REVIEW

Campylobacteriosis: the role of poultry meat

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Abstract

The incidence of human infections caused by *Campylobacter jejuni* and *Campylobacter coli*, the main bacterial agents of gastrointestinal disease, has been increasing worldwide. Here, we review the role of poultry as a source and reservoir for *Campylobacter*. Contamination and subsequent colonization of broiler flocks at the farm level often lead to transmission of *Campylobacter* along the poultry production chain and contamination of poultry meat at retail. Yet *Campylobacter* prevalence in poultry, as well as the contamination level of poultry products, vary greatly between different countries so there are differences in the intervention strategies that need to be applied. Temporal patterns in poultry do not always coincide with those found in human infections. Studies in rural and urban areas have revealed differences in *Campylobacter* infections attributed to poultry, as poultry seems to be the predominant reservoir in urban, but not necessarily in rural, settings. Furthermore, foreign travel is considered a major risk factor in acquiring the disease, especially for individuals living in the northern European countries. Intervention strategies aimed at reducing *Campylobacter* colonization in poultry and focused at the farm level have been successful in reducing the number of *Campylobacter* cases in several countries. Increasing farm biosecurity and education of consumers are likely to limit the risk of infection. Overall, poultry is an important reservoir and source of human campylobacteriosis, although the contribution of other sources, reservoirs and transmission warrants more research.

Keywords: Antimicrobial resistance, *Campylobacter*, *Campylobacter coli*, *Campylobacter jejuni*, infection, intervention measures, molecular epidemiology, poultry, transmission
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Campylobacter infections

Of the 25 *Campylobacter* species validly described to date (http://www.bacterio.net/campylobacter.html, last accessed 21 August 2015), *Campylobacter jejuni* and *Campylobacter coli* are the two predominant species causing gastrointestinal infections. However, other species such as *Campylobacter lari*, *Campylobacter upsaliensis* and *Campylobacter concisus* have also been associated with gastrointestinal disease in humans. In this review, *C. jejuni* and *C. coli* will be referred to as *Campylobacter*, unless otherwise stated.

Human campylobacteriosis typically develops 1–5 days after exposure and is characterized by watery and sometimes bloody diarrhoea, fever, abdominal cramps and vomiting lasting for approximately 5–7 days. Campylobacteriosis is the most common infection preceding the onset of post-infectious Guillain–Barré syndrome, a severe demyelinating neuropathy, occurring in approximately 3/10 000 campylobacteriosis cases [1]. Furthermore, other sequelae, such as reactive arthritis and irritable bowel syndrome, significantly add to the burden of disease [2]. Campylobacteriosis is usually self-limiting and antimicrobial treatment is often not required, except in severe cases or patients with a compromised immune status.

Several studies have estimated the burden of campylobacteriosis, expressed as disability-adjusted life-years (DALYs). Recent estimates range from 1 568 DALYs in New Zealand [3], 3 633 in The Netherlands [2] up to 18 222 in Australia [4] and 22 500 in the USA [1]. The major driver of DALYs for

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TABLE 1. Campylobacteriosis worldwide

Continent / country	Notification rate/100 000	Year	Reference
Europe			
Austria	67.7	2013	[6]
Denmark	67.3	2013	[6]
Estonia	28.9	2013	[6]
Finland	74.9	2013	[6]
Germany	77.3	2013	[6]
Iceland	31.4	2013	[6]
Lithuania	38.3	2013	[6]
Norway	65.2	2013	[6]
Slovenia	49.9	2013	[6]
Sweden	84.9	2013	[6]
United Kingdom	104	2013	[6]
North America			
Canada	29.3	2012	[a]
USA	13.5	2014	[b]
Oceania			
Australia	112.3	2010	[c]
New Zealand	152.9	2013	[d]

[a]Public Health Agency of Canada (http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/charts.php?c=pl, last accessed 22 July 2015).
[b]Campylobacteriosis rate in 2014 in the USA, http://www.cdc.gov/foodnet/index.html, last accessed 22 July 2015.
[c]http://www.health.gov.au/internet/main/publishing.nsf/content/cda-cdi3601-pdf-cnt.htm/$FILE/cdi3601a.pdf, last accessed 22 July 2015.
[d]http://www.foodsafety.govt.nz/elibrary/industry/FBI-report-2013.pdf, last accessed 28 July 2015.

Campylobacter has been the number of years lost due to disability caused by sequelae of the infections [1,4]. *Campylobacter* are a leading cause of bacterial enteritis in Europe [5] and campylobacteriosis is also one of the most expensive foodborne diseases in Europe and Oceania [2,3].

Table 1 gives an overview of the number of reported *Campylobacter* cases worldwide. Many countries have a mandatory *Campylobacter* notification system and increasing notification rates of the disease have been shown [6]. For example, in the European Union (EU) in 2009, 201 711 *Campylobacter* cases were reported, and this number increased to 214 779 in 2013 [6]. In the USA, an increase of 13% was shown in cases reported in 2014, compared with the figures from the period 2006–2008 (http://www.cdc.gov/foodnet/index.html, last accessed 28 July 2015).

Generally, *Campylobacter* infections peak in certain age groups; young children (<4 years of age), young adults (20–40 years of age) and the elderly (>75 years of age) [7,8], which may be due to different risk factors in certain age groups [7,9,10]. Reports from regions other than Europe and North America are still scarce, and often show an overall low detection rate from human samples.

Chicken food chain and *Campylobacter*

Poultry encompasses chicken, turkey, duck and laying hens, of which chicken (*Gallus gallus*) is the predominant species used for meat production (70%–80%). Global poultry meat production has increased from 58.5 million tonnes in 2000 to 95.5 million tonnes in 2014 (http://www.thepoultrysite.com/focus/global-poultry-trends/2400/global-poultry-trends-region-select-track-poultry-trends-across-the-world, last accessed 25 August 2015). Production is not equally distributed; the Americas accounted for 43% of the total production, Asia (mainly China) for 34%, Europe for 17% and Africa and Oceania for 5% and 1% of the whole production in 2012 (93 million tonnes), respectively. In 2023, poultry meat is expected to be the largest meat sector by around 130.7 million tonnes (OECD (2015), Meat consumption, http://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook_19991142, last accessed 31 August 2015). Although free-range and organic poultry productions are also increasing in industrialized countries, their quantities are still minor and beyond the scope of this review.

An Expert Opinion Assessment by the European Food Safety Authority has estimated that chicken meat consumption accounts for 20%–30% of campylobacteriosis in the EU, whereas 50%–80% may be attributed to the chicken reservoir as a whole, stressing that broiler meat production accounts for variable numbers of campylobacteriosis cases in different countries [11]. This also means that the approximate doubling of the chicken meat production from 58.5 million tonnes in 2000 to 95.5 million tonnes in 2014 has clearly affected the global burden of campylobacteriosis and the continuing growth of poultry meat production will put further pressure on the poultry industry and public health authorities to reduce poultry/chicken-associated human *Campylobacter* infections.

The stages in the chicken meat production and processing chain consist of primary production at rearing farms, transport to slaughter, the slaughter process and subsequent processing of chicken meat products, selling products at the retail level, and handling and consumption of chicken meat products at home and in public places such as restaurants. All of these stages have a role in the transmission of *Campylobacter* from farm to fork. Production chain conditions vary between countries, and this is also reflected in the annual number of *Campylobacter*-positive chicken flocks. In the EU, the variation in *Campylobacter* prevalence has been from 0.6% to 13.1% in the Nordic countries Finland, Norway and Sweden, up to 74.2%–80% in several other countries [6]. Moreover, *Campylobacter* prevalence on farms subsequently reflects the presence of *Campylobacter* found on carcasses and meat (Table 2).

The most important factors for slaughter batches to become *Campylobacter* positive have been shown to be partial depopulation of the flock (thinning), slaughter in the summer (June, July and August), increasing bird age at slaughter (from 36 days to >40 days), common health status of the flock (measured as mortality) and increasing number of rearing houses at the farm [12,13]. This indicates that the major contamination site in the