Pediatr Infect Dis J, 2002;21:623–8
Vol. 21, No. 7

Foodborne disease outbreaks in United States schools

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Background. **The objective of this study was to describe the epidemiology of foodborne disease outbreaks in schools and to identify where preventive measures could be targeted.**

Methods. **Reports by state and local health departments of foodborne disease outbreaks occurring in primary and secondary schools, colleges and universities from January 1, 1973, through December 31, 1997, were reviewed. Data from ill persons identified through foodborne outbreak investigations and subsequently reported to the Centers for Disease Control and Prevention in the Foodborne Outbreak Surveillance System were examined. The number and size of foodborne disease outbreaks, as well as the etiologic agents, food vehicles of transmission, site of food preparation and contributing factors associated with outbreaks were also examined.**

Results. **From 1973 through 1997, states and local health departments reported 604 outbreaks of foodborne disease in schools. The median number of school outbreaks annually was 25 (range, 9 to 44). In 60% of the outbreaks an etiology was not determined, and in 45% a specific food vehicle of transmission was not determined. *Salmonella* was the most commonly identified pathogen, accounting for 36% of outbreak reports with a known etiology. Specific food vehicles of transmission were epidemiologically identified in 333 (55%) of the 604 outbreaks. The most commonly implicated vehicles were foods containing poultry (18.6%), salads (6.0%), Mexican-style food (6.0%), beef (5.7%) and dairy products excluding ice cream (5.0%). The most commonly reported food preparation practices that contributed to these school-related outbreaks were improper food storage and holding temperatures and food contaminated by a food handler.**

Conclusions. **Strengthening food safety measures in schools would better protect students and school staff from outbreaks of foodborne illness. Infection control policies, such as training and certification of food handlers in the proper storage and cooking of foods, meticulous hand washing and paid sick leave for food handlers with gastroenteritis, could make meals safer for American students.**

INTRODUCTION

Each weekday millions of American students eat meals prepared and served at school.[1–3] In fiscal year 2000 >27.4 million children each day got their lunch through the National School Lunch Program.[4] Although numerous foodborne disease outbreaks in schools have been reported,[5–11] the extent of these outbreaks has not been systematically described. To better define the epidemiology of these outbreaks and thus identify areas where prevention might be improved, we reviewed data on outbreaks of foodborne disease in schools reported to the CDC from 1973 through 1997. A summary of foodborne disease outbreaks was published for years 1993 through 1997.[12] The present report summarizes data for foodborne disease outbreaks in schools reported to CDC from 1973 through 1997 and describes trends in pathogens and food vehicles that emerged during the 25-year period.

METHODS

Since 1973 CDC has maintained a collaborative, passive surveillance program for collection and reporting of data on foodborne disease outbreaks investigated by health departments. For surveillance purposes a foodborne outbreak is defined as two or more cases of similar illness resulting from the ingestion of a com-

Accepted for publication Feb. 25, 2002.
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DOI: 10.1097/01.inf.0000019885.31694.9e

mon food. Before 1992 three exceptions existed to this definition: only one case of botulism, chemical or marine toxin intoxication was required to constitute a foodborne disease outbreak; but since 1992 two or more cases have been required. Outbreaks are voluntarily reported to CDC on a standard reporting form filled out by state or local health departments after completion of an outbreak investigation. Foodborne disease outbreak reports include data on numbers of persons who were ill, were hospitalized and died. They also include data on symptoms, incubation period, duration of illness, implicated food vehicles, setting or location of the outbreak and pathogens confirmed by laboratory tests. Food preparation and handling practices thought to have contributed to the outbreak are also reported. Outbreaks of known etiology were those for which laboratory evidence of a specific agent was obtained. Outbreaks of unknown etiology were those for which epidemiologic evidence implicated foodborne transmission, but there was insufficient information to determine the etiologic agent. Outbreaks with known vehicle refer to those in which a specific food item was epidemiologically associated with illness.

We reviewed the number and size of foodborne disease outbreaks occurring in primary and secondary schools, colleges and universities between January 1, 1973, and December 31, 1997, and approved by the CDC by January 1, 2000. The etiologic agents, food vehicles of transmission, site of food preparation and contributing factors associated with outbreaks were reviewed. An epidemiologist or statistician at CDC reviewed each foodborne disease report.

RESULTS

Number and size of outbreaks. From 1973 through 1997, the median number of annual outbreaks was 25 (range, 9 to 44; Fig. 1), and the median number of ill persons per reported outbreak was 42 (range, 1 to 1000). In total, outbreaks in schools resulted in 49 963 illnesses, 1514 hospitalizations and 1 death. An etiologic agent was reported for 240 (40%) of the 604 outbreaks (Table 1). Of those outbreaks with a known etiology, bacterial pathogens caused the largest percentage of outbreaks (85%) and of ill persons (93%), followed by chemical agents (7% of outbreaks), viral agents (6% of outbreaks) and parasitic pathogens (1% of outbreaks).

Etiologic agents. Among outbreaks with a known etiology, *Salmonella* was the most commonly identified pathogen, accounting for 87 (36%) of 242 outbreaks, 7529 (37%) of 20 476 illnesses and 484 (48%) of 998 hospitalizations. The serotype was not determined in 6 *Salmonella* outbreaks, and multiple serotypes were identified in 4. Among the remaining 77 outbreaks in which a single serotype was reported, 38 (49%) were caused by *Salmonella* serotype Enteritidis and 21

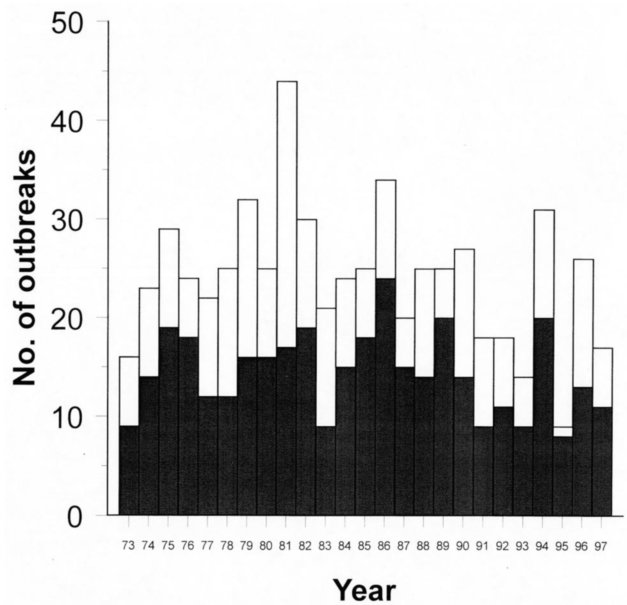

FIG. 1. Number of foodborne disease outbreaks with known and unknown etiology in US schools by year, 1973 through 1997. ■, unknown etiology; □ known etiology.

(27%) by *Salmonella* serotype Typhimurium. *Salmonella* serotype Enteritidis accounted for 153 (32%) of 484 hospitalizations for salmonellosis, more than any other serotype. Six (43%) of the 14 *Salmonella* serotype Enteritidis outbreaks in which 1 vehicle was identified were associated with consumption of eggs or egg-containing foods, whereas 4 (29%) were associated with poultry.

Sixty outbreaks (25% of outbreaks with a known cause) were caused by enterotoxin produced by *Staphylococcus aureus*. Overall staphylococcal food poisoning resulted in 6591 illnesses and 319 hospitalizations. Meat or poultry was implicated in 32 (87%) of the 37 staphylococcal outbreaks in which a single vehicle was identified. Enterotoxin made by *Clostridium perfringens* caused 25 outbreaks (11% of outbreaks with a known cause), 2165 illnesses and no hospitalizations.

Other bacterial causes of >1 outbreak included *Shigella* species (nine outbreaks), *Campylobacter* species (eight outbreaks), *Bacillus cereus* (six outbreaks), *Escherichia coli* O157:H7 (five outbreaks) and group A *Streptococcus* (two outbreaks). Bacteria causing a single outbreak each were *Vibrio parahaemolyticus* and *Yersinia entercolitica,* which had the highest case hospitalization rate (CHR) of 17.5%. The 5 outbreaks due to *E. coli* O157:H7 caused illness in 156 persons and 14 hospitalizations, yielding a CHR of 9%.

Fourteen outbreaks were reportedly caused by viruses. Among these hepatitis A caused 9 outbreaks, 232 illnesses and 12 hospitalizations for a CHR of 5.2%. Norwalk-like viruses accounted for the remaining 5 viral outbreaks, affecting a total of 804 persons and

TABLE 1. Foodborne disease outbreaks in schools, by etiologic agent, United States, 1973 through 1997

Agent	No. of Outbreaks			No. Ill	No. Hospitalized	Hospitalization Rate/100 Illnesses
	Total	1973–1989	1990–1997			
Bacterial						
Salmonella (all)	87 (14.4)*	62	25	7529 (15.1)	484 (32.0)	6.4
Enteritidis	38 (6.3)	23	15	2197 (4.4)	153 (10.1)	6.9
Typhimurium	21 (3.5)	20	1	1650 (3.3)	128 (8.4)	7.8
Heidelberg	6 (1.0)	3	3	814 (1.6)	26 (1.7)	3.2
Reading	3 (0.5)	2	1	714 (1.4)	76 (5.0)	10.6
Newport	2 (0.3)	2	0	295 (0.6)	2 (0.1)	0.7
Agona	1 (0.2)	1	0	303 (0.6)	27 (1.8)	8.9
Montevideo	1 (0.2)	0	1	13 (0.03)	1 (0.06)	7.7
Staphylococcus aureus	60 (9.9)	48	12	6591 (13.2)	319 (21.1)	4.8
Clostridium perfringens	25 (4.1)	16	9	2165 (4.3)	0	0
Shigella	9 (1.5)	6	3	1040 (2.1)	82 (5.4)	7.9
Campylobacter	8 (1.3)	5	3	279 (0.6)	4 (0.3)	1.4
Bacillus cereus	6 (1.0)	5	1	390 (0.8)	4 (0.3)	1.0
Escherichia coli O157:H7	5 (0.8)	2	3	156 (0.3)	14 (0.9)	9.0
Streptococcus group A	2 (0.3)	1	1	337 (0.7)	0	0
Streptococcus	2 (0.3)	2	0	119 (0.2)	4 (0.3)	3.4
Vibrio parahaemolyticus	1 (0.2)	1	0	8 (0.0)	—	—
Yersinia entercolitica	1 (0.2)	1	0	286 (0.6)	50 (3.3)	17.5
Other bacteria	1 (0.2)	1	0	37 (0.1)	0	0
Viral						
Hepatitis A	9 (1.5)	5	4	232 (0.5)	12 (0.8)	5.2
Norwalk-like virus	5 (0.8)	2	3	804 (1.6)	2 (0.1)	0.2
Chemical						
Chemical (non-heavy metal)	8 (1.3)	7	1	98 (0.2)	4 (0.3)	4.1
Heavy metals	7 (1.2)	7	0	326 (0.7)	16 (1.1)	4.9
Parasitic						
Giardia lamblia	2 (0.3)	2	0	71 (0.1)	1 (0.1)	1.4
Other						
Mushroom poisoning	1 (0.2)	1	0	2 (0.0)	0	0
Scombroid	1 (0.2)	1	0	6 (0.0)	6 (0.4)	100
Unknown etiology	364 (60.3)	269	95	29 487 (59.0)	516 (34.1)	1.7
Total	604 (100.0)	444	160	49 963 (100.0)	1514 (100.0)	3.0

* Numbers in parentheses, percent.

resulting in 2 hospitalizations (CHR of 0.2%). Other causes of outbreaks included *Giardia lamblia* (2 outbreaks and 71 illnesses), heavy metals (7 outbreaks and 326 illnesses), other chemicals (8 outbreaks and 98 illnesses), scombroid fish poisoning and mushroom poisoning (1 outbreak each).

Of 364 outbreaks of undetermined etiology, data on both symptoms and duration of illness were available for 155. The symptoms included abdominal cramps in 60% of outbreaks, vomiting (56%), diarrhea (52%) and headache (19%). Forty (26%) of the 155 outbreaks of undetermined etiology were characterized by vomiting in at least 50% of cases, duration of illness of 12 to 60 h for the majority of ill persons and an incubation period of 24 to 48 h, suggesting infection caused by Norwalk-like viruses. Nineteen (12%) other outbreaks of undetermined etiology were possibly caused by staphylococcal enterotoxin or *B. cereus* emetic toxin because they had estimated incubation periods of 6 h or less and vomiting in at least 80% of cases.

Food vehicles. Specific food vehicles of transmission were epidemiologically implicated in 333 (55%) of the 604 outbreaks. Multiple food items were statistically linked to illness in 115 (34.5%) of these outbreaks with a known vehicle. In many of these outbreaks, illness may have been cause by a single item, but this item could not be singled out because most ill persons ate many of the same foods. For the 7 Salmonella serotype Enteritidis outbreaks with multiple vehicles, 4 of the 7 were associated with egg- or poultry-containing foods (e.g. Monte Cristo sandwiches, bernaise sauce and turkey salad). For the *S. aureus* outbreaks with multiple vehicles, 9 did not have food types specified, 4 involved pasta dishes (1 with a meat sauce) and 2 others involved canned meat.

Overall the most frequently implicated single vehicles were foods containing poultry (18.6%), salads (6.0%), Mexican-style food (6.0%), beef (5.7%) and dairy products excluding ice cream (5.0%) (Table 2). The dairy products category includes milk, cheese and unspecified dairy products. Seventy percent of the poultry-related outbreaks were attributed to turkey. Turkey-associated outbreaks have become less common, however, given that only 2 (5%) of 38 turkey-associated outbreaks occurred during the years 1990 through 1997. Outbreaks caused by contaminated dairy prod-

TABLE 2. Number of school foodborne disease outbreaks and cases with known vehicle, by food vehicle, 1973 through 1997

Vehicle	No. of Outbreaks Total	Cases
Multiple vehicles	115	13 865
Turkey	38	4432
Mexican-style food	20	17
Other salad*	20	2095
Beef	19	1543
Poultry, fish or egg salad	17	2784
Ham	13	791
Chicken	12	990
Milk	11	1660
Baked foods	10	146
Fruits and vegetables	9	689
Ice cream	8	285
Nondairy beverages	8	399
Unknown meat	8	1210
Potato salad	5	224
Cheese	4	184
Fish	4	100
Eggs	4	195
Pork	2	284
Shellfish	2	36
Carbonated drinks	1	12
Chinese-style food	1	6
Mushrooms	1	2
Unknown dairy	1	22
Total	333	33 738

* Salads not including poultry, fish, egg or potato.

ucts have also become less common, with only 2 (10%) of the 21 dairy-associated outbreaks occurring after 1990. Conversely outbreaks caused by salads have increased considerably.

Site of preparation and contributing factors. The site of food preparation was indicated for 597 outbreaks: in 460 (77%) foods were prepared on school premises; in 42 (8%) foods were prepared at a private home; in 29 (5%) foods were prepared by a caterer; and in 22 (4%) foods were prepared at a restaurant. The remaining 37 outbreaks were attributed to foods prepared in dormitories, fraternities, dairies and a wide variety of other settings. The most commonly reported food preparation practices that the local investigator thought may have contributed to these school-related outbreaks were improper storage and holding temperatures in 234 (81%) of 290 outbreaks, likely contamination by a food handler in 115 (57%) of 203 outbreaks, inadequate cooking in 86 (43%) of 202 outbreaks, contaminated equipment in 58 (35%) of 165 outbreaks and food obtained from unsafe sources in 20 (11%) of 176 outbreaks.

DISCUSSION

Between 1973 and 1997, >600 foodborne disease outbreaks in schools were reported to CDC. These outbreaks resulted in nearly 50 000 illnesses, >1500 hospitalizations and 1 death. This represents ~5% of all foodborne disease outbreaks and 12% of all outbreak-associated cases reported to CDC. The three most commonly identified etiologic agents were *Salmonella, S. aureus* and *C. perfringens.* The percentage of outbreaks of known etiology due to *Salmonella* serotype Enteritidis increased over the surveillance period, whereas the percentage caused by *S. aureus* decreased. Other notable trends include an 8-fold decrease in the percentage of outbreaks due to turkey, a 3-fold increase in outbreaks linked to salads and a decline in the number of milk-associated outbreaks. Whether these changes reflect variation in the relative safety of these items, a change in dietary habits or both cannot be determined with certainty from these data. Nevertheless some of the changes may be attributed to fewer tours of milk dairies and raw milk tastings and a large increase in the number of salads consumed.

The majority of outbreaks with known vehicles were caused by foods prepared on school premises. Therefore prevention efforts should focus on school-based interventions. Practices identified as contributing to outbreaks in schools include improper refrigeration, prolonged handling and inadequate reheating of cooked foods.[7] Following established food safety guidelines on food preparation, handling, storage and service can greatly reduce the risk of foodborne disease outbreaks.[13–15] All meat and poultry should be thoroughly cooked, cooked foods not used immediately should be rapidly chilled to refrigeration temperature (<40°F) and cross-contamination of cooked foods with raw foods should be avoided. Because shell eggs are an important vehicle for *Salmonella* serotype Enteritidis,[16] it is particularly important that shell eggs be thoroughly cooked (>160°F), that the temperature of egg-containing products be carefully monitored and that devices used to mix or prepare raw eggs be regularly disassembled, cleaned and sanitized. Pasteurized eggs should be used for all meals requiring large quantities of pooled eggs and are the best choice for all recipes containing eggs.

Several outbreaks in schools have been attributed to contamination of food by food-handlers who worked while ill[6, 11] or had poor personal hygiene.[17, 18] In our review of reported foodborne outbreaks in school, 57% of outbreaks were attributed to likely contamination by a food-handler. The adoption of a work policy that includes paid leave for food handlers with gastroenteritis would probably increase compliance with illness-related work exclusion policies. Training and certifying all food handlers in school cafeterias in specific techniques, such as good personal hygiene, adequate hand washing, proper cooling and reheating of foods and methods of preventing cross-contamination between cooked and raw foods, would also likely reduce the incidence of foodborne disease outbreaks.[19]

In addition to promoting proper food handling and hygiene practices among school employees, it is important that schools purchase foodstuffs that have been produced safely. Purchase contracts for meat, poultry and eggs often have not stipulated food safety criteria.[20] Requiring such foods to be produced under Hazard Analysis and Critical Control Point (HACCP) or egg quality assurance plans that meet microbiologic performance requirements would be an important addition to school food safety. During school year 2000 the US Department of Agriculture (USDA), which annually purchases >100 million pounds of beef products for the National School Lunch Program and other federal food and nutrition programs, began requiring that ground beef purchased through the program test negative for both *E. coli* O157:H7 and *Salmonella*.[21] However, USDA directly provides only a small percentage of food served in schools. School food authorities purchase 83% of the food served in school lunch programs and all of the food served in school breakfast programs.[20] Additional efforts to assure the purchase of safe food stuffs may be an important step, although the extent to which this would increase the risk of foodborne outbreaks in schools is not clear. Recent US declines in *Salmonella* and *Campylobacter* are credited to the mandated HACCP rule for meat and poultry. The changes in incidence of foodborne infections have occurred in the context of the introduction of the HACCP regulations for meat and poultry in processing plants, increased attention to egg and fresh produce safety, industry efforts, food safety education, increased regulation of imported food and other prevention measures.[22]

The risk of outbreaks caused by bacterial and parasitic pathogens could be further reduced through the broader application of irradiation pasteurization of solid foods using low-dose gamma rays, radiographs or electron beams.[23–25] Although widespread use of this technology has been hampered by the perception of consumer concerns,[26] the use of irradiation to pasteurize food has been endorsed by the World Health Organization, the US Department of Health and Human Services, the USDA, the American Medical Association and the American Public Health Association.[26–29] Irradiation pasteurization of meat and poultry used in schools would be an important further step in reducing outbreaks caused by to bacterial pathogens such as *E. coli* O157:H7 and *Salmonella*. Because viral foodborne pathogens such as hepatitis A and Norwalk-like viruses are more radioresistant, irradiation pasteurization is less likely to prevent outbreaks due to these pathogens.

The limitations of our report should be recognized. The number of foodborne outbreaks reported by this passive surveillance system represents only a small proportion of those that occur. Foodborne outbreaks caused by an etiologic agent with a short incubation period (e.g. bacterial toxins) are more likely to be recognized as common source outbreaks than are diseases with longer incubation periods (e.g. hepatitis A). Furthermore our report likely underestimates the proportion of viral gastroenteritis outbreaks in schools, because stool and serum testing of specimens for viral pathogens (e.g. Norwalk-like viruses) is not widely available, making confirmation of these outbreaks more difficult. Outbreaks caused by organisms that are not routinely screened for by laboratories or that require special media for detection, such as *E. coli* O157:H7, Norwalk-like viruses, *Vibrio* species, *Yersinia*, *C. perfringens* and *Campylobacter* may be underrepresented. In addition testing of some organisms (e.g. *E. coli* O157:H7, Norwalk-like viruses, enzyme immunoassay for *Giardia* and toxin testing) became available during the course of the time period covered in this review. Information on the size and other characteristics of affected schools was not available. Other limitations include lack of information about how factors contributing to outbreak were determined and lack of information on the specific school setting (e.g. elementary school, high school or university). A recently published primer directed to primary care physicians, who are more likely to see the index case of a potential food-related disease outbreak, is a teaching tool for primary care physicians about foodborne illness and to remind them of their important role in recognizing suspicious symptoms, disease clusters and etiologic agents and reporting cases of foodborne illness to public health authorities.[30]

Relative to the number of meals served in America's schools, the number of reported outbreaks of foodborne illness may appear relatively small. Nevertheless the cumulative disease burden on this vulnerable population is considerable. Adequate training of school staff and the integration of food safety criteria into purchase contracts are measures that can be immediately employed to reduce the burden of foodborne disease among school children. Investigations of foodborne disease outbreaks in schools and continued outbreak surveillance are needed to identify trends in disease frequency, to detect the emergence of new causes of foodborne illness and to ensure the highest standards of food safety for school children in America.

Foodborne disease websites: *www.cdc.gov/foodnet, www.foodsafety.gov, www.cfsan.fda.gov, www.cdc.gov/ncidod/dbmd/diseaseinfo/foodborneinfections* and *http://www.cdc.gov/ncidod/dbmd/outbreak/default-.htm.*

ACKNOWLEDGMENTS

We thank the State Epidemiologists, Public Health Laboratory Directors and other federal, state and local health department personnel for their active role in foodborne disease outbreak surveillance.

REFERENCES

1. Macdonald DI. The school lunch program: its past, its problems, its promise. J Fla Med Assoc 1987;66:449–53.

2. Martin J. The national school lunch program: a continuing commitment. J Am Diet Assoc 1996;96:857–8.
3. Burghardt JA, Gordon AR, Fraker TM. Meals offered in the national school lunch program and school breakfast program. Am J Clin Nutr 1995;61(Suppl):187S–198S.
4. US Department of Agriculture, Food and Nutrition Service Public Information. School lunch fact sheet, February 1, 2002. Available at: *http://www.fns.usda.gov/cnd/Lunch/AboutLunch/faqs.htm*. Accessed February 20, 2002.
5. Hutin YJ, Pool V, Cramer EH, et al. A multistate, foodborne outbreak of hepatitis A. N Engl J Med 1999;340:595–602.
6. Guest C, Spitalny KC, Madore HP, et al. Foodborne Snow Mountain agent gastroenteritis in a school cafeteria. Pediatrics 1987;79:559–63.
7. Richards MS, Rittman M, Gilbert TT, et al. Investigation of a staphylococcal food poisoning outbreak in a centralized school lunch program. Public Health Rep 1993;108:765–71.
8. Martin DL, Gustafson TL, Pelosi JW, Suarez L, Pierce GV. Contaminated produce: a common source for two outbreaks of *Shigella* gastroenteritis. Am J Epidemiol 1986;124:299–305.
9. Centers for Disease Control and Prevention. Outbreaks of gastrointestinal illness of unknown etiology associated with eating burritos: United States, October 1997–October 1998. MMWR 1999;48:210–13.
10. Centers for Disease Control. Turkey-associated salmonellosis at an elementary school: Georgia. MMWR 1985;34:707–8.
11. Quiroz ES, Bern C, MacArthur JR, et al. An outbreak of cryptosporidiosis linked to a foodhandler. J Infect Dis 2000; 181:695–700.
12. Olsen SJ, MacKinnon LC, Goulding JS, Bean NH, Slutsker L. Surveillance for foodborne disease outbreaks: United States, 1993–1997. MMWR 2000;49(SS-01):1–62.
13. US Food and Drug Administration. Food Code: Recommendations of the United States Public Health Service, 1995. Springfield, VA: National Technical Information Service (http://vm.cfsan.fda.gov/~dms/fodcode.htm).
14. Tranter HS. Foodborne staphylococcal illness. Lancet 1990; 336:1044–6.
15. Griffin PM, Ostroff SM, Tauxe RV, et al. Illnesses associated with *Escherichia coli* O157:H7 infections: a broad clinical spectrum. Ann Intern Med 1988;109:705–12.
16. St. Louis ME, Morse DL, Potter ME, et al. The emergence of Grade A shell eggs as a major source of *Salmonella enteritidis* infections: new implications for the control of salmonellosis. JAMA 1988;259:2103–7.
17. Holmberg SD, Blake PA. Staphylococcal food poisoning in the United States. JAMA 1984;251:487–9.
18. Daniels NA, Bergmire-Sweat DA, Schwab KJ, et al. A foodborne outbreak of gastroenteritis associated with Norwalk-like viruses: first molecular traceback to deli sandwiches contaminated during preparation. J Infect Dis 2000;181: 1467–70.
19. Manning CK. Food safety knowledge and attitudes of workers from institutional and temporary food service operations. J Am Diet Assoc 1994;94:895–97.
20. US General Accounting Office. School meal programs. GAO/RCED-00-53. February 2000. Washington, DC.
21. US Department of Agriculture. Notice to the trade ground beef suppliers, June 2000. Washington, DC: Agricultural Marketing Service, 2000 (http://www.ams.usda.gov/lsg/cp/beef/beef—whatsnew.htm).
22. Centers for Disease Control and Prevention. Preliminary FoodNet data on the incidence of foodborne illnesses: selected sites, United States, 2001. MMWR 2002;51:325–9.
23. Monk JD, Beuchat LR, Doyle MP. Irradiation inactivation of foodborne microorganisms. J Food Protection 1995;58:197–208.
24. Radonyski T, Murano EA, Olson DG, Murano PS. Elimination of pathogens of significance in food by low-dose irradiation: a review. J Food Protection 1994;57:73–86.
25. Bruhn CM. Consumer attitudes and market response to irradiated food. J Food Protection1995;58:175–81.
26. Tauxe RV. Food safety and irradiation: protecting the public from foodborne infections. Emerg Infect Dis 2001;7(Suppl): 516–21.
27. Thayer DW, Josephson ES, Brynjolfsson A, Giddings GG. Radiation pasteurization of food. Council for Agricultural Science and Technology, April 1996, Issue Paper No. 7.
28. Mussman HC. Potentials of cold pasteurization for the safety of foods of animal origins. J Am Vet Med Assoc 1996;209: 2057–8.
29. Joint FAO/IAEA/WHO Study Group on High-Dose Irradiation. High-dose irradiation: wholesomeness of food irradiated with doses above 10 kGy. WHO technical report series 890. Geneva: WHO, 1999.
30. Diagnosis and management of foodborne illnesses: a primer for physicians. MMWR 2001;50(RR-2):1–69.