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Cyclosporiasis Epidemiologically Linked to Consumption of Green Onions: Houston Metropolitan Area, August 2017

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Abstract

During July 2017, Texas public health officials noted an increase in the number of reported cyclosporiasis cases. They detected a cluster in the Houston metropolitan area that involved four locations of a Mediterranean restaurant chain, restaurant A. A case-control study was conducted among patrons of restaurant A to identify a common food vehicle among items containing fresh produce. In matched case-control ingredient-level analyses that included both probable and confirmed cases, consumption of green onions, red onions, tomatoes, and cabbage was significantly associated with illness. A substantial percentage of case patients reported consumption of green onions, and only green onions remained statistically significantly associated with illness, whether probable and confirmed cases were included in analyses (matched odds ratio: 11.3; 95% confidence interval: 2.5 to 104.7), or only confirmed cases were included in analyses (matched odds ratio: 17.6; 95% confidence interval: 2.5 to 775.7). These results provide evidence that green onions were the likely vehicle of infection. It was not possible to trace the green onions to their source due to the need to redirect public health resources to Hurricane Harvey response efforts in Texas.

Keywords

Cyclospora cayetanensis ; Cyclosporiasis; Green onions; Outbreak; Texas

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Cyclospora cayetanensis is a coccidian parasite that causes a gastrointestinal illness called cyclosporiasis; infection is transmitted through contaminated food or water (7, 8, 12). Unlike many other foodborne or waterborne organisms, *Cyclospora* is not directly transmissible from one person to another; infected people shed a stage of the parasite, unsporulated oocysts, in their feces that typically requires at least 1 to 2 weeks in favorable environmental conditions to sporulate and become infectious. Symptoms of cyclosporiasis begin an average of 7 days (range, 2 to ≥14 days) after ingestion of the infective form of the parasite. The most commonly reported symptom is watery diarrhea; additional symptoms can include anorexia, nausea, abdominal cramps, vomiting, and fatigue.

Cyclosporiasis is most common in tropical and subtropical regions. Foodborne outbreaks of cyclosporiasis in the United States and Canada have been documented since the mid-1990s (8). Outbreaks in the United States have been linked to different types of imported fresh produce (e.g., basil, raspberries, and cilantro); commercially frozen or canned produce has not been implicated in outbreaks (1, 9, 11).

In August 2017, the Texas Department of State Health Services (DSHS) requested assistance from the Centers for Disease Control and Prevention (CDC) to support an investigation of a cyclosporiasis outbreak in collaboration with the City of Houston Health Department, Harris County Public Health, Fort Bend County Health and Human Services, and Brazoria County Health Department (10). Investigation objectives were to determine outbreak scope and identify the source of illnesses.

MATERIALS AND METHODS

Outbreak detection.

Cyclosporiasis is a nationally notifiable condition in the United States and is reportable in 44 states (including Texas), New York City, and the District of Columbia. In Texas, local or regional public health investigators contact persons reported to have a laboratory-confirmed *Cyclospora* infection to complete the Cyclosporiasis National Hypothesis Generating Questionnaire (CNHGQ). This questionnaire includes questions about a person's symptomatology and risk factors for cyclosporiasis (e.g., international travel and restaurant and grocery store food exposures) during the 14-day period before symptom onset. CNHGQ responses are used to identify possible clusters and common exposures.

On 21 July 2017, Texas DSHS identified a cluster of three laboratory-confirmed cases of *Cyclospora* infection in people who reported eating at a location of restaurant A (a Mediterranean-style restaurant, with four locations in the Houston metropolitan area) and did not have a history of international travel during the 14 days before illness onset. All three people reported illness onset dates between 28 May and 22 June. By 2 August, an additional 12 ill persons with laboratory-confirmed *Cyclospora* infection and who had dined at a restaurant A location were reported to Texas DSHS. Ziehl-Neelsen acid-fast stain testing was used to confirm *C. cayetanensis* infection. Two of 12 people lived in states other than Texas, and the remaining 10 people lived in one of three counties in the Houston metropolitan area. The additional 12 ill people had illness onsets between 26 June

and 12 July. Efforts to identify additional cases continued, including individuals who had compatible illness, but not a laboratory-confirmed diagnosis.

Case-control study.

To identify the source of infection, a case-control study was performed among patrons of restaurant A, beginning on 9 August 2017. A confirmed case was defined as laboratory-confirmed *Cyclospora* infection and clinically compatible illness in a person who became ill within 14 days after eating at one of the four restaurant A locations, whose symptom onset date was on or after 28 May, and who did not have a history of international travel during the preceding 14-day period. A probable case was defined as watery diarrhea (three or more loose stools in a 24-h period) and at least one other symptom compatible with cyclosporiasis (e.g., loss of appetite, weight loss, abdominal cramps or bloating, nausea, body aches, fatigue, vomiting, or low-grade fever), without laboratory confirmation of *Cyclospora* infection, in a person who otherwise met inclusion criteria for a confirmed case. For each case identified, three control subjects were recruited, matching by meal date (i.e., ±2 days) and same restaurant location. Control subjects were identified as either well dining companions of case patients or patrons who had dined at restaurant A during the exposure time frame being investigated (14 May to 7 July 2017) and who reported no illness. Sales receipts with printed patron name, meal date, and restaurant location were provided by the owner of restaurant A; telephone numbers were obtained from commercial databases used by local health agencies.

Texas DSHS public health officials developed a menu-specific questionnaire focusing on menu items containing fresh produce ingredients. Interviewer trainings were held before initiation of the case-control study to ensure consistency in administering the questionnaire by interviewers. Case patients and control subjects were asked about menu items consumed, demographic information, and presence of symptoms compatible with cyclosporiasis.

Responses to the menu-specific questionnaire were entered into an Epi-Info version 7 (CDC, Atlanta, GA) database. Binomial logistic regression was used for 3:1 matched case-control analyses: a menu item–level analysis, an ingredient-level analysis, and an ingredient-level analysis that included data only for confirmed cases and their matched control subjects. Matched exact odds ratios (mOR) and 95% confidence intervals (CIs) were calculated using SAS software version 9.4 (SAS Institute Inc., Cary, NC).

Environmental and traceback investigations.

Public health sanitarians conducted site visits and routine food safety inspections at each of the four restaurant locations and their central kitchen. As part of the investigation, epidemiologists visited one restaurant A location and the central kitchen to observe how food was stored, prepared, and served. To facilitate a product traceback investigation, members of the Texas Rapid Response Team, consisting of partners from Texas DSHS, the Dallas District Food and Drug Administration, and the Office of the Texas State Chemist, collected invoices from restaurant A management for all items identified during the epidemiologic investigation.

Ethical considerations.

This investigation was determined to be a nonresearch, public health response by the Office of the Associate Director for Science, Center for Global Health, at the CDC. The investigatory purpose and voluntary nature of participation were explained to each participant in the case control study and verbal assent was obtained before all interviews.

RESULTS

Restaurant A is a Mediterranean-style establishment where menu items are served cafeteria style. Food items may be ordered a la carte or as a combination plate (e.g., one meat with two side dishes), and selections are placed on the customer's plate by restaurant staff. Inspections of restaurant A locations and the central kitchen did not identify any food handling violations or other food safety concerns, and no restaurant staff reported illness. Fresh produce was ordered and supplied through the central kitchen; sauces and dips were prepared at the central kitchen before being sent to each restaurant A location. Fresh produce was chopped and salads were mixed on-site for each location.

Case-control study.

By 24 August 2017, a total of 22 case patients (16 confirmed and 6 probable) and 66 control subjects were enrolled in the study (Table 1). One case patient had been hospitalized. The median age of case patients was 52 years (range, 29 to 79 years); 12 case patients (54.5%) were female. The median age of control subjects was 46 years (range, 21 to 78 years); 35 control subjects (53.0%) were female. The overall median reported illness onset date for all case patients was 4 July (range, 28 May to 11 July; Fig. 1). Case patients and control subjects were asked to recall dining histories at restaurant A of up to 90 days before being interviewed (median, 52 days; range, 39 to 90 days) for this study. The overall median reported dining date for all case patients was 25 June (range, 17 May to 7 July); 17 of 22 case patients (77%) had dined during 21 June to 2 July.

Analysis of 75 menu items included data for all 22 case patients and 66 control subjects. Two menu items were significantly associated with illness, tabouli (mOR: 8.0; 95% CI: 2.1 to 44.5) and cilantro baba ganoush (mOR: 12.0; 95% CI: 1.2 to 91.0; Table 2). A higher percentage of case patients reported having eaten the tabouli (15 [68.2%] of 22) than the cilantro baba ganoush (4 [18.2%] of 22). Tabouli served at restaurant A contained the following fresh produce ingredients (in alphabetical order): green onions, lemon juice, mint, parsley, red onions, and tomatoes. Cilantro baba ganoush served at restaurant A contained the following fresh produce ingredients (in alphabetical order): cilantro, eggplant, garlic, jalapeno, and parsley.

Ingredient-level analyses of data for 22 case patients and 66 control subjects included 35 fresh produce items and were not limited to the ingredients of tabouli and cilantro baba ganoush. Four ingredients were significantly associated with illness, including green onions, tomatoes, red onions, and cabbage (Table 3). Overall, 82% of case patients reported eating a dish containing green onions, compared with 33% of control subjects, with an mOR of 11.3 (95% CI: 2.5 to 104.7; Table 3). In an analysis limited to the 16 confirmed case patients

and corresponding 48 matched control subjects, only green onions remained significantly associated with illness (mOR: 17.6; 95% CI: 2.5 to 775.7; Table 3). In ingredient-level subanalyses among case patients who dined 21 June to 2 July, green onions remained significantly associated with illness (mOR: 17.3; 95% CI: 2.5 to 756.1).

Traceback investigation.

Invoices were collected for a traceback investigation, but traceback efforts were hampered by the arrival of Hurricane Harvey, which made landfall in southern Texas on 25 August 2017. After the storm, public health resources were diverted for response and recovery efforts, and the source(s) and distribution of the green onions could not be determined.

DISCUSSION

In this investigation, consumption of green onions was significantly associated with illness and, based on matched case-control analyses, green onions were likely the vehicle of infection. Although green onions have been implicated in other foodborne disease outbreaks (3, 6, 13), this is the first reported U.S. outbreak of cyclosporiasis epidemiologically linked to green onions, as described in the preliminary report on this investigation in 2018 (10). This article upholds the conclusions of the initial 2018 report and provides an opportunity to describe the study methods and results in greater detail, including a discussion of not only this cluster investigation but also investigations of cyclosporiasis broadly and their associated limitations.

A substantial percentage of case patients in this outbreak reported exposure to green onions, and green onions were statistically significantly associated with illness across ingredient-level analyses. Green onions are a biologically plausible vehicle for *C. cayetanensis*, given their many loose layers of leaves growing close to the ground, as contamination by irrigation water or manure application could be possible. However, green onions could not be confirmed as the vehicle of infection in this outbreak for multiple reasons, highlighting the challenges inherent in investigating outbreaks of cyclosporiasis.

Cyclospora is transmitted on contaminated fresh produce. Although the U.S. Food and Drug Administration has developed procedures to test fresh produce, the limited shelf life of these commodities often precludes testing these items for presence of the *Cyclospora* parasite because the fresh produce item may no longer be available for testing when investigators identify a suspected food vehicle. The long incubation period of cyclosporiasis and the estimated average lag time of 6 weeks between when a patient becomes ill and when the case is reported to public health officials make case investigations particularly susceptible to recall bias. In this investigation, case patients and control subjects were asked to recall dining histories of up to 90 days before being interviewed for the case-control study, which may have resulted in incomplete or inaccurately reported exposure histories.

Traceback of green onions could not be completed for this investigation. Even when a source farm is identified for a particular suspect food, rarely has a specific produce item or route of contamination been identified for *Cyclospora* outbreaks. Multiple large-scale cyclosporiasis outbreaks have occurred in the United States where public health investigators identified

the specific contaminated fresh produce item (1, 4, 9, 11). However, salads and vegetable trays were implicated in two large-scale outbreaks in 2018, but not a single ingredient (2). In previous outbreaks, implicated fresh produce items were often part of a salad or served as a garnish; ill people may not always recall eating a specific ingredient and may have consumed multiple items at the same time.

An additional challenge to cyclosporiasis outbreak investigations is the lack of molecular typing methods that allow investigators to compare genetic relatedness of *Cyclospora* causing human illness across the country. Molecular typing could link an outbreak in a given city to cyclosporiasis cases in other locations nationwide. This knowledge could identify additional purchase locations in the United States from which to conduct product traceback investigations. Traceback from multiple points of purchase would increase the likelihood of identifying the source of epidemiologically linked fresh produce and provide increased power behind public health recommendations and potential regulatory action. Improvements in molecular analysis methods will provide tools that are more precise for foodborne disease investigators to use in identifying contaminated produce items and in preventing future cases of illness. The CDC is working to develop these methods.

This outbreak of cyclosporiasis in the Houston metropolitan area was likely caused by consumption of contaminated green onions. Although chemical disinfectants and sanitizing methods used for produce are unlikely to kill *Cyclospora*, both retailers and consumers should always follow safe produce handling recommendations, by washing fruits and vegetables with clean running water (5). Treatment for cyclosporiasis is available (8); people who are sick with diarrhea or other concerning symptoms compatible with cyclosporiasis for >3 days should consult a health care provider. Advances in molecular typing methods may make it possible in the future to link individual cases to larger clusters of cases and potential food exposures, thereby improving prevention and control of cyclosporiasis.

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HIGHLIGHTS

- Green onions were significantly associated with illness (mOR: 11.3; 95% CI: 2.5 to 104.7).
- CNHGQ was used to identify potential food sources of contamination.
- Multiple jurisdictions worked together to identify a novel source of cyclosporiasis.

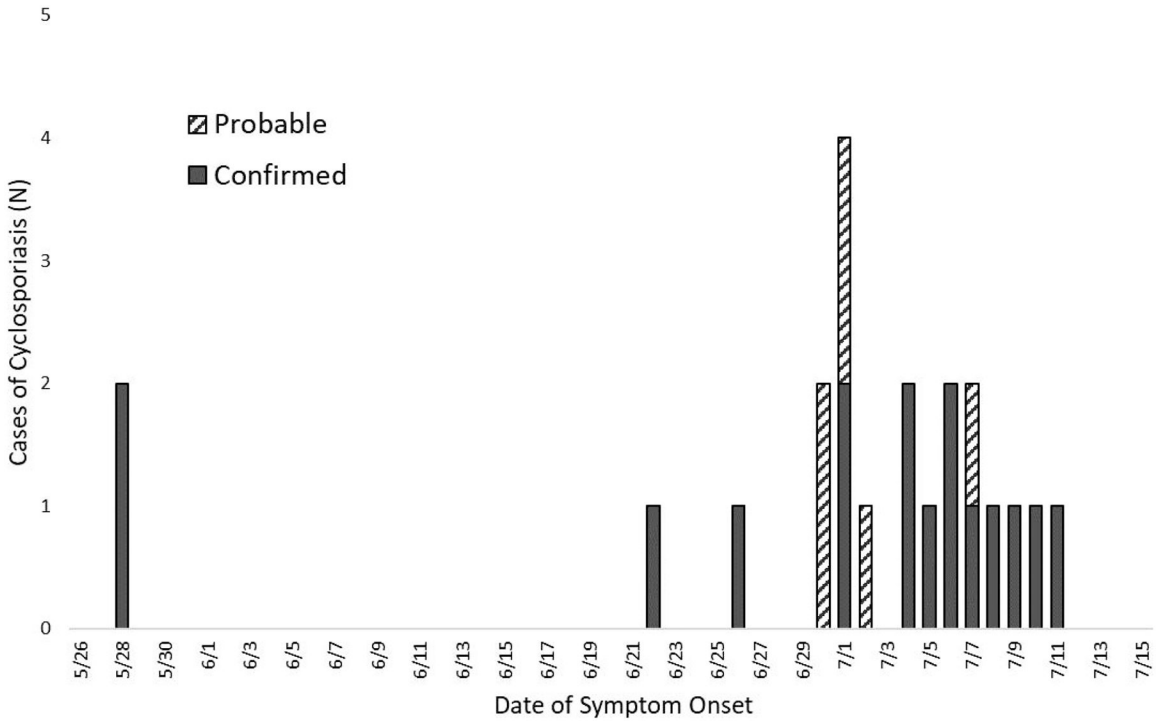

FIGURE 1.

Cases of cyclosporiasis (n = 22) associated with restaurant A, by date of symptom onset, 28 May to 11 July 2017.

TABLE 1.

Demographic characteristics of cyclosporiasis case patients (n = 22) and control subjects (n = 66) enrolled in the restaurant A case-control study, Houston, TX, 2017

Characteristic	Case patients	Control subjects
No. female/total no. (%)	12/22 (54.5)	35/66 (53.0)
Age (yr)		
Median	52	46
Range	29–79	21–78[a]
Restaurant A location visited		
Location 1	4	12
Location 2	7	21
Location 3	3	9
Location 4	8	24

[a]Two control subjects declined to provide their age.

TABLE 2.

Frequencies and mOR of selected menu items consumed at restaurant A, Houston, TX, 2017

Menu item	Case patients (n = 22)[a]			Control subjects (n = 66)			mOR	95% CI	
	Ate	Did not eat	% exposed	Ate	Did not eat	% exposed		Lower	Upper
Tabouli	15	7	68.2	16	50	24.2	8.0[b]	2.1	44.5
Baba ganoush	5	17	22.7	7	59	10.6	2.7	0.5	14.0
Cilantro baba ganoush	4	18	18.2	1	65	1.5	12.0[b]	1.2	591.0
Salmon salad	3	19	13.6	1	65	1.5	9.0	0.7	472.5

[a] Includes 16 confirmed and 6 probable cases.

[b] Denotes a statistically significant finding.

TABLE 3.

Frequencies and mOR for selected fresh produce ingredient consumption in a case-control study of cyclosporiasis linked to restaurant A, including 95% confidence intervals, Houston, TX, 2017

	Exposure					
	Matched analysis with confirmed and probable cases (case patients = 22; control subjects = 66)			Matched analysis with confirmed cases (case patients = 16; control subjects = 48)		
Ingredient	Case patients, no. (%)	Control subjects, no. (%)	mOR (95% CI)	Case patients, no. (%)	Control subjects, no. (%)	mOR (95% CI)
Green onions	18 (81.8)	22 (33.3)	11.3[a] (2.5–104.7)	14 (87.5)	17 (35.4)	17.6[a] (2.5–775.7)
Parsley	21 (95.5)	52 (78.8)	5.8 (0.8–275.8)	15 (93.8)	37 (77.1)	4.6 (0.5–236.2)
Tomato	20 (90.9)	41 (62.1)	5.5[a] (1.2–51.7)	14 (87.5)	28 (58.3)	4.4 (0.9–43.2)
Red onion	12 (54.5)	16 (24.2)	4.7[a] (1.3–21.0)	9 (56.3)	14 (29.2)	3.4 (0.8–16.3)
Cabbage	8 (36.4)	8 (12.1)	4.0[a] (1.1–15.9)	5 (31.3)	7 (14.6)	2.8 (0.5–14.9)
Mint	18 (81.8)	37 (56.1)	3.2[a] (1.0–14.0)	13 (81.3)	26 (54.2)	3.4 (0.8–20.1)
Lemon juice	22 (100.0)	59 (89.4)	3.2 (0.6–∞)	16 (100.0)	43 (89.6)	2.2 (0.4–∞)
Jalapeno	8 (36.4)	11 (16.7)	2.7 (0.8–9.0)	8 (50.0)	9 (18.8)	3.7[a] (1.0–14.8)
Cilantro	14 (63.6)	38 (57.6)	1.3 (0.4–3.9)	11 (68.8)	28 (58.3)	1.6 (0.4–6.7)

[a]Denotes a statistically significant finding.