely used for routine testing.

The Society would like to thank Dr Janet Corry, Reader in Food Microbiology, University of Bristol, for preparing this document.