The public health implications of campylobacter spp. in canada and globally

Contents

Rational for topic chosen

Introduction

Global regulations

Outbreaks linked to Campylobacter

Canada campylobacter outbreak

USA campylobacter outbreak

Other countries Campylobacter outbreak

The incidence of Campylobacter in the human (cases per 100, 000) population

Incidence of Campylobacter in foods

Sequelae linked with infection

Conclusions, recommendations and suggestions

References

Rational for topic chosen

The topic (The Public Health Implications of *Campylobacter* spp. in Canada and globally) for my Final Research Paper was suggested by Dr. Jeffrey Farber.

During my previous courses, I did some projects and wrote papers in on other food microorganisms such as *Salmonella* spp, *Listeria monocytogene* , *E coli* , and *pseudomonas* spp. However, I didn't get an opportunity to gain more knowledge of *Campylobacter* spp *.* I chose this topic for this assignment as it will be a great opportunity for me to know this bacterium in details and to know its implications on the public health in and Canada and internationally as it is consider one of the main pathogens that cause foodborne illness

Introduction

Campylobacter is considering number one bacteria that cause human gastroenteritis in the world (WHO, 2012). Campylobacter is a gram negative bacteria cause an illness called Campylobacteriosis. Most of the Campylobacter illness is due of the species which are Campylobacter jejuni and Campylobacter coli. Campylobacteriosis symptoms are fever, diarrhoea, malaise, vomiting, abdominal pain, and blood in faeces (Quetz et al., 2012). The symptoms of Campylobacteriosis start after 2 to 5 days of the infection and last in less than a week. Some people can get infected but without showing any symptoms. Other can have the symptoms back after they start feeling better (health link BC, 2017). Campylobacter spp. is considering a hard microorganism to identify and only C. jejuni can be easy isolate by using phenotypic markers. There is a new culture-independent diagnostic tests was introduced can better results on monitoring of disease trends in developed countries. If the price of these tests drop down, they can used it for presumptive diagnosis in the developing counties as well (WHO, 2012).

Food is considered the main source for spreading *Campylobacter* while Chicken is considered the main food source for the Campylobacter contamination. USDA performed some studies and surveys on *Campylobacter* contamination associated with raw chicken and they found more that 60% of the tested samples were positive for *Campylobacter* . The main cause of the contamination came from the slaughter house by the contamination that happened to chicken carcasses with chicken faces (Marler Clark, 2018)

Campylobacter considered the main pathogen that causes foodborne illness in United States. In 2006, there were 7512 cases of *Campylobacter* infection comparing to 2009 which had 6033 cases of the same infection in United States. Some studies shows that the average number of *Campylobacter* infection is 1000 cases per 100, 000 person in United States (Marler Clark, 2018)

According to Marler Clark website the food safety law firm, *Campylobacter* spp. is responsible for many complications such as Guillain Barre Syndrome, a form of paralysis. In United States, around 9, 000 people develop GBS every year which cost the government between 0. 2 to 1. 8 billion dollar. The Reactive Arthritis symptoms appear after several weeks of the *Campylobacter* infection (Marler Clark, 2018)

In many countries, Campylobacter is being isolated from patients 3 to 4 times more than any other bacterial pathogenic . In the developed countries, the reported cases of Campylobacteriosis is often goes beyond the reported cases of salmonellosis (WHO, 2012).

The Codex Alimentarius Commission committee hold several meeting to describe some guidelines for better control for *Campylobacter* . Those guidelines are based on 3 tiers which are guidance based on good hygiene practices, hazard based control measures, and risk based control measures. WHO and FAO developed a web base tool to computes the residual risk on the processing diagram to assess the impact of a proposed control measure. The web base tool is available online on this link: http://www. mramodels. org/poultryRMTool (WHO, 2012).

According to (WHO, 2012), the true number of the incidence of Campylobacteriosis gastroenteritis is not well known and they are trying to find a better approach to collect this information. The Infectious Intestinal Disease (IID) studies in the United Kingdom estimated the number of the incidence to be 9. 3 per 1000 person in the United Kingdom for year 2008 and 2009. The Sensor study in the Netherlands estimated the number of the incidence to be 5. 8 per 1000 person in the Netherlands for year 2009. In the USA, the estimation for the Incidence of Campylobacteriosis was 1. 3 million cases in 2006 or 4. 4 per 1000 person (WHO, 2012).

Public health of Ontario advices individual to store their food at the right temperature, cook their food at the right temperature, separate raw and cooked food to prevent cross contamination, wash their hand after touching animals with soap or with alcohol base sanitizer (Public health of Ontario, 2018)

Global regulations

According to health Canada regulation for *Campylobacter* spp . limit, all RTE products must be free from *Campylobacter* spp. detection. If *Campylobacter* spp . was detected on the products, immediate correct action must be taken(Health Canada, 2010)

According to Hong Kong Food and Environmental Hygiene Department, *Campylobacter* spp. must not be detected in 25g in Ready to eat product. If *Campylobacter* spp. is been detected, the product will be considered unacceptable(Centre for Food Safety, 2007)

Food Standards Australia New Zealand (FSANZ) has the same regulation for Campylobacter ssp. as Hong Kong Food and Environmental Hygiene Department(Food Standards Australia New Zealand, 2016)

Outbreaks linked to Campylobacter

Canada *campylobacter* outbreak

In 2007, there was a *Campylobacter* outbreak among mountain bikers in British Columbia, Canada linked to *Campylobacter jejuni* in mud. More than 200 bikers got infected. The researchers linked the infection due of the contamination of the mud with animal feces (Healio, 2008)

In 1994, there was a *Campylobacter* outbreak among Turkey farm workers (9 workers) in Ontario. Six of them reported eating while working, one of them report smoking while he was working, and 2 of them brought water in a container from home (no illness was reported from those 2 workers). No washing hand facility present in their working area. The root cause of the

illness was due not following the GMP and cross contamination from the Turkey to their hands (Government of Canada, 1995).

In 2000, there was a waterborne outbreak of *Escherichia coli O157: H7* and *Campylobacter* spp. in Walkerton, Ontario. The root cause of the contamination was linked to the pathogens from neighbouring cattle farms entry into the town water supply. The number of the cases was positive for Campylobacter spp. was 116 people and no death was reported (Clark et al., 2003).

USA *campylobacter* outbreak

In 2018, there was an Outbreak of Multidrug Resistant *Campylobacter* in 17 states in US. The outbreak was linked to Contact with puppies from Pet Stores. One hundred and thirteen cases were reported, 23 cases were hospitalized, but no death occurred (CDC, 2018).

There was another outbreak of *Campylobacter jejuni* in Utah in 2014 linked to the consumption of raw milk. Ninety nine cases were reported to Utah Department of Health and half of the cases were children under 19 years old. Ten cases were hospitalized and one death case was occurred (CDC, 2018).

In October 2012, there was a *Campylobacter* outbreak in Nevada linked to long distance Adventure Race. Many of the cases reported that they had their faces felt on the mud and heads submerged in surface water. Twenty two cases were reported and 20 of the 22 cases sought for medical care. All the cases were fully recovered after they hospitalized and treated with antibiotics (CDC, 2018).

On January 8, 2014, there was a Campylobacteriosis Outbreak linked to eating of raw chicken liver in Ohio and Oregon states restaurant. Three cases were reported and hospitalized. *Campylobacter jejuni* was isolated from the fecal specimens and no death occurred among the 3 cases (CDC, 2018).

Bi-national outbreak (Mexico and United States) of Guillain–Barré syndrome linked to *Campylobacter jejuni* infection in 2014. Guillain–Barré syndrome (GBS) usually happened after the infection of *Campylobacter jejuni* . Twenty six cases involved in this outbreak (18 from Sonora, Mexico and 8 from Arizona, United States). The cases of GBS were linked to an outbreak of *C. jejuni* from tap water (Jackson et al., 2014)

Other countries *Campylobacter* outbreak

There were multiple outbreaks of *campylobacter* in England and Wales happened in 2016. Some outbreaks involved only 3 reported cases and others involved up to 51 reported cases. No death occurred and most the cases were linked to eating Chicken or duck livers in restaurants, pubs, catering services, or school (public health England, 2018)

In 2012, there was a *Campylobacter* outbreak in Adelaide, Australia linked to the food that been served in a birthday party at a restaurant. The number of the guests at the party was 57 and they believe the infection was associated with chicken liver pâté. Fifteen cases were reported but only 8 cases sought medical attention. Only 3 cases had confirmation of *Campylobacter* infection from the laboratory and one case was hospitalized (Parry, Fearnley & Denehy, 2012).

In 1999, an outbreak of *Campylobacter enteritis* was occurred in a resort on north Queensland, Australia linked to untreated rainwater and food from the staff dining area. Twenty three cases were involved in the outbreak (7 confirmed and 16 probable). Only 3 cases required hospitalisation but no death occurred. After the investigation, they believe that there was faecal contamination in the rainwater tanks (Merritt, Miles & Bates, 1999).

Between June 2007 to July 2007, a study was made on 36 cases reported of Guillain-Barre syndrome (GBS) on a town called Jilin located at north of China. All those cases were linked to previous infection of *Campylobacter jejuni* (Zhang et al., 2010).

The incidence of *Campylobacter* in the human (cases per 100, 000) population

Table #1 shows the number of *Campylobacter* incidence in England and Wales from2007 to 2016 (public health England, 2018)

Year	Number of laboratory reports	Laboratory reports per 100, 000 population
2007	51831	95. 30
2008	49891	90. 97

2009	57685	104. 44
2010	62588	112. 38
2011	64527	114. 88
2012	65044	114. 98
2013	59040	103. 67
2014	62494	108. 86
2015	55697	96. 22
2016	52381	89. 72

Table #1:

In 2009, the incidence of *Campylobacter* in the human in the 27 European Union members was from 29. 9 to 13, 500 per 100, 000 populations. Bulgaria

had the highest score and Finland & Sweden had the lower score of the *Campylobacter* incidence (Kaakoush et al., 2015)

The annual national incidence of *Campylobacter* in Australia from 2007 to 2011 is between 104. 8 and 117. 3 per 100, 000 populations excluding New South Wales, Australia. However, they believe that the real number of *Campylobacter* incidence is higher due to most of the cases of infection not being reported (Parry, Fearnley & Denehy, 2012).

The table below (table #2) shows the rates of campylobacteriosis per 100, 000 populations as reported to the National Notifiable Disease Summary program (NDRS) and the National Enteric Surveillance Program (NESP) by province/territory from year of 2000 to year of 2004 (Public Health Agency of Canada, 2009)

Table #2:	NESP Rate (per 100 000 population)					NDRS Rate (per 100 000 population)				
Province / Territory	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
BC	5.47	3.29	2.89	2.19	1. 9	63.95	53.75	49.86	40.89	34.95
AB	12.	12.	14.	10.	9.	44.	40.	44.	35.	28.

	65	69	76	82	42	43	37	83	02	22
SK	28.38	25	25.3	21.92	19.9	29.67	24.8	25.5	21.51	23.62
MB	12.03	11.2	8.83	6.63	9.83	23.18	19.37	18.09	14.46	18.2
ON	3.98	2.26	3.16	2.49	1.81	42.5	42.08	37.82	32.99	31.77
QC	1.48	1.76	1.73	1.87	1.21	36.09	32.69	34.13	31.32	32.42
NB	26.12	31.47	25.72	27.69	19.55	29.31	33.6	27.72	27.16	19.41
NS	6.75	5.15	7. 7	6.19	6.18	19.7	18.34	21.51	14.95	15.99
PEI	32.24	27.8	37.24	22.57	18.86	32.24	29.27	32.86	22.57	18.86
NL	14.96	16.28	6.74	9.26	10.05	14.01	16.67	8.66	10.8	11.02
NT	24.69	24.5	19.28	16.58	4.67	29.63	24.5	24.1	16.58	11.68

NU	0	3. 56	3. 48	0	0	0	7. 11	3. 48	20. 57	0
YT	9. 86	0	6. 64	13. 08	29. 13	9. 86	6. 64	9. 95	9. 81	16. 18

Table #3 shows the incidence rates of Campylobacteriosis per 100, 000 of population per year in different countries (Kaakoush et al., 2015).

Table #3:

Country	incidence rates per 100, 000 of population per year	Year(s)
United States	14. 3	1996 to 2012
Guatemala,	185. 5 to 1, 288. 8 (children)	2008 to 2012
Barbados	5. 4 (inhabitants)	2000
Japan	1, 512	2005 to 2006
The Netherlands	52	2011
Poland	0. 92-1. 12 (inhabitants)	2001 to

		2012
Norway	30	1993 to 2011
Germany	53. 4 to 81. 4 (inhabitants)	2005 to 2011
Israel	90. 99	2010
New Zealand	161. 5	2008
Denmark	42	2009 to 2010

According to WHO, the estimated cases of Death due to Campylobacteriosis are from 0. 01% to 8. 8% depending on the population age, case definition and co-morbidity but most of the cases are related to sequelae of the Campylobacteriosis. The lower cases of death rate were in Germany 0. 01% collected from surveillance data. On the other hand, the highest cases of death were in Kenya among children under 5 years old with 8. 8% rate of death (WHO, 2012).

Incidence of Campylobacter in foods

Chicken meat is well known as a primary source of Campylobacter bacteria and the incidence of present *Campylobacter* species in chicken meat is higher than any other type of meat. A study was made in Australia from 2007 to 2008 showed that the incidence of present of *Campylobacter* in raw

poultry is 84. 3% after the post rinse of the chicken carcass. They found that 90% of the raw chicken that being sold in groceries in south of Australia were contaminated with *Campylobacter* . Moreover, they found that 72. 7% of chicken carcass was contaminated with *Campylobacter* in New Zealand (Food Standards Australia & New Zealand, 2013).

A survey was made in the European Union members in 2008 showed that 75. 8% of broiler carcasses were positive for *Campylobacter* spp. (*Campylobacter jejuni* was 51% and *Campylobacter coli* was 35. 5%). It is very common to have positive detection of *Campylobacter* spp. in the live animals such as cattle, pigs, and poultry (Food Standards Australia & New Zealand, 2013).

A survey was made in the United Kingdom from 2007 to 2008 showed that 65. 2% of poultry in groceries stores were positive for *Campylobacter* spp. (*Campylobacter jejuni* was 52. 9% and *Campylobacter coli* was 47. 1%) (Food Standards Australia & New Zealand, 2013).

A survey was made in Ireland from 2001 to 2002 showed that 49. 9% of raw poultry were positive for *Campylobacter* spp. and 37. 5% of raw Turkey were positive too (Food Standards Australia & New Zealand, 2013).

From 2007 to 2008, the detection of Campylobacter spp. in the retail stores for chicken breasts increase dramatically and that can be due of changing the sampling method from skin on in 2007 to skin off in 2008. Only 2 samples of ground beef were positive for Campylobacter spp. but no pork samples had positive detection for Campylobacter spp.(PHAC, 2010).

Sequelae linked with infection

A study was made in Arizona, USA on 2018 on the sequelaes after the *Campylobacter enteric* infection. The post-infectious sequelae (PIS) is represented in gastrointestinal disorders, joint disorders, and neurological disorders. The aims of the study were to determine the rate of the PIS incidence in Arizona, USA and to understand the long term outcomes of getting *Campylobacter* infection. The study shows that performing a large scale study will gave a better idea on PIS incidence and can improve the quality management system at the hospitals (Barrett et al., 2018)

Another study was performed on 2001 on *Campylobacter jejuni* infections trends due of the antimicrobial agent-resistant *Campylobacter* strains. The root cause of this issue is due of using antibiotics during animal farms. That led to appearance of post-infectious complication of *Campylobacter jejuni* infection called Guillain-Barré syndrome (GBS). In United States, about 1 to 2 people in 100, 000 of population get affected by GBS every year. However, the risk of getting GBS after *C. jejuni* infection is very rare. Individual with the HLA-B27 histocompatibility antigen can develop reactive arthritis after the *Campylobacter* infection by several weeks. Other people can develop hemolytic uremic syndrome, uveitis, hemolytic anemia, carditis, and encephalopathy as sequelae after the actual infection (Acheson & Mishu Allos, 2001)

In 2010, a research was made on sequelae of Foodborne Illness Caused by different 5 pathogens in Australia circa. Most of the sequelae are represented on bowel syndrome, uillain-Barré irritable, syndrome, hemolytic uremic syndrome, irritable, and reactive arthritis. The researcher found that

Campylobacter spp. infection was responsible for more than 80% of the infection cases and if the world can reduce the *Campylobacter* spp. infection cases, that will help to reduce the sequelae that comes from Foodborne Illness (Ford et al., 2014)

Conclusions, recommendations and suggestions

As *Campylobacter* spp. are one of the main reasons for foodborne illness around the world, more research projects and surveillance monitoring will be required to protect human from Campylobacteriosis. More surveillance data need to be collected from hospitals and labs to find the actual number of Campylobacteriosis infection and death related to it. Using fast accurate methods to detect Campylobacter spp. will help in prevent any foodborne illness outbreak or have it in control as soon as possible. Methods such as RT-PCR and chromogenic media can be used as they provide rapid and accurate results.

Share public awareness among all members of the community and especially in the developing countries on how the Campylobacter infection can be prevented such as proper cooking of the food, avoiding any cross contamination between cooked and raw foods, and washing hands after touch animals. That information can be shared to public by different types of media, handing flyers, and teaching in school. Food Voluntary organizations can educate members of the community in the developing countries that have high rate of Campylobacteriosis infection.

Increase the monitoring of food plants that produce ready to eat products by the government agencies such as CFIA in Canada, FDA in USA, EFSA in Europe, and others agencies.

References

- Acheson & Mishu Allos (2001). *Campylobacter jejuni* Infections: Update on Emerging Issues and Trends. *Clinical Infectious Diseases* 32(8), 1201–1206
- Barrett, Carr, L. Bell & Pogreba-Brown (2018). Post-infectious sequelae after *Campylobacter* enteric infection: a pilot study in Maricopa County, Arizona, USA. *Pilot and Feasibility Studies* 4: 142
- CDC (2018). Reports of Selected *Campylobacter* Outbreak Investigations. Retrieved from https://www. cdc. gov/campylobacter/outbreaks/outbreaks. html
- Centre for Food Safety (2007). Microbiological Guidelines for Ready-to-eat Food. Retrieved from http://blpd. dss. go. th/micro/ready. pdf
- Clark, C. G., Price, L., Ahmed, R., Woodward, D. L., Melito, P. L., Rodgers, F. G.... Ellis, A. (2003). Characterization of Waterborne Outbreak–associated *Campylobacter jejuni* , Walkerton, Ontario. *Emerging Infectious Diseases* , 9(10), 1232-1241. https://dx. doi. org/10. 3201/eid0910. 020584.
- Food Standards Australia & New Zealand (2013). *Campylobacter* species. Retrieved from https://www. foodstandards. gov. au/publications/Documents/Campylobacter%20species%20-%20dec%202013. doc

- Food Standards Australia New Zealand (2016). Compendium of Microbiological Criteria for Food. Retrieved from https://www. foodstandards. gov. au/publications/Documents/Compedium%20of %20Microbiological%20Criteria/Compendium%20of%20Microbiological %20Criteria. pdf
- Ford, Kirk M, Glass K, Hall G (2014). Equelae of Foodborne Illness Caused by 5 Pathogens, Australia, Circa 2010. 8 (11). Retrieved from https://wwwnc. cdc. gov/eid/syn/en/article/20/11/13-1316. htm#suggestedcitation
- Government of Canada (1995). Outbreak of *campylobacter* infection among farm workers: an occupational hazard. Retrieved from http://publications. gc. ca/site/archivee-archived. html? url= http://publications. gc. ca/collections/Collection/H12-21-21-17E. pdf
- Healio (2008). *Campylobacter* outbreak among mountain bikers linked to mud. Retrieved from https://www. healio. com/infectious-disease/emerging-diseases/news/print/infectious-disease-news/%7B32ebeb35-7f81-4565-8177-e3aa65fdf5d9%7D/ campylobacter-outbreak-among-mountain-bikers-linked-to-mud
- Health link BC (2017). *Campylobacter* Infection. Retrieved from https://www. healthlinkbc. ca/healthlinkbc-files/campylobacter-infection
- Health Canada (2010). Microbial Guidelines for Ready-to-Eat Foods – A Guide for the Conveyance Industry and Environmental Health Officers (EHO). Retrieved from http://publications. gc. ca/collections/collection_2014/sc-hc/H164-167-2013-eng. pdf
- Jackson, b., zegarra, j., lópez-gatell, h., sejvar, j., arzate, f., waterman, s., . . . mahon, b. (2014). Binational outbreak of Guillain–Barré

syndrome associated with *Campylobacter jejuni* infection, Mexico and USA, 2011. *Epidemiology and Infection* , 142(5)

- Kaakoush, N. O., Castaño-Rodríguez, N., Mitchell, H. M., & Man, S. M. (2015). Global Epidemiology of *Campylobacter* Infection. *Clinical microbiology reviews* , 28(3), 687-720.
- Marler Clark (2018). About *Campylobacter* . Retrieved from https://about-campylobacter. com/about-campylobacter
- Merrit A, Miles R, Bites J (1999). An outbreak of *Campylobacter enteritis* on an island resort, north Queensland. Communicable Diseases Intelligence. 23(8). Retrieved from http://www. health. gov. au/internet/main/publishing. nsf/content/cda-pubs-cdi-1999-cdi2308-cdi2308b. htm
- Parry A., Fearley E., and Denehy E. (2012). ‘ Surprise’: Outbreak of *Campylobacter* infection associated with chicken liver pâté at a surprise birthday party, Adelaide, Australia, 2012. Outbreak Investigation Report. Retrieved from https://ojs. wpro. who. int/ojs/index. php/wpsar/article/viewFile/168/188
- PHAC (2010). Archived – C-EnterNet 2008 Annual Report – *Campylobacter* . Retrieved from http://www. phac-aspc. gc. ca/foodnetcanada/pubs/2008/campylobacter-eng. php
- Public health England (2018). *Campylobacter* data 2007 to 2016. Retrieved from https://assets. publishing. service. gov. uk/government/uploads/system/uploads/attachment_data/file/711938/campylobacter_data_2007_to_2016_may_2018. pdf
- Public health of Ontario (2018). Campylobacteriosis. Retrieved from https://www. publichealthontario.

ca/en/BrowseByTopic/InfectiousDiseases/Pages/IDLandingPages/Campylobacteriosis. aspx

- Quetz J, Lima I, Havt A, Prata M, Cavalcante P, Medeiros P, Cid D, Moraes M, Rey L, Soares A, Mota R, Weigl B, Guerrant R, Lima A (2012). Campylobacter jejuni infection and virulence-associated genes in children with moderate to severe diarrhoea admitted to emergency rooms in northeastern Brazil. Journal of medical microbiology. 61(4): 507-513
- WHO (2012). The global view of campylobacteriosis. Retrieved from http://apps. who. int/iris/bitstream/handle/10665/80751/9789241564601_eng. pdf; jsessionid= DC878BFC6DEACB218828895D7DEB3F8D? sequence= 1
- Zhang, M., Li, Q., He, L., Meng, F., Gu, Y., Zheng, M., ...Zhang, J. (2010). Association study between an outbreak of Guillain-Barre syndrome in Jilin, China, and preceding *Campylobacter jejuni* infection. *Foodborne Pathogens and Disease* , 7(8), 913+. Retrieved from http://link. galegroup. com. subzero. lib. uoguelph. ca/apps/doc/A233825915/AONE? u= guel77241&sid= AONE&xid= 6800bbd9