Campylobacteriosis: A Global Threat

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Received: November 30, 2018; Published: December 10, 2018

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Abstract

Campylobacter species account for most cases of human gastrointestinal infections worldwide. In humans, Campylobacter bacteria cause illness called campylobacteriosis. It is a common problem in the developing and industrialized world in human population. Campylobacter species extensive research in many developed countries yielded over 7500 peer reviewed articles. In humans, most frequently isolated species had been Campylobacter jejuni, followed by Campylobacter coli (5-18.6 % of all Campylobacter cases), Campylobacter lari, and lastly Campylobacter fetus. C. jejuni colonizes important food animals besides chicken, which also includes cattle. The spread of the disease is allied to a wide range of livestock which include sheep, pigs, birds and turkeys. The organism has been responsible for diarrhoea in an estimated 400 - 500 million people globally each year. The most important Campylobacter species associated with human infections are C. jejuni, C. coli, C. lari and C. upsaliensis. Campylobacter colonize the lower intestinal tract, including the jejunum, ileum, and colon. The main sources of these microorganisms have been traced in unpasteurized milk, contaminated drinking water, raw or uncooked meat; especially poultry meat and contact with animals.

Keywords: Campylobacteriosis; Gasteritis; Campylobacter jejuni; Developing countries; Emerging infections; Climate change

Introduction

Campylobacter cause an illness known as campylobacteriosis is a common infectious problem of the developing and industrialized world. Campylobacteriosis accounts for most of the cases of human gastrointestinal infections worldwide and extensive research on Campylobacter species yielded over 7500 peer reviewed articles [1]. In humans, the most frequent reported species of campylobacter had been Campylobacter jejuni (C. jejuni), followed by Campylobacter coli (C. coli), Campylobacter lari (C. lari), and lastly Campylobacter fetus (C. fetus). C. jejuni colonizes in most of the livestock which include sheep, pigs, turkeys etc [2]. In a closely watched study, differences in risk factors between the two species showed that C. coli infection occurs more with drinking bottled water, while C. jejuni is more associated with the tendency in eating habits [3]. Campylobacter can colonize in most of the warm blooded animals, and poultry. The world's poultry production is colonized by campylobacter species and these bacterial species have also been isolated from different wildlife i.e. birds, wolves, cats, dogs etc [4,5]. Campylobacteriosis has been responsible for diarrhea in an estimated 400 - 500 million people globally each year and has been identified as zoonotic infection associated with asymptomatic illnesses [6,7]. Annual financial costs for the management of campylobacteriosis in the US has also swelled up to 1.2 - 4 billion [8]. Campylobacter is small, 0.2-5.0 μm long by 0.2-0.9 μm wide spirally curved, gram's negative, motile bacteria. The genus Campylobacter comprises of 21 species of which C. jejuni and 12 species of C. coli have been associated with the diseases in over 95% of human's infections [9,10].

Transmission of Campylobacter

In last 35 years, world have witnessed emergence of numerous new pathogens that have spread quickly in the communities along with new indications [11,12]. Among them, Campylobacter is one, besides, Legionella, E. coli, Rotavirus and Norovirus. Together they are now one of the leading causes of morbidity in humans. Among campylobacter species, C. jejuni, C. coli, and C. lari are associated with human infection [13] and C. upsaliensis. It is usually sporadic, but some outbreaks may occur. Campylobacter colonize the lower intestinal tract, in duodenum, jejunum, ileum, and colon. In contrast to other enteropathogenic bacteria, Campylobacter possess relatively few virulent factors, and host factors are important in determining the severity of clinical signs that develop. Campylobacter can invade intestinal epithelial cells and produce cytolethal distending toxin, which causes cell cycle arrest and apoptosis. Moreover it is believed that in children, the number of C. jejuni responsible for the illness is even lower than in adults [14].

Campylobacteriosis is normally a self-limiting disease, but in some cases complications may occur, such as Guillain-Barré (GB) syndrome - a post infectious polynuropathy, reactive arthritis (1 - 5% of Campylobacter infected patients) with the mortality.
of 2-7% and Fisher syndrome that can also lead to paralysis as a result of autoimmune damage in 0.01 - 0.03% of Campylobacter enteritis patients [15,16]. Furthermore, it can also trigger an acute respiratory (22-53%) or gastrointestinal (6-26%) infections. Although Campylobacteriosis is quite well considered and accepted as foodborne pathogen but it is also transmitted through contact with colonized animals, contaminated environments by animal waste or poor hygiene. Cross contamination during food manufacturing is considered as an important transmission route [17,18]. C. coli and C. jejuni species have the tendency to be both human and zoonotic pathogens and these microorganisms have been traced in unpasteurized milk, contaminated drinking water, raw or uncooked meat; especially poultry meat along with contact with animals [19].

**Campylobacteriosis Prevalence in the Developed World**

**North America**

United States of America: The incidence of reported Campylobacter disease in industrialized countries, like United States, has risen steadily over the past 2 decades with most reported cases being sporadic. In 2013 five Campylobacter out breaks, mostly outbreaks were associated with raw milk consumption [20]. Moreover, presence of active food borne surveillance system estimates that one out of 30 cases were reported. In March, 2013 CDC reported 14% rise in the incidence of food-borne infections caused by C. jejuni. The data from FoodNet→(2009) indicates that the number of infections by Campylobacter has reached a total of 6,033, or 13 per 100,000 people and it is reported that up to 39% of dogs are carriers of Campylobacter. Interestingly, campylobacter has also been isolated from free living American crows. If the data from 2013 is compared with 2010-2012, clearly indicates that the incidence for Salmonella decreased, but there is a considerable increase in Campylobacteriosis [21]. From 2009-2013, an average of about 105 cases of Campylobacteriosis infection has been reported each year from Alaska with increase of roughly 50% in recent years compared to older data in the region [22].

**Canada**

In Canadian territories, the cases of Campylobacteriosis have been mostly sporadic. Investigations into causative agent lead to identification of improper domestic food preparation. In Ontario (Walkerton, ONT) 2,500 people got sick with Campylobacter gastroenteritis due to cross contaminated of a supply with the thermophilic Campylobacter species (C. jejuni, C. coli and C. lari) [23].

**South America**

Small, community-based study in Guatemala suggests that Campylobacter is a common cause of diarrhea in children. In Peru, C. coli and C. jejuni were isolated in highnumbers in both cases and controls, from the urban community [24].

**European Countries**

In European countries, human Campylobacter infections incidence has continued to increase since last sixyears and is considered as the most common reported zoonotic disease since 2009. The disease has a clear seasonal trend [25]. In all European Union (EU) countries the prevalence and incidence of Campylobacteriosis has a large variation. In 2011, total of 11 waterborne outbreaks had been documented with Campylobacter and other species in the region with an estimated increase of 2.2% cases compared to 2010. Austrian surveillance program on zoonotic bacteria from farm animals has revealed as high as 59% Campylobacterspecies positivity in broiler flocks during 2002-2007 [26]. Campylobacter species has been recognized as important pathogens since last 20 years and considered as the most common reported bacterial cause of acute gastroenteritis [27,28].

In a large study on 33967 infections, from 2000-2006, in Scotland showed that rural children are at greater risk to Campylobacter infection [29]. The survey on Campylobacter infections has shown steady increase in cases since surveillance program began in 1977. In 1999, there has been >60,000 cases with an incidence rate of 103.7 per 100,000. Today incidence of Campylobacteriosis has risen to be 9.3 per 1000 person per years (2008-2009). The financial cost of Campylobacter infection to the nation has been estimated as £314.00 million (1994-95 prices). It is estimated that 20 - 40% of sporadic disease might result from eating chicken. In an interesting survey, Campylobacter has been identified in 637 ready to eat pies and 55 other cooked meat products [28]. Italy shows a statistically significant increasing trend since 2008. It has been further estimated that the incidence of true cases are 586 per year (per 100,000 inhabitants/years) [30]. Number of animal studies has shown the presence of Campylobacter species in Italian peninsula. A survey has demonstrated the presence of C. jejuni in stray cats with a prevalence of 16.8%, in Southern Italy [31].

**Scandinavian Countries**

In a telephonic survey it was found that in almost 4000 interviews, 61% have been affected in a Campylobacteriosis outbreak in Denmark [32]. Water samples obtained from the community water works contained C. jejuni/coli type HS2. In 1999, a legislation has been adopted to reduce the spread and distribution of campylobacter species in contaminated poultry by freezing to reduce bacterial counts before being supplied to customers. This simple solution resulted in 72% reduction in campylobacteriosis in following year [10]. Iceland comparable mitigation strategies have been adopted by Norway and Denmark to control the cross contamination and spread of campylobacteriosis. In Sweden, a study on Campylobacter infections has found association of Campylobacter incidence to average water pipe length per person and ruminant density. In the same study negative association was also reported between the percentage of population receiving water from a public water supply [33,10].

**Campylobacteriosis Prevalence in The Developing World**

The incidence of Campylobacter in the developing world has been high, as these countries lack sophisticated surveillance systems in line seen in many developed countries making an assessment of...
true incidence very difficult [34,35]. Even with the development of improved modalities, the true burden of campylobacteriosis especially in children has seriously been underestimated with recent reports of association between Campylobacter infection with malnutrition. One study showed an alarming high rate of infection of 60,000 per 100,000 children <5 years of age [36]. Poultry specifically has accounted for 50%-70% infection with an increase during summers due to undercooked meat from outdoor cooking facilities [35].

**African Countries**

Numerous studies have reported that in South Africa, diarrhea by Campylobacter has been clinically less severe than other developing countries. In a relatively large study in Malawi, Campylobacter species had been detected in 415/1,941 (21%) of diarrhea children. Species identification accounted for 85% being C. jejuni. Importantly median age of these children was 11 months. In Botswana, estimates from the prevalence data indicates that Campylobacter diarrheal infection of hospitalized <5 year children has range as low as 1.5%. In Mozambique it is, 1.7%, 9% in Uganda, 11% in the Central African Republic. Highest rate has been found in Tanzania where it is 18%. Where as, 3.3% in Djibouti and 0.8% in Guinea-Bissau. These low rates may be due to their socioeconomic status but still needs further evaluation [36]. In Africa, from 1993 to 2011, five studies had been conducted to assess the extent of colonization of chickens and ducks in Tanzania. All studies found to be positively associated with Campylobacter; and specifically to C. jejuni followed by C. coli. Two of these studies also looked at seasonal variation on human infections and did not found any difference. Previous study conducted in the Congo, had reported high prevalence of Campylobacter during the wet season [37].

**Middle East**

Campylobacter infection ranked among the top three etiological agents of bacterial enteritis in the region. In Jeddah, Saudi Arabia, Campylobacter infection has the second in prevalence to Salmonella with 69% cases being due to C. jejuni and 31% due to C. coli. In Kuwait, Campylobacter ranked third after Salmonella and Enterotoxigenic E. coli [38]. In Israel, campylobacteriosis is a reportable disease and microbiology laboratories of the countries submit human isolates from all sources to the National Campylobacter reference Laboratory working under Ministry of Health. Recently a sharp increase in the incidence of Campylobacter species infection was noted with rates tripling within just 12 years. These infections have been mostly among children <2 years of age. During that period, most (>99%) infections were C. jejuni followed by C. coli and remaining <1% have been identified as C. fetus, C. upsaliensis, C. lari and some unidentified cultures [39].

**Antibiotic Resistance**

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due to high incidence of antibiotic resistant strains which will limit the sensitivity and specificity of the drugs while treating human diseases. However, the use of Pre- and Pro-biotics have been reported to have shown results by some groups and need further evaluation. Interestingly, bacteriocins-producing bacteria (paenibacilluspolymyxma) has shown some interesting results and further researches are required to fully validate these results [47].

Conclusion

More research is required in this field to refine our understanding of the pathophysiology of Campylobacter infections in the developed as well as developing countries. The findings of these few studies indicate a need for increased surveillance and Campylobacter screening both at the slaughter houses and at the sales levels. Collaborative efforts from veterinary and human medicine targeting different aspects of the infections are need of the hour, to allow for efficient and more effective strategies for prevention and/or control of the disease. Thoroughly washing of hands with soap especially before eating or drinking can avoid hand-to-mouth contact, after handling of a companion animal and hands with soap especially before eating or drinking can avoid prevention and/or control of the disease. Thoroughly washing of the hour, to allow for efficient and more effective strategies for

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