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Gaps in Food Safety Professionals' Knowledge about Noroviruses

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Abstract

Noroviruses (NoVs) are the most common etiologic agents of endemic and epidemic foodborne disease in the United States. Food safety professionals play an important role in protecting the public from foodborne illness. A survey of food safety professionals (n = 314) was conducted to characterize their knowledge of NoVs and to identify gaps in this knowledge. To recruit individuals, 25 professional organizations promoted the survey via their Web sites, newsletters, and/or e-mail distribution lists. The survey used true or false and open-ended questions to assess knowledge about NoVs, including attribution, transmission, and prevention and control strategies, including food handling practices. The online survey was available from mid-October 2012 to mid-January 2013. Of the 314 respondents, 66.2% correctly identified NoVs as one of the three most common causes of foodborne disease in the United States. Only 5.4% of respondents correctly identified the three most common settings for NoV infections, and 65.0% of respondents had the misperception that cruise ships are one of the three most common settings. Seventeen respondents (5.4%) answered all 20 true-or-false questions correctly, 33 respondents (10.5%) answered at least 19 of the 20 questions correctly, and 186 respondents (65.0%) answered at least 15 of the 20 questions correctly (i.e., a score of 75% or higher). The content domain in which respondents had the most incorrect answers was food handling practices. Thirty-eight percent of respondents incorrectly responded that it is safe for restaurant workers infected with NoVs to handle packaged food, food equipment, and utensils. About half of respondents did not know the recommended sanitizing solution for eliminating NoVs from a contaminated surface. The survey findings identified several important gaps in food safety professionals' knowledge of NoVs. The study results will inform the development of a Web-based educational module on NoVs to improve efforts to prevent the spread of NoVs in retail and institutional food establishments.

According to the Centers for Disease Control and Prevention (CDC), 19 to 21 million people (1 in 15 Americans) in the United States get sick each year from noroviruses (NoVs); of these, 56,000 to 71,000 are hospitalized and 570 to 800 die (11). Additionally, NoVs are the

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most common etiologic agents of endemic and epidemic foodborne disease in the United States (10, 27). NoVs affect individuals of all ages, but the highest rates of hospitalizations and death are among persons aged 65 years or older and persons aged 5 years or younger (11). About 10% of individuals infected with NoVs seek medical attention (7, 11, 26).

NoVs are extremely contagious, particularly because of their low infectious dose (18 to 1,000 particles) (28). NoVs can be spread person-to-person or via food, water, and contaminated environmental surfaces. The majority of NoV outbreaks primarily involve person-to-person transmission via the fecal-oral route, although infectious vomitus may also play a role (13). An estimated 30% or more of all NoV cases cause secondary cases due to direct contact with primary cases (e.g., close contacts and family members) (8).

Foods implicated in NoV outbreaks are contaminated either directly with fecal matter at the source (e.g., shellfish harvested from sewage-contaminated waters or raspberries irrigated with fecal-contaminated sewage) or during food preparation by infected food handlers at or away from home (9). Contamination can also occur during processing, as demonstrated by an outbreak involving deli meat (21). Nearly two-thirds (62%) of NoV outbreaks result from food prepared in restaurants (9). Given the prolific viral shedding and low infectious dose, a food handler infected with NoV can readily contaminate large quantities of product. For example, in 2006, 500 cases of gastroenteritis were reported during an outbreak caused by a food handler who vomited at work (4). Handling of ready-to-eat foods, including foods eaten raw, by an infected food handler is commonly identified as a contributing factor in outbreaks of food-borne NoVs associated with food service establishments (9, 20). Drinking water or ice may also become contaminated with NoVs and result in NoV outbreaks in food service establishments.

Food safety professionals play an important role in protecting the public from foodborne illness through their various duties, which include providing training or education about food safety, hygiene, and sanitation in retail or institutional settings, as well as inspecting institutional food service, restaurant, and retail food store facilities. A recent Dutch study describing the behaviors, knowledge, and awareness of NoVs among food handlers in retail and institutional settings identified several gaps in education and training, particularly in regard to NoV transmission (32). To date, however, there are no published U.S. studies on this topic. As part of the Norovirus Collaborative for Outreach, Research, and Education (NoroCORE) project (http://norocore.ncsu.edu), which is funded by the U.S. Department of Agriculture, National Institute of Food and Agriculture, a Web-based survey was administered to food safety and public health professionals to characterize their knowledge of NoVs and to identify knowledge gaps. The survey results will be used in the development of a Web-based educational module on NoV prevention and control.

Materials and Methods

RTI International's Committee for the Protection of Human Subjects, which serves as RTI's Institutional Review Board, reviewed and approved the study protocol.

Survey procedures and response

The survey broadly targeted individuals whose occupations or professions included at least one of the following responsibilities: (i) provide training or education on food safety, hygiene, sanitation, and/or infectious disease control; (ii) develop, implement, or oversee training or education programs on food safety, hygiene, sanitation, and/or infectious disease control; or (iii) regulate or inspect retail and/or institutional establishments. To recruit respondents, 25 food safety and public health professional organizations were contacted and asked to promote the survey to their organizational members (e.g., National Environmental Health Association, Association of Food and Drug Officials, Conference of Food Protection, and Food Marketing Institute). Fifteen of the professional organizations agreed to promote the survey via their Web sites, newsletters, or e-mail distribution lists. These organizations provided their members a short study description and a Web link to the online survey. To encourage response, about half of the professional organizations sent reminder e-mails to their members or reposted the study information to their Web sites or in their newsletters. The online survey was hosted by Survey Monkey (Palo Alto, CA) and was open from mid-October 2012 to mid-January 2013.

A total of 1,567 surveys were received, and 1,255 were considered complete. Of the total completed surveys, 314 were completed by food safety professionals who reported they were involved in (i) training or education regarding food safety, hygiene, or sanitation in retail or institutional settings or (ii) food safety regulation or inspection in retail or institutional food settings. Because the number of individuals who received the survey announcement is unknown, neither a response nor a cooperation rate was calculated. Food safety professionals' survey results are provided in this paper. The results of data collected from other health professionals are presented elsewhere (18).

Questionnaire

Respondents' current knowledge of NoVs was measured using a 37-item questionnaire. Respondents were initially asked in three consecutive open-ended questions to list the three most common (i) etiologic agents that can cause foodborne disease, (ii) food sources to which foodborne disease is attributed, and (iii) behaviors of food service workers that can contribute to foodborne disease in the United States. Open-ended questions were used instead of closed-ended questions to not bias and/or limit respondents' responses. Next, respondents were asked to select the three most common settings for NoV infection from a list of responses. Then, respondents were asked to answer a set of true-or-false questions, which were based on information about NoVs on CDC's Web site (www.cdc.gov/norovirus) and reviewed and tailored by field experts. These questions focused on attribution, transmission, and prevention and control strategies, including food handling practices. The order of the true-or-false questions was randomized for each respondent to reduce ordering bias. The survey concluded with questions on the demographic characteristics of the respondent.

Analysis

The surveys were checked for completeness (at least 70% of the true-or-false questions had to be answered by the respondent to be considered a completed survey). For the three open-

ended questions, responses were systematically coded into categories based on recommendations in the survey literature (6, 22), and frequencies were then computed. Responses to the question on food sources attributed to foodborne disease in the United States were grouped into categories; for example, fruits, vegetables, and leafy greens were coded as “produce.” Responses to the question on behaviors of food service workers that can contribute to foodborne disease in the United States were categorized into the five broad categories of risk factors contributing to foodborne illness identified by the U.S. Food and Drug Administration (FDA) using CDC surveillance data reports (31). For the true-or-false questions, the proportion of respondents who answered each question correctly and an overall score (i.e., the percentage of correct answers) were computed. Each true-or-false question was also grouped into four content domains (prevention and control strategies, transmission, illness, and food handling practices) to compute the number of correct responses for each domain. The analysis was conducted using SAS, version 9.3 (SAS Institute Inc., Cary, NC).

Results And Discussion

The food safety professionals who responded to the survey represented a variety of occupations and professions and association memberships. The primary occupations or professions of respondents included the following: sanitarians or environmental health specialists (36.9%), food safety managers or staff (16.9%), registered dietitians or nutritionists (10.9%), quality assurance/control professionals (9.9%), extension agents (7.6%), food safety trainers (7.3%), and other professionals (10.5%). The most common association memberships were National Environmental Health Association (38.9%), Conference of Food Protection (30.3%), Academy of Nutrition and Dietetics (15.6%), International Association for Food Protection (15.0%), and Association of Food and Drug Officials (14.0%). Regarding demographic characteristics, 94.6% of respondents were college educated, and 72.9% of respondents had been at their current position for 10 or more years.

Knowledge of the three most common etiologic agents that cause foodborne disease in the United States

In the United States, the highest numbers of domestically acquired foodborne disease cases are caused by the following pathogens in descending order: NoVs (5,461,731), nontyphoidal *Salmonella* spp. (1,027,561), and *Clostridium perfringens* (965,958) (27). As presented in Table 1, the majority of respondents correctly identified *Salmonella* (84.7% of respondents) and NoVs (66.2%) among the three most common causes of foodborne disease in the United States; however, only 7.3% of respondents identified *C. perfringens*. More than 40% of the respondents incorrectly identified *Escherichia coli* as one of the three most common causes of foodborne disease in the United States. Although Shiga toxin–producing *E. coli* O157 has a much lower incidence rate than the top three pathogens, infection with this pathogen is the fifth leading cause of foodborne disease hospitalizations in the United States (27).

Knowledge of the three most common food sources to which foodborne disease is attributed in the United States

The three major food commodities most commonly associated with foodborne disease in the United States are produce (e.g., fruits, vegetables, and nuts) (46%), meat and poultry (22%), and dairy products (14%) (23). As presented in Table 2, the majority of respondents correctly identified produce (66.2% of respondents), meat (60.5%), and poultry (34.4%) among the three most common food sources attributed to foodborne disease in the United States, but only 8.9% of respondents correctly identified dairy products.

Knowledge of the three most common behaviors of food service workers that can contribute to foodborne disease in the United States

The five broad categories of risk factors contributing to foodborne disease in the United States are (i) improper hot/cold holding temperatures, (ii) inadequate final cooking temperatures, (iii) contaminated equipment, (iv) poor employee hygiene, and (v) unsafe food sources (31). As presented in Table 3, the majority of respondents correctly identified poor employee health and hygiene (97.5% of respondents) and contaminated utensils and equipment (59.6%) among the most common ways food service workers can contribute to foodborne disease in the United States. Collectively, the other three broad categories (improper hot/cold holding temperatures, inadequate final cooking temperatures, and unsafe food sources) were identified by less than 35% of respondents.

Knowledge of the three most common settings for NoV outbreaks in the United States

NoV outbreaks occur ubiquitously but are more common in closed settings where transmission is predominantly person-to-person (8, 12, 23). The three most common settings for NoV outbreaks in the United States are health care facilities (49%), restaurants or banquet facilities (15%), and schools or day-care facilities (5%) (13). Many respondents correctly identified healthcare facilities (66.9% of respondents) and schools or day-care facilities (76.4%) among the three most common settings, and 35.4% of respondents identified restaurants or banquet facilities. Only 5.4% of respondents were able to correctly identify the three most common settings for NoV infections. Sixty-five percent of respondents had the misperception that cruise ships are among the three most common settings for NoV outbreaks; however, cruise ships account for less than 1% of NoV outbreaks reported annually (5, 13).

Knowledge of NoVs based on analysis of responses to true-or-false questions

Table 4 presents the percentage of respondents who correctly answered each true-or-false question on NoVs, organized by content domain. Seventeen respondents (5.4%) answered all 20 true-or-false questions correctly. Thirty-three respondents (10.5%) answered at least 19 of the 20 questions correctly, and 186 respondents (65.0%) answered at least 15 of the 20 questions correctly (i.e., a score of 75% or higher).

With two exceptions, 70% or more respondents answered each of the questions on NoV illness and transmission correctly. Only 55.3% of respondents correctly indicated that this statement is true: “Most NoV outbreaks occur in the winter.” NoV outbreaks occur throughout the year, but over 80% of the outbreaks occur from November to April (14).

Only 68.4% of respondents correctly indicated that this statement is true: “The most common mode of transmission for NoV is person-to-person.” This suggests a key gap in knowledge related to virus transmission.

Although only 33.1% of respondents answered all four questions on prevention and control strategies correctly, the majority of respondents (68.6%) answered at least three of the four questions correctly. Less than half of respondents (46.5%) correctly indicated that the following statement is false: “Using a sanitizing solution of chlorine bleach at 100 ppm will eliminate NoV from a contaminated surface.” CDC recommends initial cleaning to remove soiling followed by use of a chlorine bleach solution with a concentration of 1,000 to 5,000 ppm to disinfect against NoVs (12). Furthermore, two recent studies determined that a concentration of 5,000 ppm will provide adequate reduction of the amount of NoVs present but will likely not completely eliminate NoVs (17, 24); thus, such concentration may not completely eliminate the risk of exposure to NoVs, which have an extremely low infectious dose (as few as 18 particles). Likewise, research indicates that the use of alcohol-based hand sanitizers may not be an effective substitute for soap and running water (29).

Respondents had the most limited knowledge with regard to food handling practices, with only 22.3% of respondents correctly answering the five questions. The FDA Food Code provides provisions for preventing food employees from spreading viruses and bacteria to food. The Food Code stipulates exclusion of food workers with symptoms of gastroenteritis even in the absence of a laboratory-confirmed diagnosis. However, 38.5% of respondents did not correctly indicate that the following statement is false: “Restaurant workers infected with NoV should be restricted to handling packaged food, wrapped single-service or single-use articles, or soiled food equipment or utensils.” Infected food workers have been epidemiologically and diagnostically implicated as a source of NoV transmission (3, 12, 14, 15). Shedding the virus in combination with inadequate personal hygiene measures (e.g., hand washing) can lead to contamination of food or food contact surfaces (3, 7, 19, 25). Because NoVs can easily be spread directly or indirectly and retain infectivity on surfaces (1, 2, 3, 15), infected food workers should not return to work for 48 to 72 hours following symptom resolution (12). Asymptomatic food service workers who have tested positive for NoVs, which might occur during an outbreak investigation, should be excluded or restricted, according to the FDA Food Code (12, 30).

In conclusion, the food safety professionals who completed the survey demonstrated general knowledge of NoV illness and transmission but could benefit greatly from education regarding prevention and control of NoVs, including recommended food safety practices. The survey results identified several gaps in the knowledge and suggest that food safety professionals need additional information on NoVs in order to improve prevention efforts in retail and institutional food settings. About one-third of respondents did not identify NoVs as one of the three most common foodborne pathogens in the United States, and respondents were unsure when (winter) and where (health care facilities, restaurant/banquet facilities, and schools/day-care facilities) most NoV outbreaks occur. In addition, almost one-third of respondents did not know that the most common mode of transmission for NoVs is person-to-person, and more than half of respondents were unaware that “using a sanitizing solution of chlorine bleach at 100 ppm will not eliminate NoV from a contaminated surface.”

Respondents had the most limited knowledge regarding food handling—in particular, the need to restrict restaurant workers from coming in contact with any food (regardless if it is packaged) or kitchen surface—which is of particular concern.

A myriad of training programs are available for employees of institutional food service, restaurant, and retail food store facilities and regulatory food safety professionals. In response to the need for a training system to support an integrated food safety system in the United States, the International Food Protection Training Institute designed a curriculum framework (16). Eventually, the curriculum framework is expected to provide the basis for competency testing and certification. As the framework gets refined, it will be important to address NoV prevention and control strategies.

Food safety professionals' knowledge must expand beyond government regulations. They must also be competent in the scientific basis on how to prevent and control NoV infections. Competent food safety professionals are more likely to influence handling practices that are known to reduce the risk for NoVs within retail and institutional food operations. As part of the next phase of this NoroCORE project, the survey findings will be used in the development of Web-based educational materials for food safety and public health professionals on NoVs to improve efforts to prevent the spread of NoVs in retail and institutional establishments.

The survey results cannot be generalized to the U.S. population of food safety professionals because a probability-based sample was not used. In addition, although the majority of the respondents were members of either National Environmental Health Association (38.9%) or Conference of Food Protection (30.3%), the survey results should not be generalized to the membership of these organizations. For the true-or-false and other knowledge questions, it is not known to what extent respondents may have consulted other sources to answer the questions. Although we used a systematic approach to code the responses to the open-ended questions, using open-ended instead of closed-ended questions can result in more subjective data. While the survey results are limited to a convenience sample of food safety professionals, they provide insights into the respondents' knowledge regarding NoVs and identify areas for improvement.

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Table 1

The most common etiologic agents that cause foodborne disease in the United States as reported by respondents

Pathogen	% of respondents listing pathogen (n = 314)[a]
Salmonella	84.7
Norovirus	66.2
E. coli	41.1
Campylobacter	29.3
Listeria	15.0
Staphylococcus	10.5
Shigella	8.3
Viruses, not specific to norovirus	7.3
Bacteria, nonspecific	7.3
Hepatitis virus	1.9
Clostridium perfringens	7.3
Other	12.1

[a]Respondents could enter up to three responses.

Table 2

The most common food sources to which foodborne disease is attributed in the United States as reported by respondents

Food source	% of respondents listing food source (n = 314)[a]
Produce (e.g., fruits, vegetables, nuts)	66.2
Meat	60.5
Poultry	34.4
Ready-to-eat foods	14.7
Seafood or shellfish	14.0
Eggs	9.6
Dairy	8.9
Other/multiple foods	20.4
Other	11.5

[a]Respondents could enter up to three responses.

Table 3

The most common behaviors of food service workers that can contribute to foodborne disease in the United States as reported by respondents[a]

Behavior	% of respondents listing behavior (n = 314)[a]
Poor employee health/hygiene	97.5
Contaminated utensils or equipment	59.6
Improper hot/cold holding temperatures	26.8
Inadequate final cooking temperatures	8.0
Unsafe food sources	0.3
Other	17.8

[a]Respondents could enter up to three responses.

Table 4

Percentage of respondents who correctly answered true-and-false questions on norovirus

Content domain, statement (correct answer)	% of respondents who answered correctly (*n* = 314)
NoV illness (%Who answered all items Correctly)	34.1
People can get vaccinated to prevent NoV infection. (False)	95.5
NoV infection can easily be treated with antibiotics. (False)	90.0
Children younger than 5 years old and adults aged 65 or older are more susceptible than the general population to severe NoV infections. (True)	87.9
Bacteria cause more cases of foodborne disease than do viruses. (False)	73.2
Most NoV outbreaks occur in the winter. (True)	55.3
Transmission (% who answered all items correctly)	33.1
Once infected with NoV, a person is permanently immune from contracting NoV again. (False)	98.7
It is safe for people infected with NoV to prepare food for others as long as they properly and frequently wash their hands while preparing food (False)	96.2
People infected with NoV may be able to spread NoV for at least 3 days even after they no longer show signs and symptoms of illness. (True)	94.3
NoV does not survive well on porous surfaces, such as textiles, upholstery, and carpeting. (False)	75.3
Most NoV infections occur on cruise ships than in any other setting. (False)	71.9
The most common mode of transmission for NoV is person to person. (True)	68.4
Prevention and control (% who answered all items correctly)	33.1
Alcohol-based hand sanitizer is as effective against NoV as washing hands with soap and water. (False)	83.9
Antimicrobial soap must be used on hands to remove NoV. (False)	76.0
Quaternary ammonium compounds and chlorine bleach are *equally* effective against NoV. (False)	71.3
Using a sanitizing solution of chlorine bleach at 100 ppm will eliminate NoV from a contaminated surface. (False)	46.5
Food handling (% who answered all items correctly)	22.3
Steaming shellfish for three minutes will inactivate NoV. (False)	66.5
Ready-to-eat foods are the most common food source for NoV infections. (True)	71.3
Any food can become contaminated with NoV. (True)	93.0
Fresh produce implicated in NoV outbreaks is always contaminated by food preparers infected with NoV. (False)	64.3
Restaurant workers infected with NoV should be restricted to handling packaged food, wrapped single-service or single-use articles, or soiled food equipment or utensils. (False)	61.5