



INTERNATIONAL
SOCIETY
FOR INFECTIOUS
DISEASES

GUIDE TO INFECTION CONTROL IN THE HOSPITAL

CHAPTER 18:

Food: Considerations for Hospital Infection Control

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KEY ISSUE

- The responsibility of a hospital food service is to provide nutritious and safe food to patients and employees.
- Although food safety has dramatically improved in the last decades, outbreaks of nosocomial gastroenteritis continue to occur worldwide.¹⁻³
- A growing number of hospitalized patients are susceptible to infectious diseases. These include the elderly and immunocompromised hosts. Coupled with mass production of food, the potential exists for large outbreaks of foodborne illnesses.
- Additionally, complex and large-scale production of food and water is a potential target for bioterrorism.
- The outbreaks may result from breakdown in only one-step of food safety control measures.

KNOWN FACTS

- Foodborne illnesses can be caused by bacteria, virus, protozoa, helminths, prions, toxins, or chemical contaminants.⁴
- Due to highly susceptible and frail populations, such as the elderly, outbreaks of nosocomial gastroenteritis have a higher crude mortality than their community-acquired equivalents.^{3,5}
- Common foodborne pathogens that are easily transmitted through food and can cause severe illness are *Salmonella* spp., *Clostridium botulinum*, Shigatoxin-producing *E. coli* (STEC), *Vibrio* spp., *Listeria monocytogenes*, *Campylobacter* spp., norovirus, *Shigella* spp., *Yersinia enterocolitica*, Hepatitis A virus, *Giardia*, and *Cryptosporidium*.⁶ Incidence varies according to geographic area, season, and availability of laboratory diagnosis, and change over time.

- Extra intestinal and post infectious manifestations associated with enteric pathogens may also contribute to the mortality and morbidity e.g., Guillain-Barré syndrome (*Campylobacter*), hemolytic uremic syndrome (STEC, *Shigella dysenteriae* serotype 1), intestinal perforation (*Salmonella*, *Shigella*, *Campylobacter*, *Yersinia*, *Entamoeba histolytica*), etc.⁷
- Furthermore, contaminated food can contribute to nosocomial outbreak of multidrug-resistant bacteria, such as extended-spectrum-beta-lactamases (ESBL)-producing Enterobacteriaceae.⁸
- The clinical presentations of infectious gastroenteritis are broad and can be quick in onset, such as in toxin mediated diseases (1-24 hours after ingestion), *Vibrio parahaemolyticus* (4-30 hours), astrovirus and norovirus (12-48 hours). The incubation period of common bacterial foodborne illnesses, such as *E. coli*, *Salmonella*, *Shigella*, *Yersinia*, *Vibrio*, *Campylobacter*, *Cryptosporidium*, *Cyclospora*, *Giardia*, ranges from 1 day to 14 days, making it difficult to determine the food involved in transmission without microbiological diagnosis. Others have long incubation periods, such as *Listeria* (2-6 weeks), hepatitis A (15-50 days), and prion associated diseases (5-20 years).⁹
- Because of low infectious dose pathogens (<500 viable organisms), infections with noroviruses, rotaviruses, *Shigella*, Shiga toxin-producing *E. coli*, *Giardia*, and *Cryptosporidium* are easily spread.¹⁰
- Noroviruses are considered the leading cause of epidemic gastroenteritis in both healthcare and non-healthcare settings. Nosocomial outbreaks caused by noroviruses are difficult to prevent and control due to^{11,12}:
 - Low infectious dose (18-100 viral particles).
 - Short incubation period (12-48 h).
 - Resistance to inactivation by freezing, heating to 60 C (100.4 F), routine water chlorination, low pH levels, and treatment with ethanol, or detergent-based cleaners.

- Multiple routes of transmission, including fecal-oral route, ingestion of aerosolized vomitus, and indirect contact via contaminated environmental surfaces.
- Genetic variability and short-term immunity.
- Prolonged viral shedding after recovery (several weeks).
- Outbreaks of norovirus can also affect staff and visitors (attack rates 5-60%). This has resulted in ward closure in up to 44% of reported outbreaks.^{5,13} Currently, there are several norovirus vaccines that are under development using strain-specific recombinant norovirus-like particles (VLPs).
- Rotavirus was the most common cause of gastroenteritis pathogens among children <5 years. An introduction of rotavirus vaccine may have contributed to decrease the incidence of community acquired and nosocomial rotavirus gastroenteritis.¹⁴
- *Cryptosporidium* and *Giardia* are resistant to routine chlorination of water. In 1993, *Cryptosporidium* caused the largest documented outbreak of gastrointestinal disease in a developed country (estimated 403,000 cases) due to contaminated drinking water supply.¹⁵
- Outbreaks of the moderate infectious dose pathogenic bacteria (10^3 to 10^5 viable organisms), such as *Salmonella* and *Campylobacter*, occasionally occurs in healthcare facilities. The most frequently reported routes of *Salmonella* transmission were foodborne (59.6%) and person-to-person transmission (13.5%).^{2,10,16}
- Undercooked meat/poultry, eggs, seeded vegetable, and sprouts are responsible for most *Salmonella* outbreaks. Egg-associated salmonellosis is linked to external contamination of the shell during passage through the hen cloaca, and internal contamination by penetration of the bacteria through the eggshell, via microscopic cracks.¹⁷
- There are increasing reports of multidrug-resistant zoonotic foodborne infections. Emerging resistance of *Salmonella* and *Campylobacter*

species contribute to excess mortality and morbidity in both outbreaks and sporadic cases of illnesses.^{18,19}

- The high infectious dose pathogens ($>10^6$ viable organisms), such as enteroinvasive *E. coli* (EAEC), Enterotoxigenic *E. coli* (ETEC), Enteropathogenic *E. coli* (EPEC), and *Vibrio cholerae*, usually cause illness by ingestion of contaminated food or water.¹⁰
- *E. coli* is a fecal pathogen. The primary sources of the *E. coli* O157 (STEC O157) outbreaks are raw or undercooked meat products, raw milk, and fecal contamination of water, vegetables, fruits, and environment. *E. coli* O157 infection can be asymptomatic or can result in symptoms ranging from abdominal cramps, mild diarrhea, and bloody diarrhea, to life-threatening diseases, including hemolytic uremic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP).
- *Listeria monocytogenes* is a ubiquitous pathogen and has been recovered in plants, soil, silage, sewage, slaughterhouse waste, human feces (1-10%), animal feces, processing environments, and catering facilities. The estimated infectious dose of *L. monocytogenes* is between 10 to 100 million colony forming units (CFU) in healthy hosts and only 0.1 to 10 million CFU in individuals at high risk of infection.²⁰ Although listeriosis is uncommon, the fatality rate in high-risk individuals (such as pregnant women, older people, and immunocompromised hosts) is as high as 20-50%. The organism can proliferate at -18 to 10 C (-0.4 to 50 F).²¹ Consequently, *Listeria* may be transmitted in foods that have been kept properly refrigerated. Thorough cooking to 75 C (167 F) can destroy the *Listeria*. In developed countries, the contamination in ready-to-eat (RTE) meats is primarily due to post-cooking contamination.
- Although person-to-person transmission and transmission through environmental contamination of *Clostridium difficile* from symptomatic or asymptomatic cases could account for most infection in healthcare setting²², community-onset *C. difficile* may be acquired by contaminated foods, exposure to spores from soil, and exposure to household contacts with *C. difficile* diarrhea.^{23,24}

- To destroy non-spore-forming microorganisms, foods should be cooked so that the internal temperature throughout the food is held at above 70 C (158 F) for not less than 2 minutes.²⁵
- Effective cooling is required to prevent growth from bacterial spores, which survive cooking. According to the guidelines for cooling, the internal temperature of cooked meat and poultry products should not remain between 54 C (130 F) and 80 F (27 C) for more than 1.5 hours, nor between 27 C (80 F) and 4 C (40 F) for more than 5 hours.²⁶
- Foodborne bacteria can multiply rapidly if food is not maintained at an appropriate temperature (below 5 C/41 F) for refrigeration and above 57 C/135 F for hot holding), and if there are delays between food preparation and distribution. Foods intended to be eaten cold or at room temperature should be consumed, preferably, within 30 min of removal from chilled storage.²⁵
- Dishwashers should reach thermal disinfection temperatures (82 C/180 F for 2 minutes).
- Enteric viruses are particularly problematic pathogens as they are more resistant to heat, disinfection, and pH changes than enteric bacteria. In addition, viral contamination does not alter the appearance, smell, or taste of food. Lastly, viruses can survive for days or weeks on hospital environment.
- Hand washing can effectively reduce the transmission of bacteria and viruses.
- Hand washing with soap and water followed by hand drying with paper towels (not hot air dryers) is the standard procedure for hand decontamination in food safety practices. Alcohol-based handrubs are inferior as these products neither inactivate viral pathogens such as norovirus, nor can destroy the spores of *C. difficile*.
- Hazard Analysis Critical Control Point (HACCP) is a systematic approach for the identification, evaluation, and control of potential hazards at every stage of food operation. This system emphasizes the role of continuous problem solving and prevention rather than solely

relying on spot-checks of manufacturing processes and random samples of finished food products.²⁷ Thus, the HACCP approach is to control problems before they happen.

- HACCP involves major seven principles:
- Analyzing hazards that must be prevented, eliminated or reduced to acceptable levels.
- Identifying critical control points (CCPs) at which control is essential to prevent or eliminate a hazard or reduce it to acceptable levels.
- Establishing preventive measures with critical limits for each control point
- Establishing procedures to monitor the critical control points
- Establishing corrective actions to be taken when monitoring shows that a critical limit has not been met
- Establishing procedures to verify that the system is working properly
- Establishing effective recordkeeping to document the HACCP system
- Currently, HACCP is recognized as an effective food safety assurance system. The success of a HACCP system depends on training and constant supervision of employees in the importance of their role in producing safe foods.
- Although implementation of HACCP system on hospital food service is still voluntary in most countries, several hospitals have adopted these principles to ensure that hospital food is safe for consumption by high-risk patients.
- Most outbreaks could have been avoided by adhering to good personal and food hygiene and HACCP principles
- To provide safe food in hospitals, adherence to HACCP is critical. In a study by the U.S. Food and Drug Administration (FDA), the most significant contributing factors to foodborne illness are²⁹:
- Foods from unsafe sources.
- Poor personal hygiene among food handlers and lack of adequate toileting and hand washing facilities.
- Inadequate cooking or re-heating.

- Improper storage of the food (holding time and temperature).
- Contaminated equipment and inadequate protection from contamination between raw and cooked food.
- The U.S. CDC estimates that approximately 18-20% of foodborne outbreaks are associated with an infected food worker.³⁰ Transmission of foodborne pathogens can occur from pre-symptomatic, symptomatic and post-symptomatic food handlers. Transmission of infections is dependent upon the amount of infectious agent excreted, the degree of contamination, the compliance and effectiveness of personal hygiene, the stability of pathogens in food and environment, the virulence of organisms, the food type/amount consumed, cooking process, food preservation techniques, and immune status of patients.

Controversial Issues

- Identification of the etiologic agents of nosocomial gastroenteritis is important for clinical management of severe cases and outbreak control. Currently, multiplex nucleic acid amplification tests (MP-NAATs) from stool specimen can simultaneously detect several enteric pathogens and toxin, such as norovirus, rotavirus, enterotoxigenic *E. coli* (ETEC), enteropathogenic *E. coli* (EPEC), enteroaggregative *E. coli* (EAEC), *E. coli* O157, Shiga-toxin-producing *E. coli*, *Salmonella*, *Shigella*, *Campylobacter*, *C. difficile*, *V. cholerae*, *Y. enterocolitica*, *Giardia*, *E. histolytica*, and *Cryptosporidium*.^{7,31} The culture-independent diagnostic tests (CIDTs) should be performed when there is an outbreak of unknown etiology in healthcare facility. However, culture-dependent diagnostic testing is still necessary for antimicrobial susceptibilities and molecular epidemiology.
- Routine microbiological assessment of food samples and fecal screening of food-handlers may not reduce the risk of outbreaks, because by the times the results are obtained, the food has been served and consumed and hard to recall.

- Most enteric outbreaks are caused by a single agent, but coinfections may occur, especially if the source is sewage contaminated food or water.
- Most nosocomial foodborne pathogens are spread by the fecal-oral route. The primary source of outbreaks may be contaminated food/water, and infected/colonized patient, visitor, staff, or food handler. In addition, contact with infected/colonized animals may also cause enteric diseases e.g., *Campylobacter*, *Salmonella*, *Giardia*, etc., especially in immunocompromised hosts. To minimize potential risks of transmission of pathogens from animals to humans, each healthcare facility with animal programs should have formal policies that effectively communicate to healthcare personnel, patients, and visitors.³²
- Outbreak investigations of nosocomial gastroenteritis are complicated and more than half of illnesses are definitively linked to food.⁶
 1. In some situations, it is not clear whether workers are the cause or the victims of enteric outbreaks. This is because some healthcare workers may deny infection or illness for a variety of reasons.
 2. Transmission of organisms during outbreaks frequently occurs by multiple sources, including person-to-person contact, contaminated environments (fomites), consumption of contaminated food or water, and airborne inhalation.
- Common molecular subtyping for the identification and investigation of outbreaks are pulsed-field gel electrophoresis (PFGE), multilocus variable-number tandem repeat analysis (MLVA), and whole genome sequencing (WGS). Standardized WGS has shown superior sensitivity and specificity and can also efficiently investigate national and international outbreaks.³³

SUGGESTED PRACTICE

- The hospital food service must develop a food safety management system, such as HACCP, that meets food standard requirements, such

as Food Code (US food standards by FDA) a Codex Alimentarius (International Food Standards by FAO/WHO).^{34,35} This should be fully reviewed by certified food safety professionals or local, external inspections. All food should be obtained from approved sources in compliance with Federal, State, and local laws and regulations.

- All food handlers must be aware that high standards of personal hygiene are important. In the hospital setting, food handlers also include nurses or domestic staff who distribute or serve meals. Therefore, these personnel should be educated about foodborne illness, food hygiene, food handling, personal hygiene, and HACCP.
- The infection control (IC) team should be invited to help in the evaluation of the catering contract, teach food handlers about hand hygiene, set up quality measures such as HACCP, and participate in the inspection of hospital food handling areas.
- Each catering company was required to provide a record of the following documents: registration with the local authority; current membership of a trade association; copies of their HACCP documentation; evidence of appropriate training of staff; copies of quantitative microbiological testing; records on maintenance of temperature during transport.
- In high prevalence areas of hepatitis A virus (HAV) infections, vaccination should be considered for all food handlers not immune to HAV. Due to the low incidence of HAV infection and high cost of vaccine, mass immunization for all food service workers in the U.S. is not cost effective, except during epidemics.
- Daily inspections of kitchens and all food handling areas should be carried out by catering, managerial and supervisory staff with the aid of check lists. Full inspections should be carried out twice yearly by the hospital management, catering manager, the infection preventionist, and a member of the estates department.³⁶
- Food handlers who have direct contact to unwrapped food, clean equipment, utensils, and linens should wear clean outer clothing and

wear hair restraints such as hats, hair coverings or nets, beard restraints, and clothing that effectively covers body hair.

- All food handlers shall keep their fingernails trimmed, filed, and maintained so the edges and surfaces are cleanable and not rough.
- Bare hand contact of ready-to-eat foods should be eliminated through the use of gloves, bakery papers and food handling utensils.
- The “touchless or hands free” faucets and paper towel dispensers are preferred to reduce the risk of cross-contamination.
- All food handlers should wash their hands and exposed portions of their arms³⁴:
 1. After touching bare human body parts other than clean hands and clean, exposed portions of arms.
 2. After using the toilet room.
 3. After caring for or handling service animals or aquatic animals.
 4. After coughing, sneezing, using a handkerchief or disposable tissue, using tobacco, eating, or drinking.
 5. After handling soiled equipment or utensils.
 6. During food preparation, as often as necessary to remove soil and contamination and to prevent cross contamination when changing tasks.
 7. When switching between working with raw food and working with ready-to-eat food.
 8. Before donning gloves to initiate a task that involves working with food.
 9. After engaging in other activities that contaminate the hands.
- All food handlers with vomiting, diarrhea, jaundice, sore throat with fever, and infected or draining skin lesions must stop working immediately and report to their manager and to the hospital’s Occupational Health Department.
- Any cuts, wounds, or open sores on the hands and exposed portions of their arms must be completely covered by impermeable bandage. The

lesions on other parts of the body must be covered by a dry, durable, tight-fitting bandage.

- Criteria for the return to work of an infected or colonized food handler with a foodborne pathogen are varied depend on the causative microorganisms and resolution of symptoms and are available in the U.S. FDA Food Code.³⁴
- Pests and flies should be controlled to reduce the risk of food contamination in hospitals.
- Foods containing raw or undercooked eggs, fish, and meat should not be served.
- Food containing unpasteurized milk and fruit juices should not be served.
- Powdered infant formula (PIF) is not a sterile product and can become contaminated during production with bacteria such as *Cronobacter* spp. (formerly *Enterobacter sakazakii*). To reduce the risk of infection, the reconstitution of powdered formula should be undertaken by caregivers using good hygienic measures and in accordance with the guidelines for safe preparation, storage and handling of powdered infant formula.^{37,38}
- For immunocompromised patients who are at increased risk of serious foodborne illness, including organ transplant patients and cancer patients undergoing chemotherapy (neutropenia), a low microbial diet (LMD) has been advised. The basis of the LMD is to avoid raw or undercooked meat/eggs, non-pasteurized milk products, unroasted raw nuts, delicatessen food, pepper, and raw and non-freshly prepared fruits or vegetables. A LMD is recommended for 3 months after autologous hematopoietic cell transplant (HCT) and allogeneic HCT recipients should remain on this diet until all immunosuppressive drugs are discontinued.³⁹ Hematopoietic stem cell transplantation (HSCT) recipients should also avoid contact with animal feces to reduce the risk for toxoplasmosis, cryptosporidiosis, salmonellosis, and campylobacteriosis.

- For the control of foodborne infections in the hospital, it is necessary to⁴⁰:
 1. Optimize and standardize methods for the detection of foodborne pathogens.
 2. Develop rapid surveillance networks to detect and report outbreaks at an early stage.
 3. Emphasize the importance of food safety quality control and management systems.
 4. Heighten awareness about the presence and spread of these organisms by food handlers and promote the good hygienic practices.
 - Early case identification of foodborne illnesses can prevent further transmissions. Through early detection, the identification and removal of contaminated products from the commercial market can be expedited.
 - Physicians should promptly report hospitalized cases of enteric infections to the IC team and to the appropriate public health authorities. In addition, physicians and other healthcare professionals can help prevent and control foodborne diseases by educating their patients about the risks of foodborne illness, and providing sound advice on safe food-handling and consumption practices.
 - Once an outbreak of nosocomial gastroenteritis is suspected, infection control measures should be instituted immediately, prior to the results of confirmatory tests. The three most important actions during an outbreak are:
 1. Effective hand hygiene with soap and drying with hand towels.
 2. Isolation of affected patients, restriction of movement of staff, patients and visitors and exclusion of affected staff.
 3. Enhanced cleaning of the environment and equipment with appropriate disinfectants, such as sodium hypochlorite at 5000 ppm (1:10 dilution of household bleach) for suspected norovirus or *C. difficile* outbreaks.²²

SUGGESTED PRACTICE IN UNDER-RESOURCED SETTINGS

- Water may be the possible source of microbial contamination. In healthcare setting, water used at each step of food preparation and production should be drinkable (drinking water quality).
- The types of food served in healthcare settings should be selected to minimize the risk of foodborne disease in vulnerable patients. Fresh vegetables have been implicated as vehicles for foodborne pathogens as these products are typically sold to the consumer in ready-to-eat form, do not generally contain preservatives, and rarely undergo any heat processing prior to consumption. Uncooked vegetables may not be served in some healthcare facilities that have vulnerable population, including elderly and immunocompromised hosts.
- Without adequate temperature control after cooking, food shall be thoroughly cooked to the right internal temperature for the proper amount of time and transported to patients as quickly as possible. Discard any perishable food left out at the “danger zone” (temperature between 4 C to 60 C/39 F to 140 F) for more than 2 hours from the point in time when the food is removed from temperature control (1 hour if the temperature is above 32 C/90 F).⁴¹
- Families and friends should be discouraged from bringing in unsafe food.

SUMMARY

- Hospital acquired enteric outbreaks, although rare, have been reported.
- Incorporation of HACCP principles at every stage of food handling is crucial for ensuring food safety.
- Food processors, manufacturers, wholesalers, retail outlets, and restaurants play a key role in maintaining the safety of food products and food ingredients.

- Strict implementation of temperature control and hygienic measures is the most important preventive measure in the hospital setting.
- Effective hand washing with soap and water before and after the handling of all foodstuffs is critical for infection control.
- To reduce the fecal oral transmission of gastrointestinal pathogens from the contaminated hospital environment, patients and their families should be educated on proper personal hygiene and sanitation.

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