

A Review of Outbreaks of Foodborne Disease Associated with Passenger Ships: Evidence for Risk Management

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SYNOPSIS

Objective. Foodborne disease outbreaks on ships are of concern because of their potentially serious health consequences for passengers and crew and high costs to the industry. The authors conducted a review of outbreaks of foodborne diseases associated with passenger ships in the framework of a World Health Organization project on setting guidelines for ship sanitation.

Methods. The authors reviewed data on 50 outbreaks of foodborne disease associated with passenger ships. For each outbreak, data on pathogens/toxins, type of ship, factors contributing to outbreaks, mortality and morbidity, and food vehicles were collected.

Results. The findings of this review show that the majority of reported outbreaks were associated with cruise ships and that almost 10,000 people were affected. *Salmonella* spp were most frequently associated with outbreaks. Foodborne outbreaks due to enterotoxigenic *E. coli* spp, *Shigella* spp, noroviruses (formally called Norwalk-like viruses), *Vibrio* spp, *Staphylococcus aureus*, *Clostridium perfringens*, *Cyclospora* sp, and *Trichinella* sp also occurred on ships. Factors associated with the outbreaks reviewed include inadequate temperature control, infected food handlers, contaminated raw ingredients, cross-contamination, inadequate heat treatment, and onshore excursions. Seafood was the most common food vehicle implicated in outbreaks.

Conclusions. Many ship-associated outbreaks could have been prevented if measures had been taken to ensure adequate temperature control, avoidance of cross-contamination, reliable food sources, adequate heat treatment, and exclusion of infected food handlers from work.

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The shipping industry is international in reach. Modern shipping involves companies from almost every nation, and virtually every nationality is represented in the seafaring population and the industry's shore-based workforce.¹ In recent years, cruise ships and ferries have expanded in number and size to accommodate an increase in the transportation of passengers by sea.¹

Some cruise ships carry more than 5,000 passengers and crew per sailing, and many feature "resort-style" amenities such as multiple dining venues, specialty restaurants, and extensive spa and fitness facilities. The International Council of Cruise Lines estimates that almost 9.8 million people sailed on cruise ships in the year 2000, and this number is forecast to grow to 20.7 million by 2010.² Ferries are also increasing in size, with some carrying more than 2,000 passengers per sailing. New "cruiseferries" are more like holiday cruise ships, with numerous amenities such as swimming pools, cinemas, casinos, and live entertainment.

Ships have long been sites for outbreaks of infectious disease, particularly gastrointestinal disease.³⁻¹⁷ These outbreaks are of particular public health importance because the passenger shipping industry is growing and many more people are thus living in confined spaces, eating from one food supply, and drinking from one water supply, placing a large cohort of people at risk. Passengers and crew may take trips ashore at different ports where infection could be acquired, and then be spread on board. The ship environment has the potential to facilitate the spread of infectious diseases, infecting susceptible cohorts of embarking passengers and crew. Some outbreaks of infectious diseases occur on successive cruises and are difficult to control. Outbreaks could have potentially serious health consequences for passengers and crew and could also result in high economic costs to an industry relying heavily on tourism.

The purpose of this article is to provide a review of documented outbreaks of foodborne diseases associated with passenger ships for the period from January 1, 1970, through June 30, 2003. This review is also designed to better identify contributing factors so that similar outbreaks can be prevented in the future. This work has been carried out in the framework of a World Health Organization (WHO) project for setting guidelines for ship sanitation. It is designed to provide scientific input into the development of these international guidelines. In an accompanying article,¹⁸ we review outbreaks of waterborne diseases associated with ships.

METHODS

Definition of foodborne disease

Foodborne diseases comprise the various acute syndromes that result from ingestion of contaminated foods. They are classified as:

- intoxications caused by ingestion of foods containing either poisonous chemicals or toxins produced by microorganisms;
- toxin-mediated infections caused by bacteria that produce enterotoxins (toxins that affect water, glucose, and electrolyte transfer) during their colonization and growth in the intestinal tract;

- infections caused when microorganisms invade and multiply in the intestinal mucosa or other tissues.

Manifestations range from slight discomfort to acute illness to severe reactions that may lead to death or chronic sequelae, depending upon the nature of the causative agent, the number of pathogenic microorganisms or concentration of poisonous substances ingested, and the host susceptibility and reaction.¹⁹

Study criteria

Inclusion criteria. All identified reports of outbreaks of foodborne disease associated with passenger ships (including ferries and river cruises) that occurred from January 1, 1970, through June 30, 2003, were included in the review. The review was not limited to any geographic area and includes reports published in peer-reviewed scientific articles, reports published on the Internet by government organizations, internal reports from public health agencies, and personal communications with representatives of government agencies.

Exclusion criteria. Outbreaks reported by the press or by industry but not confirmed by a public health agency were excluded. Outbreaks associated with private sailing boats were excluded, as were those associated with fishing vessels, naval vessels, and general cargo vessels and yachts, since very few published outbreaks have been associated with naval, fishing, or cargo vessels.

Search strategy

The search strategy for identifying studies or outbreak reports involved searching the MEDLINE, *Embase*, and *Cab Health* databases using the key words "disease outbreaks" and "ship." The bibliographies and reference lists included in articles identified in the electronic searches were checked for any relevant outbreak reports or studies. Government and industry websites were also searched for information on outbreaks associated with ships.

The search also included reports identified through personal communications with experts and government institutions. Unpublished outbreaks reported to the U.S. Centers for Disease Control and Prevention (CDC) or the U.K. Communicable Disease Surveillance Centre (CDSC) were also included in the study database.

Data extraction

All reports were initially examined to see if the outbreaks met the inclusion criteria. Reports were read to ensure that there was no duplication of outbreak information. In the event of duplicate information from multiple sources, the published manuscript was chosen as the reference source. Details of the outbreak year, the causal agent, geographic location, number of people at risk and affected, food vehicle, and contributing factors were extracted.

Categorizing levels of evidence

A method of categorizing the strength of evidence implicating a food vehicle was developed for this review (adapted from Bryan et al.²⁰). The categories take into account the

epidemiology, laboratory-based microbiology, and food hygiene information obtained as part of an environmental investigation. Food vehicles are classified as confirmed, presumptive, suspected, or unknown (see Figure).

RESULTS

A total of 50 outbreaks met the criteria for inclusion in our review; 26 were obtained through peer-reviewed journals, 17 were identified via personal communication with representatives from the CDC in the U.S. or the CDSC in the U.K., six were identified from non-peer-reviewed publications, and one came from a government report.

Type of ship and geographic location

The majority of outbreaks 44 (88%) were associated with ocean cruise ships, four outbreaks were associated with ferries, and two were associated with river cruises. One-fifth of the outbreaks were reported on Caribbean cruise ships; five outbreaks were associated with on-shore excursions and two with packed lunches.

Pathogens/toxins

Forty-one outbreaks (82%) were due to bacterial pathogens, and the rest were due to viruses, parasites, or agents of unknown etiology (Table 1). The principle pathogen associated with outbreaks was *Salmonella* spp, which caused more than one-quarter of the outbreaks. Other agents were enterotoxigenic *E coli*, *Shigella* spp, *Vibrio* spp, *Staphylococcus aureus*, *Clostridium perfringens*, *Trichinella*, and *Cyclospora*.

Mortality and morbidity

Almost 10,000 people were affected, and 33 people were hospitalized during the period from January 1, 1970, to June 30, 2003. One death was reported, which was associated with an outbreak of *Shigella flexneri* 2.

Factors contributing to outbreaks

One or more contributing factors were reported for 20 (40%) of the outbreaks. These factors included inadequate temperature control, infected food handlers, contaminated raw

ingredients, cross-contamination, and inadequate heat treatment (Table 2). Contributing factors were identified for 15 (30%) outbreaks with a confirmed or presumptive food vehicle.

Food vehicles

In 40 of the 50 outbreaks (80%) eligible for inclusion, a specific food vehicle was implicated (Table 3). In 30 outbreaks (73%), this vehicle was confirmed or presumptive, while in 10 outbreaks (20%) the food vehicle was suspected. The food vehicle was not reported or unknown in 10 outbreaks (20%). Seafood was implicated in almost one-third of the outbreaks; other vehicles included salads, eggs, poultry, and red meat.

DISCUSSION

The environmental factors that make passenger ships conducive to foodborne illness are large quantities of raw food obtained from various sources depending on the ports of call; centralized preparation and serving of meals; more meals than in the past, served with a greater variety of food; and a rapidly changing workforce.

The 50 reported foodborne disease outbreaks identified in this review most likely underestimate the true number. This is because many outbreaks do not come to the attention of the health authorities, few reports are published, and it is likely that many outbreaks go undetected. Although there are specific food poisoning issues associated with ships, some outbreaks are linked to food or water consumed on short trips ashore.

Outbreaks are infrequently detected on ferries. Although large numbers of passengers travel on ferries on each sailing, the short duration of these trips and the rapid dispersal of passengers afterward make it difficult to detect outbreaks.

A ship environment is an ideal place to investigate an outbreak, as ships are self-contained and epidemiological evidence is usually good. Passengers and crew typically report illness to one medical facility, which improves identification of cases. Case patients and contacts are generally available for interview, and it is usually possible to collect

Figure. Criteria for confirmation of vehicle responsible for foodborne illness

Confirmation Status	Criteria
Confirmed vehicle	Isolation of agent from ill individuals and food, and exposure that preceded infection by a period of time consistent with proposed biologic mechanisms, AND combination of on-site investigation and statistical evidence from epidemiological study.
Presumptive vehicle	On-site investigation demonstrating source and mode of contamination of food and survival of agent in food OR epidemiological investigation determining that there has been an association between eating and becoming ill.
Suspected vehicle	A food type that is often identified as a vehicle of foodborne illness prepared in a manner by which contamination, survival, or growth could have occurred but outbreak pathogen not detected in food OR descriptive epidemiology suggesting that the outbreak is food-related and excluding obvious alternative explanations OR food implicated in the outbreak report/publication but no information on epidemiology or microbiology available.
Unknown food vehicle	Investigation determining an association between eating and becoming ill, but a specific vehicle not identified.

Table 1. Pathogens and toxins linked to outbreaks of foodborne disease associated with 50 passenger ships, January 1, 1970–June 30, 2003, with mortality and morbidity data

Organism/toxin	Number of outbreaks	Percent	Number of passengers and crew members affected	Number of passengers and crew members hospitalized
<i>Salmonella</i> spp ^b	15	30	1,846	1
<i>Shigella</i> spp	8	16	2,076	21
Enterotoxigenic <i>Escherichia coli</i> (ETEC) ^a	8	16	2,670 ^a	0
<i>Vibrio parahaemolyticus</i> spp ^c	5	10	1,197	4
Noroviruses	4	8	866	0
<i>Staphylococcus aureus</i>	2	4	380	0
<i>Vibrio cholera</i>	1	2	62	3
Invasive <i>E. coli</i>	1	2	153	0
<i>Clostridium perfringens</i>	1	2	18	0
<i>Cyclospora</i> sp	1	2	220	0
<i>Trichinella spiralis</i>	1	2	13	0
Unknown pathogen	3	6	360	4
Total	50	100	9,861	33

^aThese columns show data for seven outbreaks.

^bOne outbreak involved two pathogens, *E. coli* O157 and *Salmonella* spp.

^cTwo outbreaks were associated with multiple organisms. Other pathogens included ETEC and *Salmonella* sp.

an adequate number of clinical and environmental samples. Sources of contamination (e.g., food, water) are easier to trace than in a community outbreak.

However, not all outbreak reports provided conclusive epidemiologic or laboratory-confirmed microbiologic data supporting food as the specific source of infection. In some studies, inadequate collection of data, poor recall on the part of interviewees, or misclassification of cases and controls may have caused bias. Thus, all epidemiologic studies were evaluated along with evidence from sanitary and microbiological investigations. To make the best use of all available evidence in outbreak reports, we used a categorization system to incorporate all information including data from descriptive epidemiology, analytical epidemiology, environmental investigation, and food and clinical microbiology. This system allowed for inclusion of suspected foodborne outbreaks that were not conclusively confirmed.

Information on contributory factors is needed to gain a better understanding of the etiologic agents and to inform decision-making on preventive measures. However, factors contributing to the outbreak were described for fewer than half the outbreaks reported, limiting the value of the review. The most common factors contributing to outbreaks included inadequate temperature control, infected food handlers, contaminated raw ingredients, cross-contamination, and inadequate heat treatment. The factors contributing to outbreaks with suspected food vehicles did not differ much from the factors contributing to the outbreaks where the vehicle was confirmed or presumptive.

Inadequate temperature control

The preparation of a wide variety of foods at the same time for a large number of people increases the risk of mishandling and temperature abuse. Inadequate temperature con-

Table 2. Factors contributing to outbreaks of foodborne disease associated with passenger ships, January 1, 1970–June 30, 2003

Main factor contributing to outbreak	Bacterial outbreaks	Norovirus outbreaks	Protozoan outbreaks	Unknown agent	Total	Percent
Inadequate temperature control	7	0	0	0	7	14
Infected food handler or suspected infected food handler	4	1	0	0	5	10
Contaminated raw ingredient	2	0	1	0	3	6
Cross-contamination	1	0	1	0	2	4
Inadequate heat treatment	1	0	0	0	1	2
Other factors	2	0	0	0	2	4
No factor identified	24	3	0	3	30	60
Total	41	4	2	3	50	100

Table 3. Food vehicles implicated in outbreaks associated with passenger ships, January 1, 1970–June 30, 2003

Vehicle	Number of confirmed outbreaks	Number of presumptive outbreaks	Number of suspected outbreaks	Total	Percent
Food implicated					
Seafood	1	9	4	14	28
Salad/buffet/fruit	2	4	1	7	14
Poultry	0	2	2	4	8
Eggs	0	3	1	4	8
Red meat	1	1	1	3	6
Cream	0	2	0	2	4
Other foods	0	5	1	6	12
Food vehicle not specified	0	0	0	10	20
Total	4	26	10	50	100

trol was the most frequently cited contributing factor, and many of the reported outbreaks were linked to buffets served on passenger ships. Elaborate passenger menus on cruise ships often contain potentially hazardous foods, increasing the risk of foodborne illness. It is often difficult to time the preparation and cooking of meals so that they are served hot. Because large numbers of people may require meals in a short space of time, it is often necessary to prepare meals hours in advance and to hold meals under refrigeration, in a hot holding apparatus, or even at ambient temperature. For example, an investigation of an outbreak of salmonellosis on a cruise ship found that food served at a midnight buffet was not refrigerated while on display and was reused at subsequent meals.²¹ Another investigation, of an outbreak of viral gastroenteritis, found that potentially hazardous foods were prepared for the evening buffet early in the morning and held in the oven or *bain marie* (water bath) or placed in the refrigerator and later reheated as much as eight hours after preparation.²² An outbreak of staphylococcal food poisoning occurred after pastry was left for a prolonged time at warm temperatures. The pastry had been prepared in large quantities in several steps by several food handlers. This provided opportunities for the introduction of staphylococci into the pastry, and the warm ambient temperatures allowed for the production of enterotoxin.²³

It is important that meals are not left for long periods of time at ambient temperatures. Food should be adequately thawed and cooked. If cooked foods are to be served cold, precautions should be taken to cool cooked dishes quickly and to store food not to be eaten freshly cooked in a refrigerator. If food hygiene procedures are strictly controlled and the storage temperatures are at levels that will not permit bacterial growth, then the risks will be reduced.²⁴

Health status of staff involved in food handling

Crew members who do not maintain an appropriate degree of personal cleanliness or who prepare or handle food while ill can contaminate food and transmit illness to consumers. Infected food handlers was a possible factor contributing to five outbreaks.^{13,25–28} Four of these outbreaks were caused by bacterial agents and one by a virus. In an outbreak of salmonellosis that occurred on a ferry in 2002 and affected 352 passengers, eight food handlers were found to be carriers of

the pathogen.²⁷ Infected food handlers were implicated in another outbreak on a cruise ship in 1990, due to norovirus. The investigators noted that crew could have been reluctant to report illness because of concern about job security.²⁸

Noroviruses (formally Norwalk-like viruses or NLVs) are transmitted by hands contaminated through the fecal-oral route, directly from person to person, through contaminated food or water, or by contact with contaminated surfaces or fomites.²⁹ Most norovirus outbreaks on ships are spread person to person.^{15,16,30–33} During the period from January 2002 to February 2003, an increased number of outbreaks due to noroviruses were reported on cruise ships sailing into ports in the U.S. Twenty-five outbreaks of acute gastroenteritis were reported on cruise ships during this time. Most of these outbreaks pointed to the likelihood that the virus was transmitted from person to person aboard the ship by passengers and crew and not transmitted through a point source outbreak via water or food.²⁹

Transmission of noroviruses is difficult to control through routine sanitary measures because of high infectivity and persistence in the environment. Outbreaks can continue on successive cruises with new passengers affected by the same virus strains.²⁹ Theoretically, any food item can potentially be infected with norovirus through fecal contamination.³⁴ Strict hygiene measures, such as frequent hand washing, thoroughly washing ready-to-eat foods that require handling but no subsequent cooking (e.g., salads), and excluding infected food handlers from work, are necessary to ensure that food does not facilitate the spread of the infection on a ship.³⁵ It is important that crew members are not penalized for reporting illness to management.²⁸

Lack of adequate personnel hygiene facilities

During the investigation of an outbreak of multiple antibiotic resistant *Shigella flexneri* 4a, investigators speculated that the spread of the infection by an infected food handler might have been facilitated by limited availability of toilet facilities for the galley crew. Only one toilet was available in the galley area for more than 100 food handlers.²⁶ Adequate sanitation facilities and instruction materials on proper hygiene should be available on every ship to ensure that an appropriate degree of personal hygiene can be maintained.

Contaminated raw ingredients

Contaminated raw ingredients was the main contributing factor in three outbreaks. Ingredients included raw meat and fish. An outbreak of food poisoning caused by *E. coli* O157 and *Salmonella bareilly* occurred on a ferry in September 2000. The ferry had been supplied with contaminated beef tenderloin fillets (Personal communication, R. Kaye, Chief Port Health Inspector, Hull Port Health Authority, U.K., August 2001). Another outbreak, on a cruise ship in 2000, was associated with shrimp. The shrimp could have become contaminated at any stage of preparation before being loaded onto the vessel.³⁵ These outbreaks show how vulnerable ships and ferries are to outside food suppliers. They also highlight the importance of training food handlers in good hygiene practices and promoting their awareness of the potential of cross-contamination from foods such as raw beef and fish.

Cross-contamination

Pathogens can be transferred from one food to another, either by direct contact or by indirect contact through food handlers, contact surfaces, or utensils. Cross-contamination was reported as the main contributing factor in two outbreaks.^{21,36} Space is sometimes limited in galleys, preventing the clear separation of raw and cooked foods. In one outbreak of salmonellosis, contamination could have been spread through inadequately washed pots and pans.²¹

An outbreak of trichinosis food poisoning was linked to beef contaminated with pork. During the cruise, one meat grinder in the butcher shop was used for both pork and beef; it may not have been thoroughly cleaned after each use.³⁶

Raw food, especially meat, should be effectively separated, either physically or by time, from ready-to-eat foods, with effective intermediate cleaning and, where appropriate, disinfection. Surfaces, utensils, equipment, fixtures, and fittings should be thoroughly cleaned and where necessary disinfected after raw food, particularly meat and poultry, has been handled.

Use of seawater in the galley

It is important that the galley is designed to prevent seawater from contaminating foodstuffs. Two outbreaks of food poisoning, both caused by *Vibrio parahaemolyticus*, were associated with the use of seawater from the ship's fire system in the galley.³⁷ Seafood was contaminated by seawater while the galley was being hosed down for cleaning. Galleys should be designed so that only potable water can be piped into spaces where food is stored, prepared, or served.

Inadequate heat treatment

Potentially hazardous foods such as meat, fish, and eggs are of special concern on passenger ships, as in other mass catering establishments. The single most frequent food vehicle implicated in foodborne outbreaks onboard ships was seafood (fish and shellfish). While the methods of food preparation and storage were responsible for many of these outbreaks, it is likely that seafood is eaten more frequently by passengers onboard ships than in the rest of the population, and this may reflect its prominence within the out-

breaks. Koo et al. estimate that almost one-third of the source-defined outbreaks investigated by CDC in 1986–1993 could have been prevented by following two safe food-handling practices: thoroughly cooking shellfish and using pasteurized eggs.¹⁰ In 1994, CDC asked that cruise lines warn passengers of the risk of consuming raw or undercooked seafood.¹⁰

Onshore meals and prepackaged lunches

Outbreaks associated with onshore meals are often beyond the control of the ship's personnel. Five outbreaks were linked to onshore meals. In 1976, an outbreak of *Vibrio parahaemolyticus* food poisoning was associated with unrefrigerated seafood dishes served at onshore buffets; other pathogens were implicated, including *Salmonella* sp, *E. coli*, and *Shigella* sp. The number and identity of pathogens suggested that coastal water, perhaps contaminated with sewage, might have been the source of the organisms. The multiple pathogens also suggested multiple errors in preparation and handling of food.³⁸ An outbreak of *Vibrio cholera* O139 that occurred among tourists traveling to Asia on a cruise ship in 1994 was associated with an onshore meal.³⁹

Berkelman et al. discuss the importance of distinguishing outbreaks due to onshore food consumption from those due to consumption of ship food.³⁸ Since most cruises do involve onshore visits, they must be considered as possible sources of illness for cruise passengers. Some cruise lines have a policy that meals provided on shore be catered by the ship and not onshore caterers.¹⁰ Passengers should be made aware of potential foodborne and waterborne hazards when disembarking for onshore visits and advised to take precautions with all food, drink, and drinking water consumed.

Pre-packaged meals prepared for passengers to take on shore trips can also be a hazard and were suspected vehicles in two outbreaks of salmonellosis, one on a cruise ship in 1989 and one on a ferry in June 2000 (Unpublished CDSC data). These meals are often prepared in advance of need and are frequently carried around for many hours in unsuitable temperatures before consumption, giving ample time for bacterial multiplication to occur. Cruise ship operators should consider alternatives to packed lunches or eliminate potentially hazardous foods from their menus for packed lunches.

CONCLUSIONS AND RECOMMENDATIONS

Fifty outbreaks associated with ships were examined for this review. Many could have been prevented if measures had been taken to ensure adequate temperature control, avoidance of cross-contamination, reliable food sources, adequate heat treatment, and exclusion of infected food handlers from work. Reviewing outbreaks can help to identify hazards and critical control points in order to prevent future outbreaks. The control measures identified in this review are probably incomplete, as factors contributing to sporadic cases of infection may be different from those contributing to outbreaks.

Although many different food vehicles were implicated, some specific to each pathogen, the results of this review can be summarized in a few sentences. Bacterial pathogens are

the most common foodborne hazards and are often associated with foods of animal origin. Critical control points include ensuring that raw ingredients are cooked thoroughly, avoiding time/temperature abuse, and maintaining a high level of personal hygiene and kitchen hygiene. Foodborne outbreaks on board vessels can largely be avoided by the training of food handlers, optimum construction of galleys, and strict personal hygiene.

Control measures for biological hazards include:

- *Temperature/time control*: proper control of refrigeration and storage time and proper cooking of food.
- *Source control*: control of the presence and level of microorganisms by obtaining ingredients from suppliers who can demonstrate adequate controls over the ingredients.
- *Cross-contamination control*, both direct and indirect.
- *Proper cleaning and sanitizing to eliminate or reduce levels of microbiological contamination*. Galleys should be designed so that the risk of cross-contamination is reduced. An adequate number of hand washing and toilet facilities should be provided for crew.⁴¹ Seawater should not be used near food or food preparation areas.
- *Personal and hygienic practices*. Prevention of outbreaks attributed to infected food handlers requires the cooperation of employers, since many food handlers may conceal infection to avoid pay loss or penalty.⁴¹ It is recommended that ships have policies for ensuring that infected people or chronic carriers do not perform any tasks connected with food handling. No individuals with diarrhea, vomiting, sore throats, colds, fevers, or infected skin lesions should handle food. Such individuals should immediately report their condition to the ship's medical officer. Staff should not be penalized for reporting illness. Cuts, sores, and other abrasions and wounds should be covered with approved waterproof dressings that prevent the transmission of infectious agents onto surfaces or foods.

The above should be supported by the implementation of a Hazard Analysis Critical Control Point System (HACCP).⁴¹ Such a system should be used as a tool to help determine critical control points specific to a particular menu, i.e., the stages in the preparation and cooking of food that must be controlled to ensure the safety of the food. Once identified, a monitoring system can be set up for each critical control point to ensure that correct procedures are maintained and action taken if control point criteria are not achieved. The chief advantage of HACCP is that it is proactive—it aims to prevent problems from occurring.

The WHO *Guide to Ship Sanitation*⁴⁰ is the official global reference on health requirements for ship construction and operation and is directly referenced in Article 14 of the 1969 International Health Regulations.⁴² Its purpose is to standardize the sanitary measures taken on ships, to safeguard the health of travelers, and to prevent the spread of infection from one country to another. The *Guide* was first published in 1967 and was reprinted with minor amendments in 1987. The construction, design, and size of ships have changed dramatically since the 1960s and new hazards (e.g.,

E. coli O157) were not foreseen when the *Guide* was first published. Therefore, WHO is updating the *Guide* in close collaboration with the shipping industry and collaborating Member States for the IHR. It has been proposed that the revised guide be based on a critical review of available evidence, including the outbreaks discussed in this review.

Any opinions, findings, conclusions and recommendations expressed in this article are those of the authors and do not necessarily reflect the official views of their institutions.

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