

Original Article



OPEN ACCESS

Received: Sep 24, 2018

Accepted: Jan 14, 2019

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Conflict of Interest

No conflicts of interest.

Author Contributions

Conceptualization: CRK, JHB. Data curation:

CRK. Formal analysis: CRK, SIC. Writing -

original draft: CRK. Writing - review & editing:

CRK, JHB, SIC.

Campylobacter jejuni Foodborne Infection Associated with Cross-contamination: Outbreak in Seoul in 2017

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ABSTRACT

Background: In July 2017, there was an outbreak of *Campylobacter jejuni* infection in three auxiliary police squads in Seoul, Korea. An epidemiological investigation was conducted to identify the cause and source of the illness.

Materials and Methods: A retrospective cohort study of all members of the three auxiliary police squads was conducted. Self-administered questionnaires were distributed to all members of the three squads and the food handlers. Rectal swabs were collected from symptomatic police and food handlers.

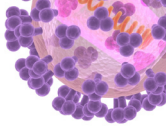
Results: The overall attack rate was 20.4%, and the epidemic curve indicated a point source type outbreak. Of the 257 auxiliary policemen who consumed the incriminated lunch, 55 met the case definition. Of 36 rectal swabs, 10 were positive for *C. jejuni* and had the same pulsed-field gel electrophoresis pattern. The major symptoms were loose stool (100%) and abdominal pain (59.3%); the median incubation period was 69 hours. In the univariate epidemiological analysis, watermelon (relative risk [RR], 5.75; 95% confidence interval [CI], 2.14–15.43), half-cut chicken soup (RR, 3.96; 95% CI, 1.49–10.54), steamed rice with millet (RR, 2.73; 95% CI, 1.29–5.77), and radish kimchi (RR, 2.57; 95% CI, 1.45–4.55) were positively associated with the illness. Inspection of the food service facility found that the drainpipe under the meat cleaning sink did not work.

Conclusion: This outbreak could have been caused by cross-contamination with *C. jejuni* from raw chicken via environmental sources.

Keywords: *Campylobacter*; *Campylobacter jejuni*; Foodborne outbreak; Cross-contamination; Seoul Metropolitan Government

INTRODUCTION

Campylobacter is one of the most common bacterial causes of gastroenteritis worldwide, and *Campylobacter jejuni* causes the majority of *Campylobacter* infections [1, 2]. In Korea, the isolation rate of *Campylobacter* has increased gradually from 2012 to 2015 compared with other common pathogens (*Salmonella* species and pathogenic *Escherichia coli*), and *Campylobacter*



outbreaks tend to occur during summer [3]. As *Campylobacter* is found in the gastrointestinal tracts of poultry, poultry products can be the source of *Campylobacter* human infection [4]. Moreover, inadequate cooking of poultry or cross-contamination of foodstuffs with raw meat can lead to outbreaks of *Campylobacter* infection [5]. In Korea, one outbreak of *Campylobacter* infection was reported, but it was not known how cross-contamination of food items by raw chicken could have occurred [6]. In this study, we examined whether cross-contamination with *C. jejuni* from raw chicken through environmental sources caused an outbreak.

On July 17, 2017, the administrator of auxiliary police notified the regional Public Health Center of a cluster of gastroenteritis cases that had occurred in three auxiliary police squads in Seoul, Korea. The majority of the cases developed on July 14–16. The Department of Public Health of Metropolitan Seoul was promptly engaged, and an epidemiological investigation was conducted to identify the cause and source of the illness.

MATERIALS AND METHODS

1. Epidemiological investigation

We conducted a retrospective cohort study of all members of the three auxiliary police squads where the outbreaks were reported. The auxiliary police were doing their obligatory military service in a riot squad and lived in a communal setting with support for accommodation. They were provided with meals at their own food service facility where 12 food handlers worked: 2 dietitians and 10 kitchen police. When the police are dispatched, they often have lunches delivered or go to a nearby restaurant and buy meals. Canteen food provided on July 12 (lunch) was consumed by all members of the three auxiliary police squads during the week of the outbreak. A probable case was defined as a person who ate lunch on July 12, was on duty in the same squads in which ill patients were reported, and had experienced three or more loose stools during a 24-hour period or two or more loose stools accompanied by one or more other symptoms, such as abdominal pain, nausea, and vomiting. A laboratory-confirmed case was defined as a person in whom the pathogen was isolated in the microbiological tests but who was not included as a probable case. Self-administered questionnaires were distributed to all members of the three squads and the food handlers. The questionnaire asked about demographic characteristics, food items consumed on July 12 (lunch), and symptoms and their onset (for cases). To identify the source of the outbreak, food-specific attack rates and the relative risks of each food were calculated; the association between food items and the risk of illness was determined using the chi-square test. The data were analyzed using Epi-Info, ver. 7 [7]. We considered a *P*-value <0.05 to be statistically significant.

2. Laboratory investigation

Rectal swabs from symptomatic persons and food handlers, samples of preserved foods and drinking water, and swabs of environmental samples from the cookware and countertops were collected for microbiological examination, which was performed by the Seoul Institute of Health and Environment. These were cultured to isolate *Salmonella*, *Shigella*, and *Vibrio* spp.; *Staphylococcus aureus*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Bacillus cereus*, pathogenic *E. coli*, *Clostridium perfringens*, and *C. jejuni*. Polymerase chain reactions were performed to isolate viral pathogens, such as rotavirus, norovirus, adenovirus, astrovirus, and sapovirus. If bacteria were isolated from the samples, pulse-field gel electrophoresis (PFGE) was conducted using the isolated colonies to analyze the genotype pattern.

3. Environmental investigation

We examined the cooking environment and cooking process for food items served for lunch on July 12, which were consumed by all cases affected by the outbreak.

RESULTS

1. Epidemiological investigation

Of the 258 members of the three squads, 257 auxiliary policemen completed the questionnaires; one policeman was on vacation and could not participate in the survey (this person was not a case). The 12 food handlers who consumed canteen food completed the questionnaires. Fifty-four auxiliary policemen met the case definition, and one asymptomatic kitchen police officer was revealed to be a laboratory-confirmed case. The overall attack rate was 20.4% (55/270); the attack rates of the three squads were 22.6% (19/84), 18.0% (16/89), and 22.3% (19/85). The dates of symptom onset for the 54 cases were July 13–19, 2017, with a peak on July 15 (**Fig. 1**). The epidemic curve was compatible with a point-source outbreak. The incriminated canteen foods that were consumed by all cases before the first symptom were eaten at lunch on July 12. The median incubation period was 69 (range 22–168) hours. The most frequent symptom was loose stool (54/54, 100%), followed by abdominal pain (59.3%), chills (41.8%), fever (38.2%), nausea (20.0%), vomiting (7.3%), and headache (5.5%).

During the incriminated lunch on July 12, five food items were offered: steamed rice with millet, half-cut chicken soup, oven-baked chicken, radish kimchi, and watermelon. The watermelon (relative risk [RR], 5.75; 95% confidence interval [CI], 2.14–15.43), half-cut chicken soup (RR, 3.96; 95% CI, 1.49–10.54), steamed rice with millet (RR, 2.73; 95% CI, 1.29–5.77), and radish kimchi (RR, 2.57; 95% CI, 1.45–4.55) were positively associated with the illness (**Table 1**). Only the oven-baked chicken was not significantly associated with the illness (RR, 1.59; 95% CI, 0.90–2.79).

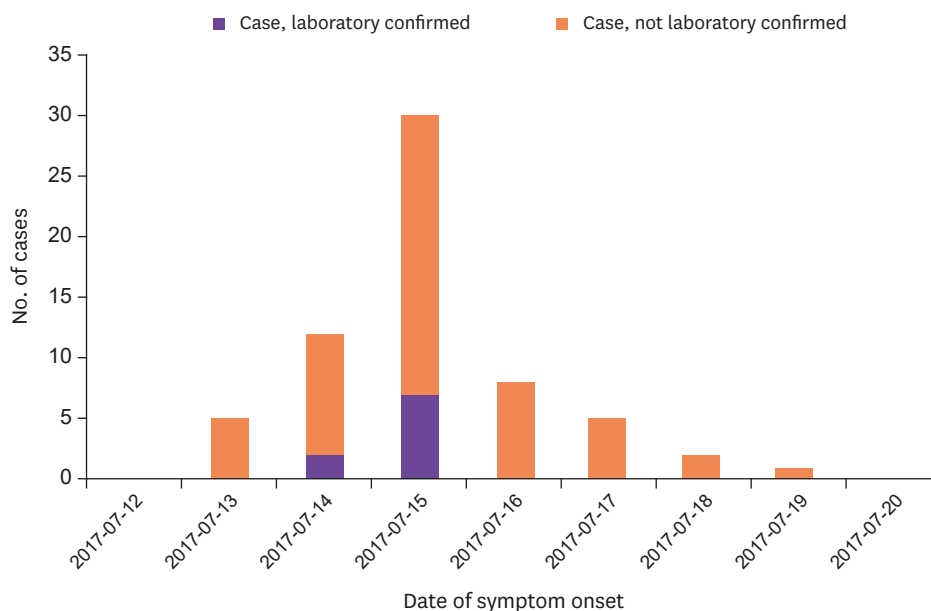
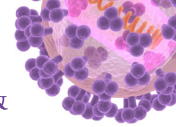


Figure 1. Number of cases of gastroenteritis by the date of symptom onset in three auxiliary police squads in Seoul, Korea in July 2017.



Campylobacter jejuni outbreak associated with cross-contamination

Table 1. Food-specific attack rates and relative risks

Food item	Intake		Non-intake		RR	95% CI	P-value
	n	Cases (AR,%)	n	Cases (AR,%)			
Steamed rice with millet	180	45 (25.0)	76	7 (9.2)	2.71	1.28–5.74	<0.01
Half-cut chicken soup	203	50 (24.6)	64	4 (6.3)	3.94	1.48–10.49	<0.01
Oven-baked chicken	173	42 (24.3)	85	13 (15.3)	1.59	0.90–2.79	0.13
Radish kimchi	104	32 (30.8)	116	14 (12.1)	2.55	1.44–4.50	<0.01
Watermelon	167	46 (27.5)	83	4 (4.8)	5.71	2.13–15.33	<0.01

n, number of subjects; AR, attack rate; RR, relative risk; CI, confidence interval.

2. Laboratory investigation

Thirty-six rectal swab samples were obtained from 24 of the 54 auxiliary policemen (7/19, 5/16, and 12/19 in the three squads), who were defined as cases, and from all 12 food handlers. It was difficult to convene the auxiliary policemen for the epidemiological investigation at any given time because of their field work or vacation; therefore, it was impossible to collect samples from all cases. *C. jejuni* was isolated from 10 samples, including one from a food handler. No other pathogen was found. PFGE revealed one pattern shared by all 10 samples positive for *C. jejuni* (Fig. 2). Samples of preserved food from the incriminated lunch and the surfaces of the cookware and countertops were negative for pathogenic bacteria or viruses. It was impossible to investigate the environmental samples from the day in question, July 12, because of the delay between the onset of the outbreak and when it was reported.

3. Environmental investigation

The main ingredient of the half-cut chicken soup and oven-baked chicken that were provided for lunch on July 12 was chicken. The raw chicken was shipped to the food service facility in a refrigerated state, and the chicken was washed and cooked on the day it was served. Inspection of the food service facility found that the drainpipe under the meat cleaning sink did not work. Wash water escaped from the drainpipe and onto the floor. Although the segregation of raw and cooked foods was structurally satisfactory, the decrepit facility could have resulted in cross-contamination via environmental sources, such as the countertop, hands of food handlers, and kitchen utensils. Watermelon was put on a countertop in the shell and cut into slices; other vegetables were shredded with a knife and added to each bowl

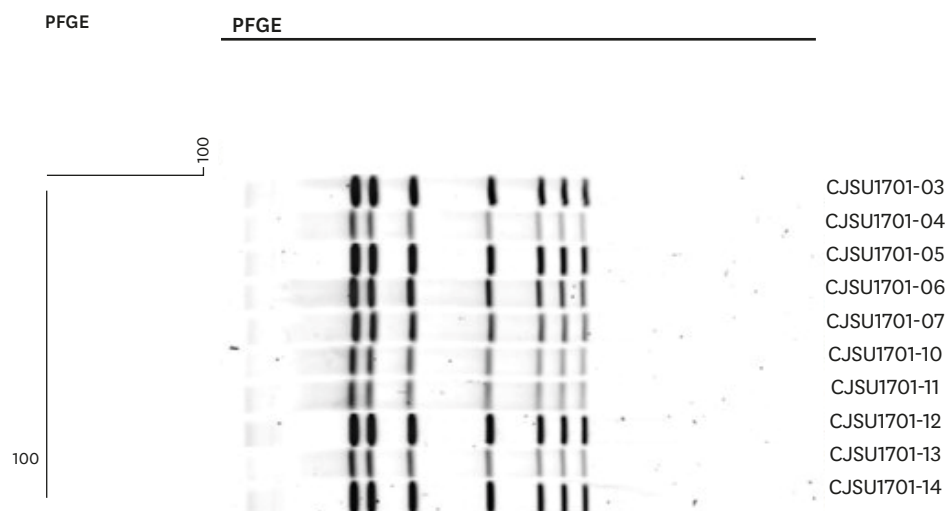
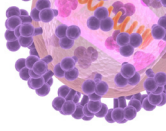


Figure 2. Results of pulsed-field gel electrophoresis analyses of *Campylobacter jejuni* isolated from 10 confirmed cases (one pattern shared 100% similarity). PFGE, pulse-field gel electrophoresis.



of the half-cut chicken soup; boiled rice with millet was scooped with rice paddles, and radish kimchi was ladled into distribution containers. These food items were probably in contact with cookware on the countertop. The oven-baked chicken was taken out of the oven after cooking and immediately put into distribution containers.

DISCUSSION

C. jejuni is microaerophilic and is sensitive to high oxygen tension under aerobic conditions [8]. However, hyper-aerotolerant *C. jejuni* is prevalent in raw chicken, which increases the probability of *C. jejuni* outbreaks under aerobic conditions [9]. The infectious dose of *C. jejuni* is low [10], and cross-contamination via environmental sources is an efficient mechanism for *C. jejuni* transmission to humans [11, 12]. In this outbreak, the inspection of the food service facility suggested the possibility of cross-contamination via environmental sources.

In Korea, a *Campylobacter* outbreak was associated with eating chicken soup with ginseng [6]. In that recipe, the inside of the chicken may be undercooked because stuffing is added to the chicken body, which is then cooked in bulk at collective catering facilities. In the present outbreak, however, boiled half-cut chickens without stuffing were provided. Therefore, it was less likely that the inside of the chicken body was undercooked. Moreover, watermelon exhibited the strongest association with the outbreak (RR = 5.17), and the relative risks were significantly higher for the recipes that involved contact with cookware after cooking. Because water used to clean the meat was spilled on the floor due to the drainpipe failure and watermelon was put on the countertop in the shell, sliced with knives, and served without heating, we postulate that cross-contamination of the hands of food handlers, kitchen utensils, and foodstuffs occurred via the countertop contaminated with watermelon exposed to washing water on the floor.

In this outbreak, a food handler was found to be an asymptomatic confirmed case. *Campylobacter* outbreaks caused by an infected symptomatic food handler have been reported [13]. However, there have been no reports of person-to-person infection with *Campylobacter* associated with an asymptomatic food handler [14]. Therefore, the asymptomatic food handler, who was a confirmed case in this outbreak, was not the source of the infection but rather had a *Campylobacter* infection because he ate the incriminated food.

During the epidemiological investigation of this outbreak, we discovered a problem related to hygiene management at the food service facility. According to the Food Sanitation Act, food service facilities that provide meals for more than 50 people need to be registered and should be supervised by the local government. They are subject to a fine or business suspension if food poisoning occurs or problems are found during a hygiene inspection. However, the police food service facility was not subject to registration because it is operated in accordance with the Police Food Safety Regulations and does not have to be supervised by the local government. Consequently, the hygiene management of police food service facilities may be insufficient and their cooking facilities may be outdated due to a lack of investment in facility improvement. It is necessary to improve the system to strengthen the hygiene management of police food service facilities.

Lack of microbiological evidence from preserved foods could be considered a study limitation. However, the preserved foods were sampled immediately after being cooked; therefore, it is not possible to confirm the presence or absence of contamination that occurred during

the process after cooking through laboratory testing of the preserved foods. We could not isolate *C. jejuni* in the watermelon, but we think that the watermelon was the causative food in this outbreak for the following reasons. First, *C. jejuni* is fastidious to transport and culture. Therefore, it is difficult to identify *C. jejuni* in food. Second, *C. jejuni* infection can occur via cross-contamination, and in this outbreak, the condition of the kitchen was vulnerable to cross-contamination. Third, the relative risk was highest for the watermelon.

Despite these limitations, this study demonstrated that the outbreak of *C. jejuni* could have been caused by cross-contamination of food. A previous study could not identify an association between the incriminated food and the risk of disease [6], whereas the current study described an outbreak of *C. jejuni* caused by cross-contamination of food based on the association between the food consumed and the risk of disease. In conclusion, this could have resulted in the following sequence of cross-contamination: from the raw chicken to the hands of the food handlers and the kitchen utensils via a countertop contaminated by watermelon contaminated with water used to wash the raw chicken.

ACKNOWLEDGMENTS

We are grateful to the members of the outbreak control team of the Public Health Center in Seoul for their efforts in the epidemiological investigation. The authors also thank the anonymous reviewers whose comments helped to improve this paper.

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