Risk of Cholera Transmission by Foods

A variety of foods have been implicated as vehicles for the causal agent of cholera, *Vibrio cholerae*. Depending on the type of food, contamination can occur prior to harvesting or during handling and preparation. The viability of the organisms in food is influenced by environmental conditions and handling, and these factors, along with the varying likelihood of contamination, determine the extent of the health threat posed by foodborne cholera infection.

FACTORS AFFECTING VIBRIO SURVIVAL

Temperature. *V. cholerae* grows optimally between 32° and 35°C, although it can grow at temperatures ranging from 0° to 40°C, and can survive at even greater extremes. The organisms remain viable longer under refrigeration than at tropical room temperatures. The effects of freezing on the survival of *V. cholerae* appear to depend upon the temperature used; more of the organisms are damaged or killed when frozen at −2° to −10°C than at −30°C (*1, 2*). The temperatures to which food is normally reheated do not destroy *V. cholerae*. Experiments have shown that the microorganism remains viable in cooked foods that were contaminated after preparation and reheated at up to 60°C (*3, 4*).

pH. *V. cholerae* is most favored by an alkaline environment (pH 8.5–9.0), and it can survive at a pH of 10. However, it is very vulnerable to acid pH conditions.

Washing. Surface contamination is effectively removed by scrubbing with soap and water, when the food's size and shape permit such handling. In addition, immersion of food for 30 seconds in boiling water invariably kills all vibrios on the surface.

Time. Length of survival of the vibrios has been studied in artificially contaminated foods and beverages. At room temperature, the organisms survive only a short time in acidic foods such as citrus fruits and tomatoes (e.g., one hour in lemons, one day in tomatoes), and likewise have a short life (one to two days) in dried fruits and powdered spices (*5*). However, they were viable up to a week at room temperature on fruits and vegetables that remained moist (*6*). Maximum survival time in refrigeration on raw and uncut vegetables and fruits was two weeks, but it was longer in some sliced or cooked fruits and vegetables (*7*).

Given the proper conditions of pH and temperature, *V. cholerae* survives longer in water than in foods. In sea water it can remain viable 10 to 13 days at ambient temperatures and up to 60 days in refrigeration. In bottled water *V. cholerae*, biotype El Tor, was found to survive 1 to 19 days (*8*).

SOURCES OF CONTAMINATION AND RISKS OF TRANSMISSION

Foods Other than Fishery Products

Vegetables and fruits grown at soil level (such as melons) may be contaminated if irrigated with water containing *V. cholerae*, and any produce may become contaminated in handling. In practice, however, patients in the acute phase of the disease who are excreting numerous

Source: Pan American Health Organization, Veterinary Public Health Program. Risks of transmission of cholera by food. Washington, DC: March 1991. (Mimeographed document).

vibrios are unlikely to remain at work on farms or in food-production industries, nor is it likely that fruits and vegetables would come into contact with their feces during packing or shipping. Also, most consumers clean the surface of food, especially when there is visible dirt. Thus, the danger of infection from produce may not be as great as it would appear from the results of the experimental studies cited above.

Theoretically, fresh produce poses a risk of cholera transmission if eaten raw and unwashed or allowed to cross-contaminate other foods. Fruit concentrates and pulps with a pH of less than 4.5, as well as pickled foods, pose no risk of cholera transmission. Canned foods will be free of *V. cholerae* provided they were processed and handled according to the relevant Codex Alimentarius standards (*9*). Thoroughly dried foods do not contain *V. cholerae*.

Implications for International Trade

The chance that food exports will cause transmission of cholera appears more theoretical than real. In practice, they should pose no risk if at least 10 days have elapsed between shipping and marketing in the importing country. Cholera is endemic in many food exporting countries; nevertheless, the World Health Organization has no documented evidence of a cholera outbreak occurring as a result of the passage of food across international borders. This finding, as well as the results of experimental studies, points to the conclusion that excessive restriction on imported foods from cholera-infected or endemic countries is unwarranted.

Fishery Products

Substantial evidence points to the existence of an aquatic reservoir of *V. cholerae* and related species. These organisms have been found in surface waters not known to be fecally contaminated and in areas where no human infection has been recorded, including brackish and estuarine environments (*10–12*). Although the organism may be present naturally in the marine environment, the small number of seafood-linked cases in nonendemic areas (for example, on the Gulf of Mexico coast in the United States) suggests that most of the naturally occurring strains lack the necessary virulence to cause human disease (*13*). Of greater concern is *V. cholerae* contamination stemming from human pollution of coastal waters from which seafood is harvested or of the water supply used in its processing.

Cholera has been linked to consumption of numerous types of fishery products (*14–16*), including crustaceans (shrimp, crab, lobster), shellfish (oysters, clams, mussels, scallops, abalone), and finfish. Crustaceans and molluscs are more likely to harbor *V. cholerae* than finfish, and deep-sea fish are unlikely to have been infected in their habitat, but they may become contaminated during handling.

The consumption of fresh raw fishery products poses the greatest risk, although the potential for disease transmission also exists with frozen, iced, or refrigerated seafood. Since freezing does not kill the organisms effectively, previously frozen seafood still poses a risk if eaten raw or allowed to cross-contaminate other foods.

Because *V. cholerae* can contaminate marine animals *in situ*, it must be destroyed in the preparation of the food. Proper cooking is essential. For example, studies by the U.S. Centers for Disease Control indicated that large whole crabs must be boiled at least 8 minutes or steamed at least 25 minutes to kill all the vibrios (*17*).

Recommendations

A number of steps can be taken to improve the safety of raw molluscan shellfish and seafood. Most fundamental is that sewage must be properly treated and disposed of to avoid contamination of harvest areas by human enteric pathogens. Effective enforcement needs to be maintained to prevent harvesting of shellfish from areas known to be sewage-contaminated. Monitoring programs must be established for *Vibrio* species in molluscan shellfish growing areas, especially during warm months. National standards should be established for seafood quality and safety; appropriate laboratory and inspection systems, as well as trained personnel, will be needed to monitor compliance with those standards as they apply to all facets of the industry (harvesting, processing, transportation, and storage). Export and import procedures must include inspection and analysis of safety and quality. The importation of shellfish for raw consumption should be prohibited unless there is clear equivalence of standards for harvest waters and for postharvest processing.

Information regarding the safe handling of seafood should be widely disseminated, and consumers should be made aware of the risks of consuming raw fish or shellfish. Thorough cooking of all seafood would eliminate microbiological pathogens.

Street Foods

The sale of foods in public places, including the streets, is a traditional practice in many developing countries. In the last decade, this activity has increasingly provided much-needed employment in Latin American cities. Although street food has some advantages (it is inexpensive, frequently nutritious, and tasty), it also carries the important disadvantage of possible microbial contamination associated with deficient hygiene of the vendors, use of inappropriate utensils, lack of potable water or nearby sanitary facilities, and accumulation of trash.

A group of expert consultants working with the United Nations Food and Agriculture Organization met in Indonesia in December 1988 to discuss this issue. The group recognized the socioeconomic and nutritional significance of foods sold on the streets, as well as the potential public health problems. It recommended that national authorities adopt measures necessary to support this industry and initiate activities to improve it through training, in order to integrate street vendors as participants in the urban food supply system (*18*). An educational program for vendors and consumers was called for, as well as licensing and sanitary inspections. However, the overall problems of environmental sanitation, water supply, waste disposal, and availability of sanitary services must be addressed in order to eliminate the disease risks, including that of cholera, associated with sale of foods by street vendors (*19*).

CONCLUSIONS

Since food can be a vehicle for cholera transmission, the World Health Organization recommends some simple measures that should be taken by the consumer to avoid acquisition of the disease (*20*). These include washing and cleaning foods thoroughly, especially foods to be eaten raw; cooking food until it is thoroughly hot and eating it while it remains hot; washing and completely drying all cooking and serving utensils after use; washing hands thoroughly with soap after defecation and before preparing and eating food; and covering prepared food to avoid contact with flies.

The risk of transmission of cholera by

foods requires that government authorities and the food industry cooperate to eliminate or control this risk. Food that is susceptible to contamination with *Vibrio cholerae* should be produced and handled according to strict sanitation and environmental health standards. Technical services, including laboratories and inspection systems, should be strengthened to assure food safety. Education of food handlers and consumers is critical to ensuring that foods are safe and wholesome. Appropriate attention to this problem will assist in promoting public health and the economic development of the food industry in developing countries.

REFERENCES

1. Miyaki K, Iwahara S, Sato K, Fujimoto S, Aibara K. Basic studies on the viability of El Tor vibrios. *Bull WHO*. 1967;37:773.
2. Reily LA, Hackney CR. Survival of *Vibrio cholerae* during cold storage in artificially contaminated seafoods. *J Food Sci*. 1985;50:838.
3. Guthrie RK, Makukutu CA, Gibson RW. Recovery of *Vibrio cholerae* 01 after heating and/or cooling. *Dairy Food Sanit*. 1985;5:427.
4. Makukutu CA, Guthrie RK. Behavior of *Vibrio cholerae* in hot foods. *Appl Environ Microbiol*. 1986;52:824.
5. Concon JM. Chapter 15: Bacterial contaminants—foodborne infections. In: *Food toxicology—part B, contaminants and additives*. New York: Marcel Dekker; 1988:889.
6. Prescott LM, Bhattacharjee NK. Viability of El Tor vibrios in common foodstuffs found in an endemic cholera area. *Bull WHO*. 1969;40:980.
7. Felsenfeld O. Notes on food, beverages and fomites contaminated with *Vibrio cholerae*. *Bull WHO*. 1965:33;725.
8. Hugues J, Boyce J, Levine R. Epidemiology of cholera in rural Bangladesh: importance of surface water in transmission. *Bull WHO*. 1982;60:395.
9. World Health Organization. Small risk of cholera transmission by food imports. *Wkly Epidemiol Rec*. 1991;66:55.
10. Colwell RR, Kaper J, Joseph SW. *Vibrio cholerae, Vibrio parahaemolyticus*, and other vibrios: occurrence and distribution in Chesapeake Bay. *Science*. 1977;198:394.
11. Colwell RR, Seidler RJ, Kaper J, et al. Occurrence of *Vibrio cholerae* serotype 01 in Maryland and Louisiana estuaries. *Appl Environ Microbiol*. 1981;41:555.
12. Garay E, Arnau A, Amaro C. Incidence of *Vibrio cholerae* and related vibrios in a coastal lagoon and seawater influenced by lake discharges along an annual cycle. *Appl Environ Microbiol*. 1985;50:426.
13. Morris JG Jr, Takeda T, Tall BD, et al. Experimental non-0 group 1 *Vibrio cholerae* gastroenteritis in humans. *J Clin Invest*. 1990;85:697.
14. Blake PA. Vibrios on the half shell: what the Walrus and the Carpenter didn't know. *Ann Intern Med*. 1983;99:558.
15. Lowry PW, Pavia AT, McFarland LM, et al. Cholera in Louisiana: widening spectrum of seafood vehicles. *Arch Intern Med*. 1989;149:2079.
16. Pavia AT, Campbell JF, Blake PA, Smith JD, McKinley TW, Martin DL. Cholera from raw oysters shipped interstate. *JAMA*. 1987;258:2374.
17. Blake PA, Allegra DT, Snyder JD, et al. Cholera—a possible endemic focus in the United States. *N Engl J Med*. 1980;302:305.
18. Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). *Capacitación de vendedores callejeros de alimentos: guía didáctica*. Santiago, Chile: FAO; 1990.
19. Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). *Venta callejera de alimentos: un resumen de estudios de la FAO y otras actividades relacionadas con la venta callejera de alimentos*. Santiago, Chile: FAO; 1990.
20. World Health Organization. *Guidelines for cholera control*. Geneva: WHO; 1991. (WHO/CDD/SER/80.4 Rev. 2).