International Journal of Medical Microbiology 304 (2014) 817–823

Contents lists available at ScienceDirect

International Journal of Medical Microbiology

journal homepage: www.elsevier.com/locate/ijmm

Mini Review

Relevance of *Campylobacter* to public health—The need for a One Health approach

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ARTICLE INFO

Keywords:
Campylobacter
Public health
Food safety
Transmission
Animal health

ABSTRACT

Campylobacter species belong to the most important foodborne bacteria which cause gastroenteritis in humans in both developed and developing countries. With increasing reporting rates, the public awareness towards *Campylobacter* infections is growing continuously. This strengthens the necessity to establish intervention measures for prevention and control of thermophilic *Campylobacter* spp. along the food chain, as in particular poultry and poultry meat represent a major source of human infections.

An interdisciplinary One Health approach and a combined effort of all stakeholders are necessary to ultimately reduce the burden of campylobacteriosis cases in humans. Numerous studies point out, however, that at present a complete elimination of *Campylobacter* in the food chain is not feasible. The present aim should therefore be to establish control measures and intervention strategies to minimize the occurrence of *Campylobacter* spp. in livestock (e.g. poultry flocks) and to reduce the quantitative *Campylobacter* burden in animals and foods. To this end, a combination of intervention methods at different stages of the food chain appears most promising. That has to be accompanied by targeted consumer advice and education campaigns to raise the awareness towards *Campylobacter* infections.

Introduction

Even though intestinal *Campylobacter* spp. were presumably described as early as 1886 by Theodor Escherich, they have only been recognized as important human gastrointestinal pathogens for the past 30 years (Kist, 2002).

As of today, intestinal *Campylobacter* species belong to the most important foodborne bacteria, which cause gastroenteritis in humans in both developed and developing countries (WHO, 2011). In many countries, the number of human campylobacteriosis cases has increased considerably to exceed the number of *Salmonella* infections in humans by about two- to threefold.

Although various pathogenic *Campylobacter* species in humans have been identified as causative species in localized and systemic human diseases, the thermophilic intestinal species *Campylobacter* (*C.*) *jejuni* and *C. coli* are nowadays responsible for the majority of human campylobacteriosis cases (Moore et al., 2005).

With increasing reporting rates, the public awareness towards *Campylobacter* infections is growing continuously. Both developments strengthen the necessity to establish intervention measures for prevention and control of thermophilic enteropathogenic *Campylobacter* spp. along the food chain.

The major risk of human campylobacteriosis has generally been linked to the consumption of animal products, in particular poultry meat. Nevertheless, contact with pets and other animals, drinking of raw or improperly pasteurized milk, and different environmental sources have also to be considered for an adequate risk assessment.

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http://dx.doi.org/10.1016/j.ijmm.2014.08.015
1438-4221/

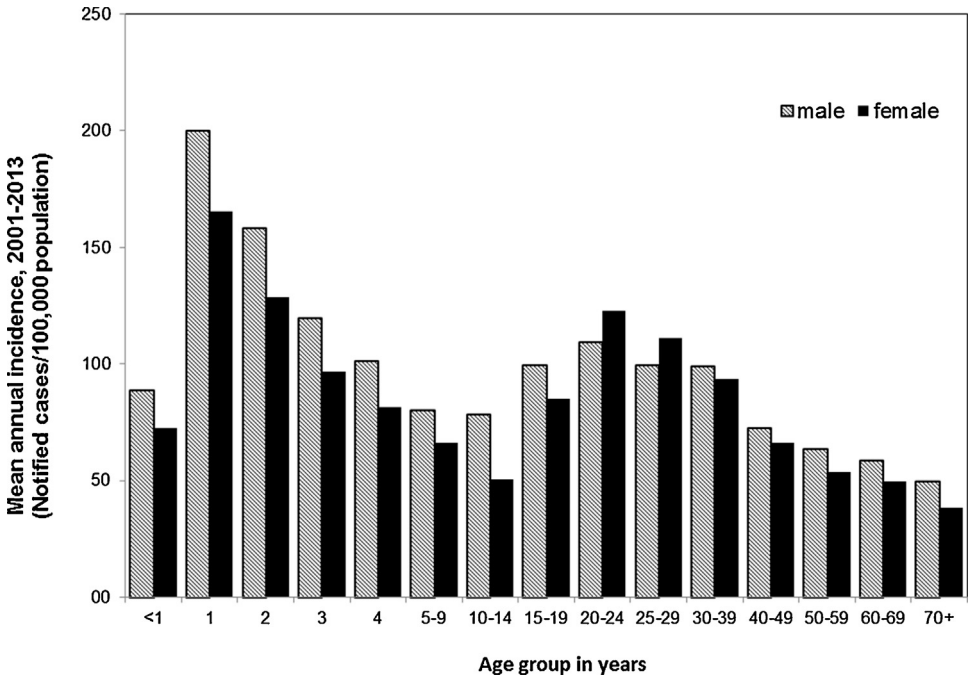

Fig. 1. Mean annual incidence of campylobacteriosis cases notified in Germany by age group and sex, 2001–2013 (RKI, 2014). Please note that age group ranges vary.

In many cases the direct link between a specific source and the human infection is missing. To complicate matters, the genetic instability of *Campylobacter* spp. makes epidemiological source studies difficult.

Human campylobacteriosis occurs world-wide, with incidences showing significant regional differences. In the EU, *Campylobacter* are reported as the most common bacterial diarrheal pathogens with an incidence of approx. 55.5 per 100,000 population in the year 2012 (EFSA and ECDC, 2014). Even among the EU countries, a large variation in the notification rate is detectable: the highest rate was reported in the Czech Republic (174 cases per 100,000), followed by Slovakia, Luxembourg and the United Kingdom (106–117 per 100,000 population), while the lowest rates were reported in Bulgaria, Latvia, Italy, Poland and Romania (<2 per 100,000). For Germany, the rate of confirmed cases per 100,000 was 76.5. In the US, *Campylobacter* infections are second to *Salmonella*, with a notification rate of 13.8 per 100,000 population (Crim et al., 2014). In New Zealand, after peaking in the year 2006 with 379 per 100,000 population, the reporting rate was 161.5 per 100,000 in 2008 (Sears et al., 2011).

Due to the predominantly self-limiting course of the human intestinal disease, which frequently leads to underreporting, it can be assumed that actual incidences are approx. 8–30-fold higher (Samuel et al., 2004).

In several industrialized countries, including Germany, higher *Campylobacter* incidences are observed in young infants (<4 years) and young adults (20–29 years) (Fig. 1). This may be due to age-specific differences in risk factors, such as the incompletely matured mucosal and systemic immunity in young children or age-specific patterns concerning food preparation (e.g. higher levels of exposures to contaminated food, animal and environmental reservoirs; insufficient hand and food hygiene). In general, across most age groups, males are more frequently affected than females (Cody et al., 2012). Behavioural (e.g. differences in nutritional habits, leading to different exposures and risks) and physiological/immunological differences have been suggested as a cause of that gender bias. The latter was supported by Strachan et al. (2008) who demonstrated a similar sexual dimorphism in a mouse model, where infection and shedding rates were higher in male mice.

A strong seasonality with a peak of *Campylobacter* incidences in the summer months is seen world-wide (Nichols, 2005; Schielke et al., 2014). It is speculated that the higher detection rates in poultry flocks and foods of animal origin in the summer period as well as the specific seasonal leisure behaviour of humans (barbecues, picnics) during that period contribute to the increase of transmission of *Campylobacter* to humans. Increased vector-borne transmission by flies was suspected as a possible seasonal driver as well (Nichols, 2005). Climate changes with increasing temperatures might have an impact on the human campylobacter cases (Stark et al., 2009). It is estimated that an average increase in the ambient temperature by 1 °C will generally lead to increased incidences of food-borne gastrointestinal infections by 4–5% (Health Protection Agency, 2008).

In order to reduce human *Campylobacter* spp. infections, a combined effort of all stakeholders is necessary. This review summarizes current information of public health challenges related to *Campylobacter*.

Campylobacter in animals and the environment

Thermophilic *Campylobacter* occur almost ubiquitously in the environment. In large numbers, they can be found in the intestinal tract of warm-blooded animals, usually without showing clinical symptoms. However, *C. jejuni* can cause abortions in sheep. Recently, a highly virulent clone causing outbreaks of ovine abortions has emerged in the US. Its zoonotic potential has recently been suggested (Sahin et al., 2012).

A primary cause of *Campylobacter* contamination of food and water are *Campylobacter*-shedding animals such as food animals and possibly environmental bird species. Poultry flocks are highly colonized with *Campylobacter* spp. with prevalences ranging from 30% to 100%. An EU baseline survey detected a prevalence of 71.2% in broiler batches at EU level (Member states prevalence in caecal content ranging from 2% to 100%) and a prevalence of 75.8% on broiler carcasses (prevalences on carcasses ranging from 4.9% to 100%) (EFSA, 2010). The distribution of *Campylobacter* counts on carcasses during that study is shown in Fig. 2. In addition to a high variety of *Campylobacter* counts between countries, a tendency for high counts in countries with high prevalences was observed.